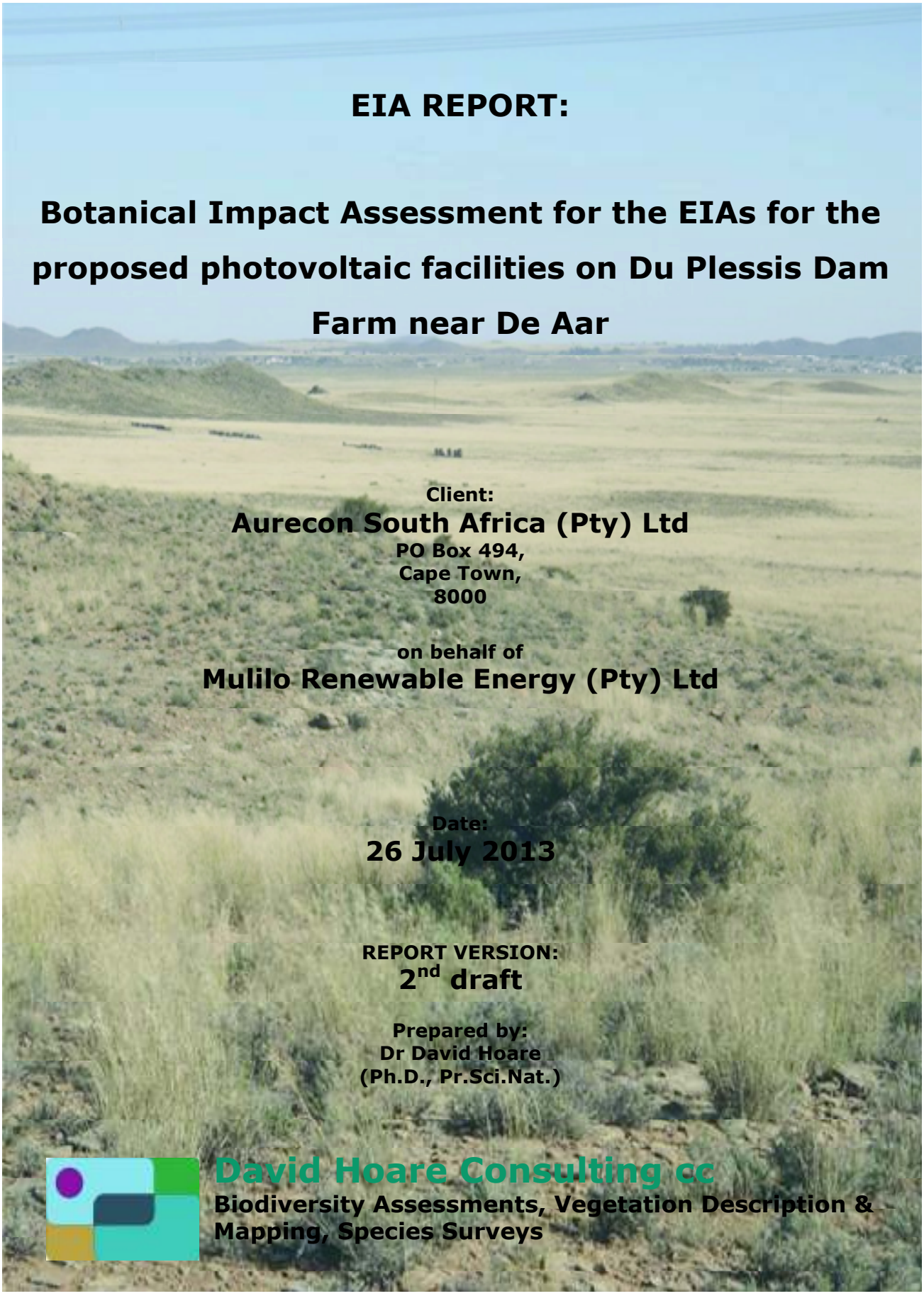

EIA REPORT:

Botanical Impact Assessment for the EIAs for the proposed photovoltaic facilities on Du Plessis Dam Farm near De Aar

Client:

Aurecon South Africa (Pty) Ltd

PO Box 494,
Cape Town,
8000

on behalf of

Mulilo Renewable Energy (Pty) Ltd

Date:

26 July 2013

REPORT VERSION:

2nd draft

Prepared by:
Dr David Hoare
(Ph.D., Pr.Sci.Nat.)

David Hoare Consulting cc
Biodiversity Assessments, Vegetation Description & Mapping, Species Surveys

APPOINTMENT OF SPECIALIST

David Hoare of David Hoare Consulting cc was commissioned by Aurecon South Africa (Pty) Ltd to provide specialist consulting services for the Environmental Impact Assessment for the proposed Botanical Impact Assessment services for the EIAs for the proposed photovoltaic facilities on Badenhorst Dam Farm near De Aar. The consulting services comprise an assessment of potential impacts on the flora and vegetation in the study area by the proposed project.

Details of specialist

Dr David Hoare
David Hoare Consulting cc
Postnet Suite no. 116
Private Bag X025
Lynnwood Ridge, 0040

Telephone: 012 804 2281
Cell: 083 284 5111
Fax: 086 550 2053
Email: dhoare@lantic.net

Summary of expertise

Dr David Hoare:

- Has majors in Botany and Zoology with distinction from Rhodes University, Grahamstown, an Honours Degree (with distinction) in Botany from Rhodes University, an MSc (cum laude) from the Department of Plant Science, University of Pretoria, and a PhD in Botany from the Nelson Mandela Metropolitan University, Port Elizabeth with a focus on species diversity.
- Registered professional member of The South African Council for Natural Scientific Professions (Ecological Science, Botanical Science), registration number 400221/05.
- Founded David Hoare Consulting cc, an independent consultancy, in 2001.
- Ecological consultant since 1995, with working experience in Gauteng, Mpumalanga, Limpopo, North West, Eastern Cape, Western Cape, Northern Cape and Free State Provinces, Tanzania, Kenya, Mozambique and Swaziland.
- Conducted, or co-conducted, over 330 specialist ecological surveys as an ecological consultant. Areas of specialization include general ecology, biodiversity assessments, vegetation description and mapping, plant species surveys and remote sensing of vegetation. Has undertaken work in grassland, thicket, forest, savannah, fynbos, coastal vegetation, wetlands and nama-karoo vegetation, but has a specific specialization in grasslands and wetland vegetation.
- Published six technical scientific reports, 15 scientific conference presentations, seven book chapters and eight refereed scientific papers.
- Attended 15 national and international congresses & 5 expert workshops, lectured vegetation science / ecology at 2 universities and referee for 2 international journals.

Independence

David Hoare Consulting cc and its Directors have no connection with Mulilo Renewable Energy (Pty) Ltd. David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project

and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. David Hoare is an independent consultant to Aurecon South Africa (Pty) Ltd and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he 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 this specialist performing such work.

Conditions relating to this report

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. David Hoare Consulting cc and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from on-going research or further work in this field, or pertaining to this investigation.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

TABLE OF CONTENTS

INTRODUCTION

Terms of reference and approach

On 14 March 2013 David Hoare Consulting cc was appointed by Aurecon South Africa (Pty) Ltd to undertake a botanical assessment of the study area. The intention is to compile one EIA report per farm. The EIA report was to include the assessment of the projects individually and cumulatively per farm. The specific terms of reference for the EIA study are as follows:

DESKTOP STUDY:

A description and characterisation of the broad study area is to be undertaken. A description of the receiving environment must be provided and any major sensitivities within the study area in the form of a desktop study, as follows:

1. Description of the broad vegetation types and/or habitats for the area, including any areas of potential conservation value. This is to be based on published sources, including the vegetation map of South Africa (Mucina et al. 2006), the National Spatial Biodiversity Assessment and any Biodiversity Conservation Plans that exist for the Province.
2. The national conservation status of major vegetation types in which the study sites are located is to be provided, as listed in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004).
3. Investigation into the Red Data (threatened and endangered) flora species within the Province and more specifically the project study area, including information on habitats in which they are most likely to be encountered.
4. The potential presence/absence of Red Data species is to be assessed by means of assessments of the presence, status and linkage of available habitat in the study area. These attributes are to be rated for each Red Data species that has a geographical distribution including the sites using the available literature and personal field experience. Three parameters are to be used to assess the probability of occurrence for each species:
    a. *Habitat requirements*: most Red Data species have very specific habitat requirements and the presence of these habitat characteristics within the study area will be assessed;
    b. *Habitat status*: in the event that available habitat is considered suitable for these species, the status or ecological condition is assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water-quality plays a major role); and
    c. *Habitat linkage*: for animals, movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to these surrounding habitats and adequacy of these linkages are assessed for the ecological functioning Red Data species within the study area.
5. Investigation into the potential presence of trees protected according to the National Forests Act (Act 84, 1998) and fauna and flora protected under the National Environmental Management: Biodiversity Act (Act No. 10, 2004).
6. An assessment of the general status of vegetation on site in order to provide a description of which areas contain natural habitat versus those that are transformed and/or degraded.
7. Potential impacts on biodiversity, sensitive habitats and ecosystem function are to be listed and described. These are to be compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of such development on the ecological environment.

These descriptive components are to be incorporated into a single Sensitivity Analysis for the site. An indication of major sensitivities is to be provided, including a description of sensitive features that could potentially occur as well as a map of the potential location of these features.

FIELD DATA COLLECTION

The study area is to be visited and assessed to confirm patterns identified from the desktop assessment. Specific features of potential concern are to be investigated in the field, including the following:

- General vegetation status;
- Presence of habitats of conservation concern;
- Presence of protected trees;
- Potential presence of species of concern.

ASSESSMENT OF IMPACTS:

Impacts identified are to be assessed according to standard criteria (nature, extent, duration, magnitude, probability, significance, status as well as the degree to which impacts can be reversed, the degree to which impacts will cause irreplaceable loss of resources and the degree to which impacts can be mitigated).

This report provides details of the results of the EIA specialist study. The findings of the study are based on a combination of a desktop assessment of the study area, interpretation of aerial photography and fieldwork undertaken on site.

METHODOLOGY

The assessment is to be undertaken in a single phase, an Environmental Impact Assessment phase. This report contains descriptive information on flora and fauna for the study area as well as an assessment of potential impacts.

Assessment philosophy

Many parts of South Africa contain high levels of biodiversity at species and ecosystem level. At any single site there may be large numbers of species or high ecological complexity. Sites also vary in their natural character and uniqueness and the level to which they have been previously disturbed. Assessing the potential impacts of a proposed development often requires evaluating the conservation value of a site relative to other natural areas and relative to the national importance of the site in terms of biodiversity conservation. A simple approach to evaluating the relative importance of a site includes assessing the following:

- Is the site unique in terms of natural or biodiversity features?
- Is the protection of biodiversity features on the site of national/provincial importance?
- Would development of the site lead to contravention of any international, national or provincial legislation, policy, convention or regulation?

Thus, the general approach adopted for this type of study is to identify any critical biodiversity issues that may lead to the decision that the proposed project cannot take place, i.e. to specifically focus on red flags and/or potential fatal flaws. Biodiversity issues are assessed by documenting whether any important biodiversity features occur on site, including species, ecosystems or processes that maintain ecosystems and/or species. These can be organised in a hierarchical fashion, as follows:

Species

1. threatened plant species

2. protected trees

Ecosystems
1. threatened ecosystems
2. protected ecosystems
3. critical biodiversity areas
4. areas of high biodiversity
5. centres of endemism

Processes
1. corridors
2. mega-conservancy networks
3. rivers and wetlands
4. important topographical features

It is not the intention to provide comprehensive lists of all species that occur on site, since most of the species on these lists are usually common or widespread species. Rare, threatened, protected and conservation-worthy species and habitats are considered to be the highest priority, the presence of which are most likely to result in significant negative impacts on the ecological environment. The focus on national and provincial priorities and critical biodiversity issues is in line with National legislation protecting environmental and biodiversity resources, including, but not limited to the following which ensure protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment:
1. Environment Conservation Act (Act 73 of 1989)
2. National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998)
3. National Environmental Management Biodiversity Act, 2004 (Act 10 0f 2004).

Plant species of conservation concern

There are two types of species of concern for the site under investigation, (i) those listed by conservation authorities as being on a Red List and are therefore considered to be at risk of extinction, and (ii) those listed as protected according to National and/or Provincial legislation.

Red List plant species
Determining the conservation status of a species is required in order to identify those species that are at greatest risk of extinction and, therefore, in most need of conservation action. South Africa has adopted the IUCN Red List Categories and Criteria to provide an objective, rigorous, scientifically founded system to identify Red List species. A published list of the Red List species of South African plants (Raimondo *et al.* 2009) contains a list of all species that are considered to be at risk of extinction. This list is updated regularly to take new information into account, but these are not published in book/paper format. Updated assessments are provided on the SANBI website (http://redlist.sanbi.org/). According to the website of the Red List of Southern African Plants (http://redlist.sanbi.org/), *the conservation status of plants indicated on the Red List of South African Plants Online represents the status of the species within South Africa's borders. This means that when a species is not endemic to South Africa, only the portion of the species population occurring within South Africa has been assessed. The global conservation status, which is a result of the assessment of the entire global range of a species, can be found on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species: http://www.iucnredlist.org*. The South African assessment is used in this study.

The purpose of listing Red List plant species is to provide information on the potential occurrence of species at risk of extinction in the study area that may be affected by the proposed infrastructure. Species appearing on these lists can then be assessed in terms of their habitat requirements in order to determine whether any of them have a likelihood of occurring in habitats that may be affected by the proposed infrastructure.

Lists were compiled specifically for any species at risk of extinction (Red List species) previously recorded in the area. Historical occurrences of threatened plant species were obtained from the South African National Biodiversity Institute (http://posa.sanbi.org) for the quarter degree square/s within which the study area is situated. Habitat information for each species was obtained from various published sources. The probability of finding any of these species was then assessed by comparing the habitat requirements with those habitats that were found, during the field survey of the site, to occur there.

Protected trees

Regulations published for the National Forests Act (Act 84 of 1998) as amended, provide a list of protected tree species for South Africa. The species on this list were assessed in order to determine which protected tree species have a geographical distribution that coincides with the study area and habitat requirements that may be met by available habitat in the study area. The distribution of species on this list was obtained from published sources (e.g. van Wyk & van Wyk 1997) and from the SANBI Biodiversity Information System website (http://sibis.sanbi.org/) for quarter degree grids in which species have been previously recorded. Species that have been recorded anywhere in proximity to the site (within 100 km), or where it is considered possible that they could occur there, were listed and were considered as being at risk of occurring there. The site was searched for these species during the field survey and any individuals or concentrations noted.

Other protected plant species

National legislation was evaluated in order to provide lists of any plant or animal species that have protected status. The most important legislation is the following:

- *National Environmental Management: Biodiversity Act (Act No 10 of 2004)*

This legislation contains lists of species that are protected. These lists were scanned in order to identify any species that have a geographical range that includes the study area and habitat requirements that are met by those found on site. These species were searched for within suitable habitats on site or, where relevant, it was stated that it was considered possible that they could occur on site.

There is additional legislation that provides lists of protected species, but the legislation to which these are attached deal primarily with harvesting or trade in listed species and do not seem to specifically address transformational threates to habitat or individuals. This includes the following legislation:

- *Northern Cape Nature Conservation Act (Act No 9 of 2009)*
- *CITES: Convention on the Trade in Endangered Species of Wild Fauna and Flora*.

Species probability of occurrence

Some species of plants may be cryptic, difficult to find, rare, ephemeral or generally not easy to spot while undertaking a survey of a large area. An assessment of the possibility of these species occurring on the site was therefore provided. For all threatened or protected flora that occur in the general geographical area of the site, a rating of the likelihood of it occurring on site is given as follows:

- LOW: no suitable habitats occur on site / habitats on site do not match habitat description for species;

- MEDIUM: habitats on site match general habitat description for species (e.g. karoo shrubland), but detailed microhabitat requirements (e.g. mountain shrubland on shallow soils overlying sandstone) are absent on the site or are unknown from the descriptions given in the literature or from the authorities;
- HIGH: habitats found on site match very strongly the general and microhabitat description for the species (e.g. mountain shrubland on shallow soils overlying sandstone);
- DEFINITE: species found in habitats on site.

Habitat sensitivity

The purpose of producing a habitat sensitivity map is to provide information on the location of potentially sensitive features in the study area. This was compiled by taking the following into consideration:

1. The general status of the vegetation of the study area was derived by compiling a landcover data layer for the study area (*sensu* Fairbanks et al. 2000) using available satellite imagery and aerial photography. From this it can be seen which areas are transformed versus those that are still in a natural status.
2. Various provincial, regional or national level conservation planning studies have been undertaken in the area, e.g. the National Spatial Biodiversity Assessment (NSBA). The mapped results from these were taken into consideration in compiling the habitat sensitivity map.
3. Habitats in which various species of plants or animals occur that may be protected or are considered to have high conservation status are considered to be sensitive.

An explanation of the different sensitivity classes is given in Table 1. Areas containing untransformed natural vegetation of conservation concern, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered potentially sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to potentially have low sensitivity.

Table 1: Explanation of sensitivity ratings.

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
VERY HIGH	Indigenous natural areas that are highly positive for any of the following: • presence of threatened species (Critically Endangered, Endangered, Vulnerable) and/or habitat critical for the survival of populations of threatened species. • High conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk). • Protected habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act) And may also be positive for the following: • High intrinsic biodiversity value (high species richness and/or turnover, unique ecosystems)	• CBA 1 areas. • Remaining areas of vegetation type listed in Draft Ecosystem List of NEM:BA as Critically Endangered, Endangered or Vulnerable. • Protected forest patches. • Confirmed presence of populations of threatened species.

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
	• High value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value) • Low ability to respond to disturbance (low resilience, dominant species very old).	
HIGH	Indigenous natural areas that are positive for any of the following: • High intrinsic biodiversity value (moderate/high species richness and/or turnover). • presence of habitat highly suitable for threatened species (Critically Endangered, Endangered, Vulnerable species). • Moderate ability to respond to disturbance (moderate resilience, dominant species of intermediate age). • Moderate conservation status (moderate proportion remaining intact, moderately fragmented, habitat for species that are at risk). • Moderate to high value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value). And may also be positive for the following: • Protected habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)	• CBA 2 "critical biodiversity areas". • Habitat where a threatened species could potentially occur (habitat is suitable, but no confirmed records). • Confirmed habitat for species of lower threat status (near threatened, rare). • Habitat containing individuals of extreme age. • Habitat with low ability to recover from disturbance. • Habitat with exceptionally high diversity (richness or turnover). • Habitat with unique species composition and narrow distribution. • Ecosystem providing high value ecosystem goods and services.
MEDIUM-HIGH	Indigenous natural areas that are positive for one or two of the factors listed above, but not a combination of factors.	• CBA 2 "corridor areas". • Habitat with high diversity (richness or turnover). • Habitat where a species of lower threat status (e.g. (near threatened, rare) could potentially occur (habitat is suitable, but no confirmed records).
MEDIUM	Other indigenous natural areas in which factors listed above are of no particular concern. May also include natural buffers around ecologically	

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
	sensitive areas and natural links or corridors in which natural habitat is still ecologically functional.	
MEDIUM-LOW	Degraded or disturbed indigenous natural vegetation.	
LOW	No natural habitat remaining.	

Any natural vegetation within which there are features of conservation concern will be classified into one of the high sensitivity classes (MEDIUM-HIGH, HIGH or VERY HIGH). The difference between these three high classes is based on a combination of factors and can be summarised as follows:

1. Areas classified into the VERY HIGH class are vital for the survival of species or ecosystems. They are either known sites for threatened species or are ecosystems that have been identified as being remaining areas of vegetation of critical conservation importance. CBA1 areas would qualify for inclusion into this class.
2. Areas classified into the HIGH class are of high biodiversity value, but do not necessarily contain features that would put them into the VERY HIGH class. For example, a site that is known to contain a population of a threatened species would be in the VERY HIGH class, but a site where a threatened species could potentially occur (habitat is suitable), but it is not known whether it does occur there or not, is classified into the HIGH sensitivity class. The class also includes any areas that are not specifically identified as having high conservation status, but have high local species richness, unique species composition, low resilience or provide very important ecosystem goods and services. CBA2 "irreplaceable biodiversity areas" would qualify for inclusion into this class, if there were no other factors that would put them into the highest class.
3. Areas classified into the MEDIUM-HIGH sensitivity class are natural vegetation in which there are one or two features that make them of biodiversity value, but not to the extent that they would be classified into one of the other two higher categories. CBA2 "corridor areas" would qualify for inclusion into this class.

Assessment of impacts

For each impact, the EXTENT (spatial scale), MAGNITUDE and DURATION (time scale) were described (see Table 2 for a description of these criteria and ratings). These criteria were used to ascertain the SIGNIFICANCE of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place.

The tables on the following pages show the scale used to assess these variables, and defines each of the rating categories.

Table 2: Assessment criteria for the evaluation of impacts

Criteria	Category	Description
Extent or spatial influence of impact	Regional	Beyond a 10 km radius of the site
	Local	Within a 10 km radius of the site.
	Site-specific	On site or within 100 m of the site.
Magnitude of impact (at the indicated spatial scale)	High	Natural functions and/or processes are *severely* altered
	Medium	Natural functions and/or processes are *notably* altered
	Low	Natural functions and/or processes are *slightly* altered
	Very low	Natural functions and/or processes are *negligibly* altered
	Zero	Natural functions and/or processes remain *unaltered*

Duration of impact	Construction period	Up to four years if PV facilities are constructed consecutively
	Short term	Up to 5 years after construction
	Medium term	5-15 years after construction
	Long term	More than 15 years after construction

The SIGNIFICANCE of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained in Table 3.

Table 3: Definition of significance ratings.

Significance rating	Level
HIGH	High magnitude with a regional extent and long term duration
	High magnitude with either a regional extent and medium term duration or a local extent and long term duration
	Medium magnitude with a regional extent and long term duration
	High magnitude with a local extent and medium term duration
MEDIUM	High magnitude with a regional extent and construction period or a site specific extent and long term duration
	High magnitude with either a local extent and construction period duration or a site specific extent and medium term duration
	Medium magnitude with any combination of extent and duration except site specific and construction period or regional and long term
	Low magnitude with a regional extent and long term duration
LOW	High magnitude with a site specific extent and construction period duration
	Medium magnitude with a site specific extent and construction period duration
	Low magnitude with any combination of extent and duration except site specific and construction period or regional and long term
	Very low magnitude with a regional extent and long term duration
VERY LOW	Low magnitude with a site specific extent and construction period duration
	Very low magnitude with any combination of extent and duration except regional and long term
NEUTRAL	Zero magnitude with any combination of extent and duration

Once the significance of an impact had been determined, the PROBABILITY of this impact occurring as well as the CONFIDENCE in the assessment of the impact were determined using the rating systems outlined in Table 4 and Table 5 respectively. Lastly, the REVERSIBILITY of the impact is estimated using the rating system outlined in Table 6.

Table 4: Definition of probability ratings.

Probability rating	**Criteria**
Definite	Estimated greater than 95 % chance of the impact occurring
Probable	Estimated 5 to 95 % chance of the impact occurring
Unlikely	Estimated less than 5 % chance of the impact occurring

Table 5: Definition of confidence ratings.

Confidence rating	**Criteria**
Certain	Wealth of information on and sound understanding of the environmental

	factors potentially influencing the impact
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact

Table 6: Definition of reversibility ratings

Reversibility	Criteria
Irreversible	The activity will lead to an impact that is in all practical terms permanent.
Reversible	The impact is reversible within 2 years after the cause or stress is removed.

Limitations

- Red List species are, by their nature, usually very rare and difficult to locate. Compiling the list of species that could potentially occur in an area is limited by the paucity of collection records that make it difficult to predict whether a species may occur in an area or not. The methodology used in this assessment is designed to reduce the risks of omitting any species, but it is always possible that a species that does not occur on a list may be unexpectedly located in an area.

PROJECT DESCRIPTION AND ALTERNATIVES

During the Scoping Phase, various alternatives were screened to derive a list of feasible alternatives that need to be assessed in further detail in the EIA Phase. Subsequently, the following types of alternatives are the most pertinent to the proposed project:

- Layout alternative dependent on the scale and magnitude alternative;
- Technology alternative;
- Transmission line routing alternative; and
- Scale and magnitude alternative.

The alternative types pertinent to this project are described in the subsequent sections.

Location alternative

It is proposed that three PV facilities be constructed at Du Plessis Dam farm. A previous EIA, similar to this study, was undertaken at the same location (Aurecon, 2012). After completion of the EIA (DEA Reference Number: 12/12/20/2498), the Department of Environmental Affairs (DEA) authorised a PV facility with 20MW capacity (Environmental Authorisation (EA) dated 28 September 2012). The approved PV facility will herein after be referred to as Du Plessis PV1. Therefore, information is readily available (Hoare 2012) and environmental sensitive areas have been identified. These sensitive areas were taken into consideration in the preliminary designs. It therefore makes sense to further develop a site which is already well studied, suitable for the proposed development, located close to existing and proposed Eskom infrastructure, and where no fatal flaws have been identified.

It is also more economically feasible to group developments to promote infrastructure sharing. As mentioned in Section 1.2, Mulilo already received an EA for one PV facility on this farm (referred to as PV1) which is further motivation for this location alternative as it could result in the following benefits:

- Sharing of supply infrastructure including water, sewage and electricity;
- Reducing the impact on the environment due to combining infrastructure and footprints;
- Utilizing a single laydown area and construction camp minimizing traffic and associated impacts with multiple camps;
- Allowing phased approach to construction activities thereby extending the construction period for employment and creating more long term employment jobs;
- Reducing the need for multiple electricity grid connection points and transmission lines;
- Motivation for the creation of an industrial zone within De Aar whereby specialised services and manufacturing processes are able to develop in response to consistent demand; and
- Improved accuracy in terms of assessing cumulative impacts during the EIA phase.

The selection of this preferred and only location alternative was furthermore based on the following characteristics of the site:

- Solar resource potential based on historic satellite data;
- Grid connectivity and close proximity to strong grid access;
- Flat, level, and open land;
- Little environmentally and socially sensitive areas; and
- Non-arable or low arable potential of the land.

Based on the above motivation, it was proposed to only assess one location alternative namely Du Plessis Dam Farm, De Aar. The location of the proposed PV facilities on Du Plessis Dam Farm is shown in Figure 1.

Layout alternatives (dependent on the scale and magnitude alternatives)

Layout alternative 1

The Department of Energy (DoE) introduced a capacity limit of 75MW for solar facilities. The capacity (MW) of the facilities therefore determines the layout of the facilities. This layout consists of the three proposed 75MW PV facilities and associated infrastructure as indicated in Figure 1 referred to as PV2, PV3 and PV4. These layouts take cognisance of the 75MW DoE cap and the environmentally sensitive areas as identified by Aurecon (2012). Table includes details of the proposed layouts.

Layout alternative 2

This alternative consists of one 400MW PV facility, covering 1000 ha. The layout for this alternative was developed by extending and combining the proposed 75MW facilities. This alternative is thus not limited to the DOE's 75MW cap per project. By increasing the capacity it has the benefit of utilising industries at scale thereby reducing associated development and construction costs which reduces lending rates and essentially lower the tariff of electricity sold (Aurecon, 2013).

Table 7: Footprints, capacities and coordinates of the three alternative layouts

Facility	Footprint	Capacity	Coordinates of middle point
PV2	169ha	75MW	30°38'11.38"S; 24° 4'22.75"E

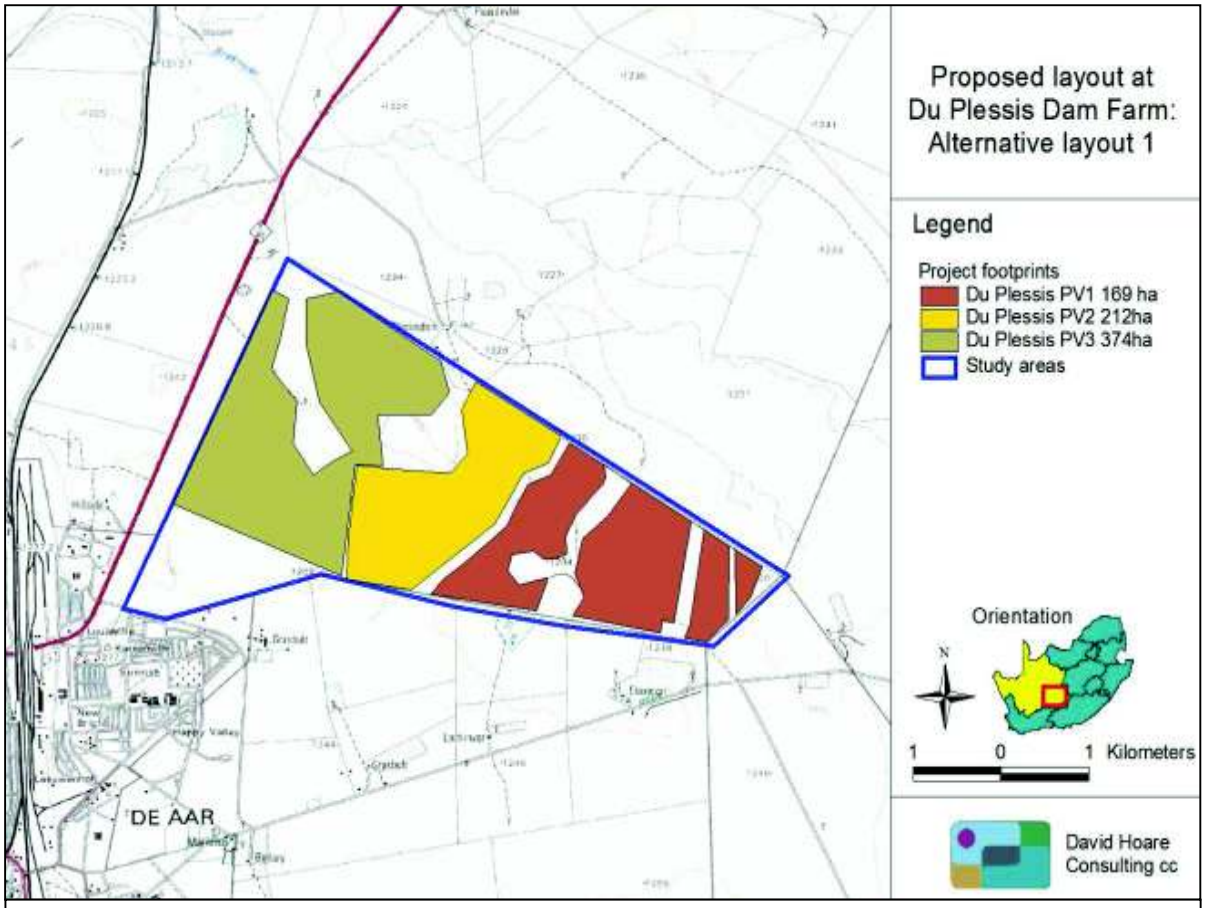

Figure 1: Location of the proposed pv Solar facilities.

PV3	212ha	75MW	30°37'53.03"S; 24° 3'28.26"E
PV4	374ha	75MW	30°37'27.44"S; 24° 2'31.14"E

Layout of additional infrastructure

It is proposed that one layout for the proposed roads and water pipeline be assessed. The layouts provided took the environmentally sensitive areas into consideration and follows the shortest viable route as shown in Figure 2.

Technology alternative

A number of sites are proposed for wind energy facilities in the surrounding area which indicates that the proposed site could also be suitable for wind power. However, the selection of the Badenhorst Dam farm was based on the requirements for solar energy. Therefore, all of the technology alternatives considered revolves around the Solar PV technologies.

Solar panel alternatives

Three solar panel types were considered for the proposed plants: concentrated photovoltaic (CPV), concentrated solar power (CSP) and conventional PV solar cells. Information gathered through previous EIAs (Aurecon, 2012), as well as the recent technology advances informed this investigation.

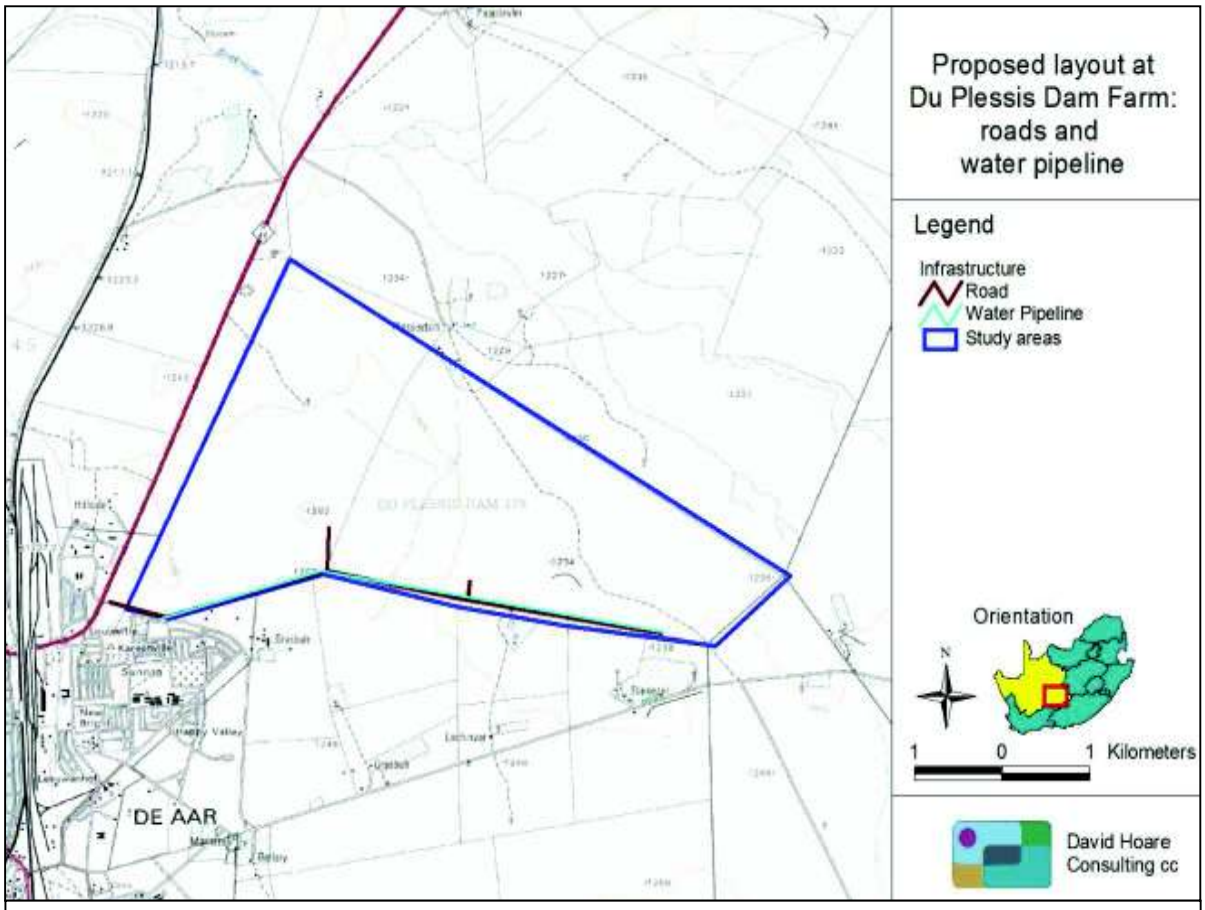

Figure 2: Location of proposed road and water pipeline.

The conventional PV and CPV technologies require less water (19L/MWh of water per day) than the CSP system which needs approximately 3,420L/MWh of water per day during the operational period. Therefore, due to the scarcity of water in this area, and the large volume of water required for the CSP system, only conventional PV and CPV technologies will be considered for the proposed solar facilities.

Mounting Alternatives

In terms of the mounting alternatives, single axis tracking systems will be considered along with fixed axis tracking systems. This decision will be made by the proponent closer to detail design phase after taking into consideration the economic viability, water requirements, land requirements, efficiency and potential environmental impacts of the proposed solar panel types.

In a fixed axis tracking system the PV panels are installed at a set tilt and cannot move, whereas in a single axis tracking system the panels follow the sun to ensure maximum exposure to sunlight.

The photovoltaic single axis tracking technology has the following benefits:

- The panels are the highest efficiency panels with the highest efficiency inverter, maximizing the system output. The installation costs are less as fewer panels are required.
- The panel's anti-reflective glass and exceptional low-light performance characteristics enhances energy delivery; and

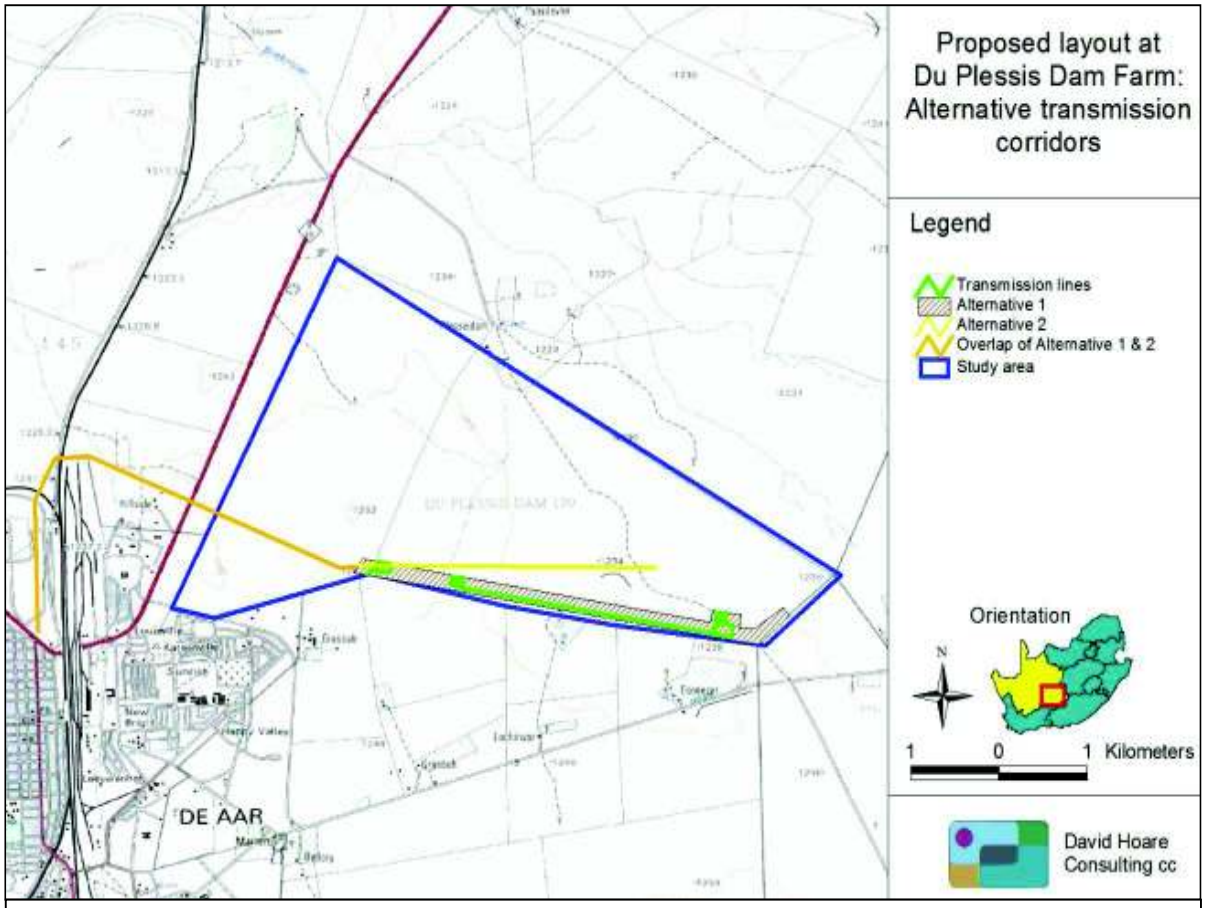

Figure 3: Location of proposed transmission lines and substations.

- By minimising shading and grouping trackers closer together, this highly efficient technology produces the most energy per hectare of any tracking system. It requires up to 20% less land than conventional crystalline fixed tilt systems and up to 60% less than thin film technology.

These highly efficient panels not only require less land, but also less concrete, steel and cabling per MW.

Transmission line routing and substations alternative

It is envisaged that each PV facility would require an onsite substation specific to each PV facility i.e. three onsite substations. These substations would feed into one central onsite substation by means of onsite overhead 132kV transmission lines (shown in green in Figure 3).

Based on the uncertainties regarding the capacity of Eskom's substations and transmission lines, it is proposed to assess a transmission line corridor instead of assessing the preliminary layouts which could be subject to changes. The width of the proposed transmission corridor ranges from 150m to 350m. The proposed transmission corridor is shown in Figure 3. As an alternative, a transmission line slightly north of this corridor is also a possibility.

No-Go alternative

The "no-go" option is taken to be the existing rights on the property, including the approved PV facility, and this includes all the duty of care and other legal responsibilities that apply to the owner of the property.

DESCRIPTION OF STUDY AREA

Topography

The study sites are located on plains and the topography of the sites is therefore relatively gentle. There is a low, narrow ridge that cuts diagonally through the centre of the site. There is also a range of low hills on the eastern side of the site. The remainder of the site is gently sloping. The elevation on site varies from 1233 to 1261 m above sea level.

Land types and soils

Detailed soil information is not available for broad areas of the country. As a surrogate, landtype data was used to provide a general description of soils in the study area (landtypes are areas with largely uniform soils, topography and climate). There is one land type in the study area, namely the Ae land type (Land Type Survey Staff, 1987). The Ae land type covers the entire site.

The A-group of land types refer to yellow and red soils without water tables belonging to one or more of the following soil forms: Inanda, Kranskop, Magwa, Hutton, Griffin, Clovelly. The Ae landtype consists of red, high base status, > 300 mm deep soils and no dunes (MacVicar et al. 1974).

Climate

The climate is arid to semi-arid. Rainfall occurs from November to March, but peaks in mid- to late summer (February / March). Mean annual rainfall is approximately 200 mm per year. All

areas with less than 400 mm rainfall are considered to be arid. The study area can therefore be considered to be arid.

Broad vegetation types of the region

The study area falls within the Nama-Karoo Biome (Rutherford & Westfall 1986, Mucina & Rutherford 2006). The most recent and detailed description of the vegetation of this region is part of a national map (Mucina, Rutherford & Powrie, 2005; Mucina *et al*. 2006). This map shows one vegetation type occurring within or close to the study sites, namely Northern Upper Karoo. No other vegetation type occurs anywhere near to the site. The Northern Upper Karoo vegetation type is described in more detail below.

Northern Upper Karoo
This vegetation type occurs in the northern parts of the Upper Karoo Plateau, with its southern extent ending near De Aar. It is a shrubland dominated by dwarf karoo shrubs, grasses and some low trees, including *Acacia mellifera* subsp. *detinens* (Mucina et al. 2006). There are five known endemics in this vegetation (Mucina *et al*. 2006), namely the succulent shrubs, *Lithops hookeri* and *Stomatium pluridens*, the low shrubs, *Atriplex spongiosa* and *Galenia exigua* and the herb, *Manulea deserticola*. At a national scale this vegetation type has been transformed only a small amount (approximately 4%) and none is conserved; it is considered to be a Least Threatened vegetation type (Mucina *et al*. 2006).

Conservation status of broad vegetation types

On the basis of a recently established approach used at national level by SANBI (Driver *et al*. 2005), vegetation types can be categorised according to their conservation status which is, in turn, assessed according to the degree of transformation relative to the expected extent of each vegetation type. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. The original extent of a vegetation type is as presented in the most recent national vegetation map (Mucina, Rutherford & Powrie 2005) and is the extent of the vegetation type in the absence of any historical human impact. On a national scale the thresholds are as depicted in Table 8, as determined by best available scientific approaches (Driver *et al*. 2005).

The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% of the ecosystem still remaining in a natural state (Driver et al. 2005). The vegetation types occurring in the study area (Table 8) are classified as Least Threatened (Driver *et al*. 2005; Mucina *et al*., 2006).

Table 8: Determining ecosystem status (from Driver et al. 2005). *BT = biodiversity target (the minimum conservation requirement).

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

The National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists national vegetation types that are afforded protection on the basis of rates of

transformation. The thresholds for listing in this legislation are higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature. The vegetation types occurring on site are not listed in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011).

Table 9: Conservation status the vegetation types occurring in the study area, according to Driver *et al*. 2005 and Mucina *et al*. 2005.

Vegetation Type	Target (%)	Conserved (%)	Transformed (%)	Conservation status	
				Driver *et al*. 2005; Mucina *et al*., 2006	Draft Ecosystem List (NEMBA)
Northern Upper Karoo	21	0	4	Least Threatened	Not listed

Critical Biodiversity Areas have been identified for all municipal areas of the Northern Cape Province and are published on the SANBI website (bgis.sanbi.org). These maps identify no areas of concern in the current study area. This is consistent with patterns identified from other sources within the current scoping document.

Landuse and landcover of the study area

A landcover map of the study area (Fairbanks *et al*. 2000) indicates that the site consists primarily of natural vegetation, classified as "shrubland and low fynbos". This is confirmed from 1:50 000 topo-cadastral maps (see Figure 1), Google imagery of the sites and the site visits.

The farm is used as grazing for domestic and wild livestock. It is probable that it has been used for cattle, sheep and/or goats at some stage in the past.

The vegetation on site is dominated by grasses, with a significant number of karoo shrubs of low stature amongst the grasses. A general view of the site from the western side is shown in Figure 4.

The vegetation on site is in moderate condition. There were no trees on site.

Red List plant species of the study area

Lists of plant species of conservation concern previously recorded in the quarter degree grids in which the study area is situated were obtained from the South African National Biodiversity Institute (SANBI). These are listed in Appendix 1. Additional species that could occur in similar habitats, as determined from database searches and literature sources, but have not been recorded in these grids are also listed.

There is one species incorrectly listed on this list, *Protea subvestita*, which is listed as Vulnerable. This species occurs along the southern and eastern Great Escarpment of the country in montane habitats, particularly highland grassland and fynbos. The record from the adjacent grid is an incorrect database record and this species does not occur anywhere near to the site. There are, therefore, no threatened, near threatened, declining or rare plant species that could occur on site.

Protected plants (National Environmental Management: Biodiversity Act)

Plant species protected under NEM:BA are listed in Appendix 4. One plant species that appears on this list that could potentially occur in the region, although it has not previously been recorded in the grid, is *Hoodia gordonii*. This species is currently listed in Appendix II to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which includes species not currently considered endangered but are at risk if trade is not

Figure 4: View of the vegetation of the site.

controlled. *Hoodia gordonii* has a wide tolerance of growing habitats and is found in deep Kalahari sands, on dry stony slopes or flats and under the protection of xerophytic bushes. Suitable conditions do occur on site and it is considered possible that this species could occur on site. However, it was not found during the field survey.

Another protected species that could potentially occur in the region, although it has not previously been recorded in the grid, is *Harpagophytum procumbens* (devil's claw). This species is associated mainly with dry sandveld on deep Kalahari sand. It usually occupies plains, dune bases and interdunes. Soils are usually sandy but can be rocky. They are generally nutrient poor, often with lime. The soil conditions expected on site do not co-incide with the habitat requirements for this species and it is not considered likely that it occurs on site. It was not found during the field survey.

Protected trees

Tree species protected under the National Forest Act are listed in Appendix 2. The only one that has a geographical distribution that includes the study area is *Boscia albitrunca* (Shepherd's Tree / Witgatboom / !Xhi). *Boscia albitrunca* occurs in semi-desert areas and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils. This species is usually quite common where it is found, but was not recorded on site.

The tree, *Acacia haematoxylon*, has been previously recorded within 100 km of the site to the north (near Hopetown). The potential presence of this species is, therefore, also assessed for this site. *Acacia haematoxylon* occurs on deep Kalahari sand between dunes or along dry watercourses. Collection records for this species obtained from the SANBI website (http://sibis.sanbi.org/) indicate that this species does not occur anywhere near to the site. No individuals were observed on site or in the surrounding areas during this and other field assessments.

Sensitivity assessment

The sensitivity assessment identifies those parts of the study area that have high conservation value or that may be sensitive to disturbance. Areas of sensitivity are shown in Figure 5. There are features that need to be taken into account in order to evaluate sensitivity in the study area. These include the following:

1. Non-perennial streams and drainage lines: this represents a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal. Wetlands are protected according to the National Water Act and the NEMA.

These factors have been taken into account in evaluating sensitivity within the study area (Figure 5). The sensitivity classification is as follows:

1. MEDIUM-HIGH: All of the drainage lines on site are classified as having medium-high sensitivity (see Figure 5). They are protected according to the National Water Act (Act 36 of 1998). Ecologically, they are areas that provide moderate value ecosystem goods and services.
2. MEDIUM: The majority of the study area is classified as having medium sensitivity (see Figure 5). These are areas of natural vegetation which harbour no particular features of conservation concern.

LEGISLATIVE AND PERMIT REQUIREMENTS

Relevant legislation is provided in this section to provide a description of the key legal considerations of biodiversity importance to the proposed project. The applicable legislation is listed below.

Legislation

National Environmental Management Act, Act No. 107 of 1998 (NEMA)

NEMA requires, inter alia, that:

- "development must be socially, environmentally, and economically sustainable",
- "disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied." ,
- "a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions",

NEMA states that "the environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage."

Environment Conservation Act No 73 of 1989 Amendment Notice No R1183 of 1997

The ECA states that:

Development must be environmentally, socially and economically sustainable. Sustainable development requires the consideration of inter alia the following factors:

- that pollution and degradation of the environment is avoided, or, where they cannot be altogether avoided, are minimised and remedied;

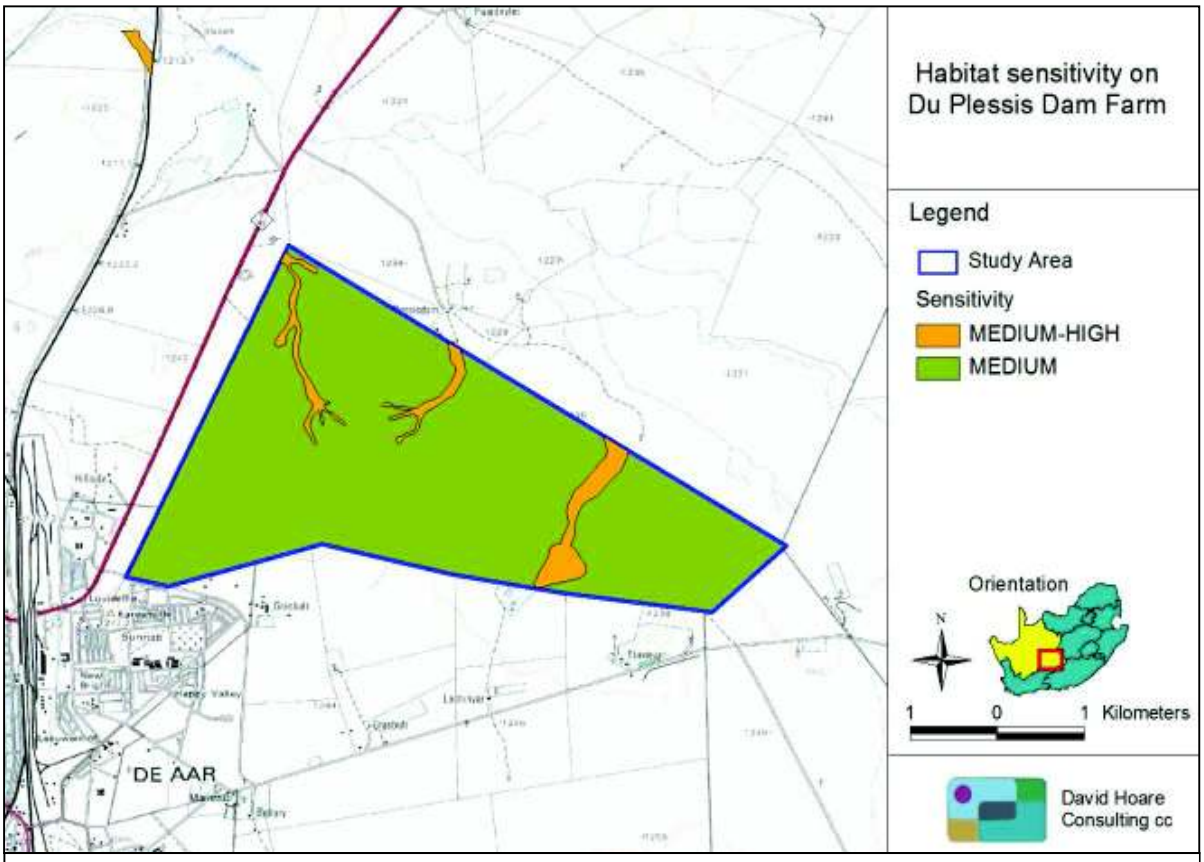

Figure 5: Watercourses and drainage areas of the study area.

- that the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;
- that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised; and
- that negative impacts on the environment and on peoples' environmental rights be anticipated and prevented, and where they cannot be altogether prevented are minimised and remedied.

The developer is required to undertake Environmental Impact Assessments (EIA) for all projects listed as a Schedule 1 activity in the EIA regulations in order to control activities which might have a detrimental effect on the environment. Such activities will only be permitted with written authorisation from a competent authority.

National Forests Act (Act no 84 of 1998)

Protected trees

According to this act, the Minister may declare a tree, group of trees, woodland or a species of trees as protected. The prohibitions provide that 'no person may cut, damage, disturb, destroy or remove any *protected tree*, or collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a licence granted by the Minister'.

Forests

Prohibits the destruction of indigenous trees in any natural forest without a licence.

National Environmental Management: Biodiversity Act (Act No 10 of 2004)

In terms of the Biodiversity Act, the developer has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not just by listed activity as specified in the EIA regulations).
- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all development within the area are in line with ecological sustainable development and protection of biodiversity.
- Limit further loss of biodiversity and conserve endangered ecosystems.

Chapter 4 of the Act relates to threatened or protected ecosystems or species. According to Section 57 of the Act, "Restricted activities involving listed threatened or protected species":

- (1) A person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit issued in terms of Chapter 7.

Such activities include any that are "of a nature that may negatively impact on the survival of a listed threatened or protected species".

Chapter 5 of the Act relates to species and organisms posing a potential threat to biodiversity. According to Section 75 of the Act, "Control and eradication of listed invasive species":

- (1) Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.
- (2) Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.

- (3) The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

Government Notice No. 1002 of 2011: National List of Ecosystems that are Threatened and in need of protection

Published under Section 52(1)(a) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004). This Act provides for the listing of threatened or protected ecosystems based on national criteria. The list of threatened terrestrial ecosystems supersedes the information regarding terrestrial ecosystem status in the National Spatial Biodiversity Assessment (2004).

The Environmental Impact Assessment (EIA) Regulations include three lists of activities that require environmental authorisation:

• Listing Notice 1: activities that require a basic assessment (R544 of 2010),

• Listing Notice 2: activities that require seeping and environmental impact report (EIR) (R545 of 201 0),

• Listing Notice 3: activities that require a basic assessment in specific identified geographical areas only (R546 of 2010).

Activity 12 in Listing Notice 3 relates to the clearance of 300m2 of more of vegetation, which will trigger a basic assessment within any critically endangered or endangered ecosystem listed in terms of S52 of the Biodiversity Act. This means any development that Involves loss of natural habitat In a listed critically endangered or endangered ecosystem Is likely to require at least a basic assessment in terms of the EIA regulations.

It is important to note that while the original extent of each listed ecosystem has been mapped, a basic assessment report in terms of the EIA regulations is triggered only in remaining natural habitat within each ecosystem and not in portions of the ecosystem where natural habitat has already been irreversibly lost.

GNR 151: Critically Endangered, Endangered, Vulnerable and Protected Species List

Published under Section 56(1) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).

GNR 1187: Amendment of Critically Endangered, Endangered, Vulnerable and Protected Species List

Published under Section 56(1) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).

Conservation of Agricultural Resources (Act No. 43 of 1983) as amended in 2001

Declared Weeds and Invaders in South Africa are categorised according to one of the following categories:

- Category 1 plants: are prohibited and must be controlled.
- Category 2 plants: (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread.
- Category 3 plants: (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading thereof, except within the floodline of watercourses and wetlands.

National Water Act

Wetlands, riparian zones and watercourses are defined in the Water Act as a water resource and any activities that are contemplated that could affect the wetlands requires authorisation (Section 21 of the National Water Act of 1998). A "watercourse" in terms of the National Water Act (act 36 of 1998) means:

- River or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and

Any collection of water which the Minister may, by notice in the gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

National Veld and Forest Fire Act (Act No. 101 of 1998)

Provides requirements for veldfire prevention through firebreaks and required measures for fire-fighting. Chapter 4 of the Act places a duty on landowners to prepare and maintain firebreaks. Chapter 5 of the Act places a duty on all landowners to acquire equipment and have available personnel to fight fires.

Northern Cape Nature Conservation Act, No. 9 of 2009

This Act provides for the sustainable utilisation of wild animals, aquatic biota and plants; provides for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; provides for offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; and provides for the issuing of permits and other authorisations. Amongst other regulations, the following may apply to the current project:

- Boundary fences may not be altered in such a way as to prevent wild animals from freely moving onto or off of a property;
- Aquatic habitats may not be destroyed or damaged;
- The owner of land upon which an invasive species is found (plant or animal) must take the necessary steps to eradicate or destroy such species.

The Act provides lists of protected species for the Province.

Other Acts

Other Acts that may apply to biodiversity issues, but which are considered to not apply to the current site are as follows:

- National Environmental Management Protected Areas Act (Act No. 57 of 2003)
- Marine Living Resources Act (Act No. 18 of 1998)
- Sea Birds and Seals Protection Act (Act No. 46 of 1973)
- Lake Areas Development Act (Act No. 39 of 1975)
- Mountain Catchment Areas Act (Act No. 63 of 1970)
- Integrated Coastal Zone Management Act (Act No. 24 of 2008)

IDENTIFICATION OF RISKS AND POTENTIAL IMPACTS

Potential issues relevant to potential impacts on the ecology of the study area include the following:

- Impacts on biodiversity: this includes any impacts on populations of individual species of concern (flora), including protected species, and on overall species richness. This includes impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of concern.
- Impacts on sensitive habitats: this includes impacts on any sensitive or protected habitats, including indigenous forest, fynbos and wetland vegetation that leads to direct or indirect loss of such habitat.
- Impacts on ecosystem function: this includes impacts on any processes or factors that maintain ecosystem health and character, including the following:

    - Disruption to nutrient-flow dynamics;
    - Impedance of movement of material or water;
    - Habitat fragmentation;
    - Changes to abiotic environmental conditions;
    - Changes to disturbance regimes, e.g. Increased or decreased incidence of fire;
    - Changes to successional processes;
    - Effects on pollinators;
    - Increased invasion by alien plants.

    Changes to factors such as these may lead to a reduction in the resilience of plant communities and ecosystems or loss or change in ecosystem function.
- Secondary and cumulative impacts on ecology: this includes an assessment of the impacts of the proposed project taken in combination with the impacts of other known projects for the area or secondary impacts that may arise from changes in the social, economic or ecological environment.
- Impacts on the economic use of vegetation: this includes any impacts that affect the productivity or function of ecosystems in such a way as to reduce the economic value to users, e.g. reduction in grazing capacity, loss of harvestable products. It is a general consideration of the impact of a project on the supply of so-called ecosystem goods and services.

A number of direct risks to ecosystems that would result from **construction** of the proposed solar energy facility are as follows:

- Clearing of land for construction.
- Construction of access roads.
- Placement of power lines, cables and water pipelines.
- Establishment of borrow and spoil areas.
- Chemical contamination of the soil by construction vehicles and machinery.
- Operation of construction camps.
- Storage of materials required for construction.

Description of potential impacts

Major potential impacts are described briefly below. These are compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of solar energy facilities on the ecological environment. The major expected negative impact will be due to loss of habitat which may have direct or indirect impacts on individual organisms or on ecosystems as a whole.

Impact 1: Loss or fragmentation of indigenous natural vegetation (terrestrial)
Nature: Construction of infrastructure may lead to direct loss of vegetation. This may lead to localised or more extensive reduction in the overall extent of vegetation. There are factors that may aggravate this potential impact. For example, where this vegetation has already been stressed due to degradation and transformation at a regional level, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat and a change in the conservation status (current conservation situation). Consequences of the potential impact of loss of indigenous natural vegetation occurring may include:

1. Negative change in conservation status of habitat (Driver et al. 2005);
2. Increased vulnerability of remaining portions to future disturbance;
3. General loss of habitat for sensitive species;
4. Loss in variation within sensitive habitats due to loss of portions of it;
5. General reduction in biodiversity;
6. Increased fragmentation (depending on location of impact);
7. Disturbance to processes maintaining biodiversity and ecosystem goods and services; and
8. Loss of ecosystem goods and services.

The vegetation type site is Northern Upper Karoo, classified nationally as Least Threatened. The Northern Upper Karoo vegetation type occurs across an extensive area (covers an area of almost 42 000 km^2). The regional impact on the vegetation type as a whole therefore appears to be insignificant. Nevertheless, the local impact (at the farm scale) is potentially significant.

Impact 2: Loss of individuals of threatened plants
Nature: Plant species are especially vulnerable to infrastructure development due to the fact that they cannot move out of the path of the construction activities, but are also affected by overall loss of habitat.

Threatened species include those classified as critically endangered, endangered or vulnerable. For any other species a loss of individuals or localised populations is unlikely to lead to a change in the conservation status of the species. However, in the case of threatened plant species, loss of a population or individuals could lead to a direct change in the conservation status of the species, possibly extinction. This may arise if the proposed infrastructure is located where it will impact on such individuals or populations. Consequences may include:

1. Fragmentation of populations of affected species;
2. Reduction in area of occupancy of affected species; and
3. Loss of genetic variation within affected species.

These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chance of survival of the species.

There are no threatened, near threatened or rare plant species that occur on site. This potential impact is therefore not applicable to the current proposal and is not evaluated further.

Impact 3: Loss of individuals of protected tree species
There are a number of tree species that are protected according to Government Notice no. 1012 under section 12(I)(d) of the National Forests Act, 1998 (Act No. 84 of 1998). In terms of section1 5(1) of the National Forests Act, 1998 "no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a license granted by the Minister to an (applicant and subject to such period and conditions as may be stipulated".

One species has a geographic distribution that includes the study area, *Boscia albitrunca*. This species does not occur in any part of the study area. This potential impact is therefore not applicable to the current proposal and is not evaluated further.

Impact 4: Loss of individuals of protected plant species
There are two plant species that are protected according to National Environmental Management: Biodiversity Act (Act No. 10 of 2004) and are known to occur in the general geographical area that includes the site. According to this Act, "*a person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit issued in terms of Chapter 7*". Such activities include any that are "*of a nature that may negatively impact on the survival of a listed threatened or protected species*". This implies that any negative impacts on habitats in which populations of protected species occur or are dependent upon would be restricted according to this Act.

The species that have a geographic distribution that includes the study area are *Hoodia gordonii* and *Harpagophytum procumbens*. No individuals were found during the field survey and it is considered unlikely that they occur on site. This potential impact is therefore not applicable to the current proposal and is not evaluated further.

Impact 5: Establishment and spread of declared weeds and alien invader plants
Major factors contributing to invasion by alien invader plants includes *inter alia* high disturbance (such as clearing for construction activities) and negative grazing practices (Zachariades *et al*. 2005). Exotic species are often more prominent near infrastructural disturbances than further away (Gelbard & Belnap 2003, Watkins *et al*. 2003). Consequences of this may include:

1. Loss of indigenous vegetation;
2. Change in vegetation structure leading to change in various habitat characteristics;
3. Change in plant species composition;
4. Change in soil chemical properties;
5. Loss of sensitive habitats;
6. Loss or disturbance to individuals of rare, endangered, endemic and/or protected species;
7. Fragmentation of sensitive habitats;
8. Change in flammability of vegetation, depending on alien species;
9. Hydrological impacts due to increased transpiration and runoff; and
10. Impairment of wetland function.

Potential weeds with a distribution centred on arid regions of the country include *Salsola kali*, *Atriplex lindleyi*, *Opuntia ficus-indica, Opuntia imbricata, Prosopis glandulosa, Prosopis velutina, Atriplex numularia,* and *Nicotiana glauca*. Species observed during the field survey on the three sites include *Agave americana*, *Prosopis glandulosa*, *Opuntia ficus-indica*, *Datura*

ferox, *Argemone ochroleuca* and *Echinopsis spechiana*. The shrub, *Prosopis glandulosa*, is potentially the most problematic in the study area and is widely distributed in the Northern Upper Karoo vegetation type. It was found at a relatively high frequency on site and in immediately adjacent areas. This species invades riverbeds, riverbanks and drainage lines in semi-arid and arid regions. There is therefore the potential for alien plants to spread or invade following disturbance on site.

Impacts to be assessed for the current project

The impacts to be assessed for the current project are as follows:

- Loss or fragmentation of indigenous natural vegetation (terrestrial)
- Establishment and spread of declared weeds and alien invader plants

ASSESSMENT OF IMPACTS

Impacts are assessed for each component of infrastructure for the proposed solar energy facilities. There is therefore a separate assessment for the solar arrays (including alternative layouts), roads and water pipeline together, overhead power lines and substations together and the no-go alternative.

Solar arrays (layout option 1 & 2)

There are arrays proposed in different parts of the sites (see Figure 1). These are in areas of natural vegetation, and may also indirectly affect some drainage areas, identified as being sensitive. The impacts of potential concern are therefore on natural vegetation, drainage areas and due to the potential establishment and spread of alien plants. Both layout options affect an almost identical area and the impact will be the same for both options.

Differences due to different technology alternatives and mounting alternatives are considered to be irrelevant due to the fact that construction activities (for example, clearing and trampling of vegetation) will extend beyond indivudal components of infrastructure. It is expected that the entire area under the solar panels will be completely cleared of vegetation. For the purposes of undertaking this assessment, it is assumed that the entire footprint of the solar array area will be disturbed and/or lost.

Impact 1: Loss or fragmentation of indigenous natural vegetation
The vegetation type on site that will be affected by construction of infrastructure is Northern Upper Karoo.

Extent: The impact will occur at the site of the proposed solar arrays. The construction of the arrays potentially affects a high proportion of natural vegetation on site and is scored as ***site specific***.

Magnitude: At a site specific scale, the vegetation will probably be almost entirely lost. Natural functions and/or processes will therefore be severely altered. The magnitude of the impact is therefore scored as ***high***.

Duration: The impact will occur during construction, but cause effects that will last longer than 15 years (probably longer than 100 years). It is therefore scored as ***long term***.

Significance: On the basis of the impact being of high magnitude at a site specific scale and of long term duration, the impact is scored as having a significance of ***medium***. Mitigation measures will not reduce the extent, magnitude or duration of the impact. The significance will, therefore, remain ***medium*** after mitigation measures have been implemented.

Probability: According to the provided layout, it is ***definite*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that is in all practical terms permanent. The impact is therefore considered to be ***irreversible***.

Mitigation measures:

1. Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint of the solar array and other associated infrastructure.
2. Areas outsie the construction footprint should be fenced and access to these areas should be limited as much as possible.

Impact 5: Establishment and spread of declared weeds and alien invader plants
There are existing infestations of weeds on site and in immediately adjacent areas. There is therefore the potential that activities on site could promote the spread of these onto the site and/or into other natural areas.

Extent: The impact will occur at the site of the proposed solar arrays and in surrounding areas, but could potentially spread into the surrounding landscape, depending on the habitat and the alien species that could potentially invade the site. The impact is therefore scored as ***local***.

Magnitude: At a local scale, natural functions and/or processes will possibly be notably altered. The magnitude of the impact is therefore scored as ***medium***.

Duration: The impact will occur during construction, but cause effects that will last longer than 15 years, if not controlled. It is therefore scored as ***long term***.

Significance: On the basis of the impact being of medium magnitude at a local scale and of long term duration, the impact is scored as having a significance of ***medium***. Mitigation measures will reduce the extent to site specific, the magnitude to very low and the duration of the impact to short term. The significance will, therefore, be reduced to ***very low*** after mitigation measures have been implemented.

Probability: On the basis of known patterns of alien invasions, it is ***probable*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that could be reversed, if identified and managed. Impacts are possibly reversible within 2 years after the cause or stress is removed. The impact is therefore considered to be ***reversible***.

Mitigation measures:
1. Disturbance of indigenous vegetation outside of the footprint of construction must be kept to a minimum.
2. Where disturbance is unavoidable, disturbed areas should be rehabilitated as quickly as possible.
3. Any alien plants within the control zone of the company must be immediately controlled to avoid establishment of a soil seed bank. Control measures must follow established norms and legal limitations in terms of the method to be used and the chemical substances used.
4. An on-going monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

Roads and water pipelines

The proposed access road and water pipeline are shown in Figure 2. These are relatively limited in extent.

Impact 1: Loss or fragmentation of indigenous natural vegetation
The vegetation type on site that will be affected by construction of infrastructure is Northern Upper Karoo. The access road and water pipeline will affect very small, localised areas of vegetation.

Extent: The impact will occur at the site of the proposed access road and water pipeline. The construction potentially affects a small proportion of natural vegetation on site and is scored as ***site specific***.

Magnitude: At a site specific scale, the vegetation will be affected in localised areas. Natural functions and/or processes will therefore be slightly altered. The magnitude of the impact is therefore scored as ***low***.

Duration: The impact will be initiated during construction, but may only result in effects that are evident during operation. It will probably cause effects that will last longer than 15 years. It is therefore scored as ***long term***.

Significance: On the basis of the impact being of low magnitude at a site specific scale and of long term duration, the impact is scored as having a significance of ***low***. Mitigation measures will not reduce the extent, magnitude or duration of the impact. The significance will, therefore, remain ***low*** after mitigation measures have been implemented.

Probability: According to the provided layout, it is ***definite*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that is in all practical terms permanent. The impact is therefore considered to be ***irreversible***.

Mitigation measures:

1. Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint of the tower structures and/or the servitude of the power line.

Impact 5: Establishment and spread of declared weeds and alien invader plants
There are existing infestations of weeds on site and in immediately adjacent areas. There is therefore the potential that activities on site could promote the spread of these onto the site and/or into other natural areas.

Extent: The impact will occur at the site of the proposed road and water pieline and in surrounding areas, but could potentially spread into the surrounding landscape, depending on the habitat and the alien species that could potentially invade the site. The impact is therefore scored as ***local***.

Magnitude: At a local scale, natural functions and/or processes will possibly be notably altered. The magnitude of the impact is therefore scored as ***medium***.

Duration: The impact will occur during construction, but cause effects that will last longer than 15 years, if not controlled. It is therefore scored as ***long term***.

Significance: On the basis of the impact being of medium magnitude at a local scale and of long term duration, the impact is scored as having a significance of ***medium***. Mitigation measures will reduce the extent to site specific, the magnitude to very low and the duration of the impact to short term. The significance will, therefore, be reduced to ***very low*** after mitigation measures have been implemented.

Probability: On the basis of known patterns of alien invasions, it is ***probable*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that could be reversed, if identified and managed. Impacts are possibly reversible within 2 years after the cause or stress is removed. The impact is therefore considered to be ***reversible***.

Mitigation measures:

1. Disturbance of indigenous vegetation outside of the footprint of construction must be kept to a minimum.
2. Where disturbance is unavoidable, disturbed areas should be rehabilitated as quickly as possible.
3. Any alien plants within the control zone of the company must be immediately controlled to avoid establishment of a soil seed bank. Control measures must follow established norms and legal limitations in terms of the method to be used and the chemical substances used.
4. An on-going monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

Overhead power lines and substations

The proposed overhead power lines will, in most cases, be adjacent to existing Eskom overhead power lines. Substations will affect only very small local areas of habitat. Both overhead powerline options will have the same relative effect on the ecological environment.

Impact 1: Loss or fragmentation of indigenous natural vegetation

The vegetation type on site that will be affected by construction of infrastructure is Northern Upper Karoo. Power line tower structures will affect very small, localised areas of vegetation. Access roads may affect larger areas.

Extent: The impact will occur at the site of the proposed power line tower structures and access roads. The construction of the power line infrastructure potentially affects a small proportion of natural vegetation on site and is scored as ***site specific***.

Magnitude: At a site specific scale, the vegetation will be affected in localised areas. Natural functions and/or processes will therefore be slightly altered. The magnitude of the impact is therefore scored as ***low***.

Duration: The impact will occur during construction. Indications from existing power lines on site are that the base of tower structures becomes re-vegetated. The impact will therefore be ***medium-term***.

Significance: On the basis of the impact being of low magnitude at a site specific scale and of medium term duration, the impact is scored as having a significance of ***low***. Mitigation measures will reduce the magnitude to very low and the duration of the impact to short term. The significance will, therefore, be reduced to ***very low*** after mitigation measures have been implemented.

Probability: According to the provided layout, it is ***probable*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that is in all practical terms permanent. The impact is therefore considered to be ***irreversible***.

Mitigation measures:

1. Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint of the tower structures and/or the servitude of the power line.
2. Existing access roads must be used, where possible.
3. Service roads in the servitude must be properly maintained to avoid erosion impacts.

Impact 5: Establishment and spread of declared weeds and alien invader plants

There are existing infestations of weeds on site and in immediately adjacent areas. There is therefore the potential that activities on site could promote the spread of these onto the site and/or into other natural areas.

Extent: The impact will occur at the site of the proposed solar arrays and in surrounding areas, but could potentially spread into the surrounding landscape, depending on the habitat and the alien species that could potentially invade the site. The impact is therefore scored as ***local***.

Magnitude: At a local scale, natural functions and/or processes will possibly be notably altered. The magnitude of the impact is therefore scored as ***medium***.

Duration: The impact will occur during construction, but cause effects that will last longer than 15 years, if not controlled. It is therefore scored as ***long term***.

Significance: On the basis of the impact being of medium magnitude at a local scale and of long term duration, the impact is scored as having a significance of ***medium***. Mitigation measures will reduce the extent to site specific, the magnitude to very low and the duration of the impact to short term. The significance will, therefore, be reduced to ***very low*** after mitigation measures have been implemented.

Probability: On the basis of known patterns of alien invasions, it is ***probable*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that could be reversed, if identified and managed. Impacts are possibly reversible within 2 years after the cause or stress is removed. The impact is therefore considered to be ***reversible***.

Mitigation measures:

1. Disturbance of indigenous vegetation outside of the footprint of construction must be kept to a minimum.
2. Where disturbance is unavoidable, disturbed areas should be rehabilitated as quickly as possible.
3. Any alien plants within the control zone of the company must be immediately controlled to avoid establishment of a soil seed bank. Control measures must follow established norms and legal limitations in terms of the method to be used and the chemical substances used.
4. An on-going monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

The 'no-go' option

Assessment of the 'no-go' option is as if current activities continue on site. This includes mostly animal husbandry.

Impact 1: Loss or fragmentation of indigenous natural vegetation
The vegetation type on site is Northern Upper Karoo. This will remain intact, although local degradation due to over-utilization could potentially occur.

Extent: The impact will occur at the site of the farm and is scored as ***site specific***.

Magnitude: At a site specific scale, the vegetation will be affected in localised areas. Natural functions and/or processes will therefore be negligibly altered. The magnitude of the impact is therefore scored as ***very low***.

Duration: The existing land-use has been ongoing for many decades. Any impacts will be due to judgement errors by land-users, most of whom have a good understanding on how to manage the land. However, any impact is likely to be ***long-term***.

Significance: On the basis of the impact being of very low magnitude at a site specific scale and of long term duration, the impact is scored as having a significance of ***very low***.

Probability: According to the current land-use, it is ***probable*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that is in all practical terms ***reversible***.

Impact 5: Establishment and spread of declared weeds and alien invader plants
There are existing infestations of weeds on site and in immediately adjacent areas. There is therefore the potential that activities on site could promote the spread of these onto the site and/or into other natural areas, although the lack of major earth disturbance due to existing activities means that any spreading of invasive species is likely to be slow.

Extent: The impact will occur on the farm, but could potentially spread into the surrounding landscape, depending on the habitat and the alien species that could potentially invade the site. The impact is therefore scored as ***local***.

Magnitude: At a local scale, natural functions and/or processes will possibly be slightly altered. The magnitude of the impact is therefore scored as ***low***.

Duration: The impact will cause effects that will last longer than 15 years, if not controlled. It is therefore scored as ***long term***.

Significance: On the basis of the impact being of low magnitude at a local scale and of long term duration, the impact is scored as having a significance of ***low***. Management measures could reduce the extent to site specific, the magnitude to very low and the duration of the impact to short term. The significance will, therefore, be reduced to ***very low*** after mitigation measures have been implemented.

Probability: On the basis of known patterns of alien invasions, it is ***probable*** that the impact will occur.

Confidence: There is a reasonable to high amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. The confidence in the assessment is therefore rated as ***sure***.

Reversibility: The activity will lead to an impact that could be reversed, if identified and managed. Impacts are possibly reversible within 2 years after the cause or stress is removed. The impact is therefore considered to be ***reversible***.

DISCUSSION AND CONCLUSIONS

There is one major vegetation types that occurs in the study area, namely Northern Upper Karoo. This vegetation type is classified as Least Threatened and also has a wide distribution and extent. The natural vegetation in the study area is therefore not considered, from this perspective, to have high conservation status.

Local factors that may lead to parts of the study area having elevated ecological sensitivity are the presence of watercourses / drainage areas. The assessment of impacts on these areas has been undertaken in a separate aquatic specialist study.

There is one protected tree species that occurs in the area, *Boscia albitrunca* (Shepherd's Tree). It has been evaluated as having a moderate probability of occurring in the general area, but was not found on site.

There are no threatened, near threatened, declining or rare plant species that occur in the area.

There are two protected plant species that have a geographical distribution that includes the area, but neither species was found on site and, based on a field evaluation of the site, neither species is likely to occur there.

The study area is in a mostly natural condition. All of the drainage lines / watercourses on the sites are classified as having medium-high sensitivity. The majority of the study area is classified as having medium sensitivity.

A risk assessment was undertaken which identified two main potential negative impacts on the receiving environment. The identified potential impacts are the following:

1. Impacts on indigenous natural vegetation
2. Establishment and spread of declared weeds and alien invader plants

Impacts were assessed after collection of relevant data in the field. A summary of the significance of impacts is given in Table 10 below. This shows that the potential impact on natural vegetation by the solar arrays (same for both option 1 and 2) is the only impacts with a significance of "medium". This significance score is due to the fact that the impact will be long-term and will definitely occur. The assessment methodology masks the fact that the vegetation type is very extensive and, although the impact will occur at a site specific scale, the regional effect is very low. No mitigation measures will reduce the significance of this impact, but given the large extent of the vegetation type, this is not considered to be a serious impact. Other potential impacts are either "low" or can be reduced to "very low" with mitigation.

In terms of the option between the two solar array layout options, either option is acceptable, although Option 1 affects a slightly lesser amount of natural vegetation. In terms of the option between the two overhead powerline options, either option is acceptable

Conclusion

The overall impacts of this proposed project are of low or moderate significance. With mitigation measures implemented, it should be possible to reduce all negative impacts to low significance, except for the significance of impacts on natural vegetation, which remains medium. Relative to other parts of the country where similar assessments have been

conducted, this site has low sensitivity and few conservation issues. Taking this assessment into consideration and the relatively low sensitivity and conservation value of the site, this project is supported from an ecological point of view.

Table 10: Summary of significance of impacts

Impact	Solar arrays (option 1)		Solar arrays (option 2)		Roads and water pipeline		Overhead power lines (option 1)		Overhead power lines (option 2)		No-go option
	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation
1. Loss or fragmentation of vegetation	Medium	Medium	Medium	Medium	Medium	Medium	Low	Very low	Low	Very low	Very low
2. Spread of alien plants	Medium	Very low	Medium	Very low	Medium	Very low	Medium	Very low	Medium	Very low	Low

REFERENCES:

ALEXANDER, G. & MARAIS, J. 2007. A guide to the reptiles of southern Africa. Struik, Cape Town.

BARNES, K.N. (ed.) (2000) The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

BRANCH, W.R. (1988) South African Red Data Book—Reptiles and Amphibians. South African National Scientific Programmes Report No. 151.

CHITTENDEN, H. 2007. Roberts bird guide: a comprehensive field guide to over 950 bird species in southern Africa. John Voelcker Bird Book Fund, Cape Town.

DENT, M.C., LYNCH, S.D. & SCHULZE, R.E. 1989. Mapping mean annual and other rainfall statistics in southern Africa. Department of Agricultural Engineering, University of Natal. ACRU Report No. 27. Massachusetts: Clark University.

DRIVER, A., MAZE, K., ROUGET, M., LOMBARD, A.T., NEL, J., TURPIE, J.K., COWLING, R.M., DESMET, P., GOODMAN, P., HARRIS, J., JONAS, Z., REYERS, B., SINK, K and STRAUSS, T. 2005. National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia 17. South African National Biodiversity Institute, Pretoria.

DU PREEZ, L. & CARRUTHERS, V. 2009. A complete guide to the frogs of southern Africa. Random House Struik, Cape Town.

FAIRBANKS, D.H.K., THOMPSON, M.W., VINK, D.E., NEWBY, T.S., VAN DEN BERG, H.M & EVERARD, D.A. 2000. The South African Land-Cover Characteristics Database: a synopsis of the landscape. *S.Afr.J.Science* 96: 69-82.

FRIEDMANN, Y. & DALY, B. (eds.) 2004. The Red Data Book of the Mammals of South Africa: A Conservation Assessment: CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa.

GERMISHUIZEN, G., MEYER, N.L., STEENKAMP, Y and KEITH, M. (eds.) (2006). A checklist of South African plants. Southern African Botanical Diversity Network Report No. 41, SABONET, Pretoria.

HARTMANN, M.O. 1988. The soils of the Eastern Cape. In: M.N. Bruton & F.W. Gess. (ed.) Towards an environmental plan for the Eastern Cape. Rhodes University, Grahamstown.

HENNING, S.F. & HENNING, G.A. 1989. South African Red Data Book - Butterflies. *South African National Scientific Programmes* No. 158, Foundation for Research Development, CSIR, Pretoria.

IUCN (2001). *IUCN Red Data List categories and criteria: Version 3.1*. IUCN Species Survival Commission: Gland, Switzerland.

MACVICAR, C. N., SCOTNEY, D. M. SKINNER, T. E. NIEHAUS, H. S. & LOUBSER, J. H., 1974. A classification of land (climate, terrain form, soil) primarily for rainfed agriculture. S. Afr. J. Agric. Extension, 3(3): 1-4.

MARAIS, J. 2004. A complete guide to the snakes of southern Africa. Struik Publishers, Cape Town.

MILLS, G. & HES, L. 1997. The complete book of southern African mammals. Struik Publishers, Cape Town.

MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. and KLOEPFER, D. (eds.) 2004. Atlas and Red Data Bookof the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington, DC.

MONADJEM, A., TAYLOR, P.J., COTTERILL, E.P.D. & SCHOEMAN, M.C. 2010. Bats of southern and central Africa. Wits University Press, Johannesburg.

MUCINA, L, BREDENKAMP, G.J., **HOARE, D.B** & MCDONALD, D.J. 2000. A National Vegetation Database for South Africa *South African Journal of Science* 96: 1–2.

MUCINA, L. AND RUTHERFORD, M.C. (editors) (2006). Vegetation map of South Africa, Lesotho and Swaziland: an illustrated guide. *Strelitzia* 19, National Botanical Institute, Pretoria.

MUCINA, L. AND RUTHERFORD, M.C. (editors) 2006. Vegetation map of South Africa, Lesotho and Swaziland: an illustrated guide. *Strelitzia* 19, South African National Biodiversity Institute, Pretoria.

MUCINA, L., RUTHERFORD, M.C. AND POWRIE, I.W. (editors) 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 SCALE SHEET MAPS South African National Biodiversity Institute, Pretoria.

MUCINA, L., RUTHERFORD, M.C., **HOARE, D.B**. & POWRIE, L.W. 2003. VegMap: The new vegetation map of South Africa, Lesotho and Swaziland. In: Pedrotti, F. (ed.) Abstracts: Water Resources and Vegetation, 46th Symposium of the International Association for Vegetation Science, June 8 to 14 – Napoli, Italy.

MUCINA, L., RUTHERFORD, M.C., PALMER, A.R., MILTON, S.J., SCOTT, L., VAN DER MERWE, B., **HOARE, D.B.**, BEZUIDENHOUT, H., VLOK, J.H.J., EUSTON-BROWN, D.I.W., POWRIE, L.W. & DOLD, A.P. 2006. *Nama-Karoo Biome.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

MUELLER-DOMBOIS, D. AND ELLENBERG, H. 1974. Aims and methods of vegetation ecology. Wiley, New York.

PASSMORE, N.I. & CARRUTHERS, V.C. (1995) South African Frogs; a complete guide. Southern Book Publishers and Witwatersrand University Press. Johannesburg.

RUTHERFORD, M.C. & WESTFALL, R.H. (1994). Biomes of southern Africa: an objective categorization. *Memoirs of the Botanical Survey of South Africa* No. 63.

TOLLEY, K. & BURGER, M. 2007. Chameleons of southern Africa. Struik Publishers, Cape Town.

APPENDICES:

Appendix 1: Plant species of conservation importance (Threatened, Near Threatened and Declining) that have historically been recorded in the study area.

Sources: South African National Biodiversity Institute in Pretoria.

Family	Taxon	Status	Habitat	Likelihood of occurrence on site
PROTEACEAE	Protea subvestita	VU	Found primarily in the eastern and southern Great Escarpment region of South Africa. Montane areas, mostly highland grassland and fynbos. Collection in grid 3024CC was from 1886 - no locality information is provided for this specimen and it is possibly incorrectly linked to this grid (no other records are in similar geographical location or habitat and typical habitat does not match anything found in grid).	LOW

* Conservation Status Category assessment according to IUCN Ver. 3.1 (IUCN, 2001), as evaluated by the Threatened Species Programme of the South African National Biodiversity Institute in Pretoria. *IUCN (3.1) Categories: VU = Vulnerable, EN = Endangered, CR = Critically Endangered, NT = Near Threatened.

Appendix 2: List of protected tree species (National Forests Act).

Acacia erioloba	*Acacia haematoxylon*
Adansonia digitata	*Afzelia quanzensis*
Balanites subsp. *maughamii*	*Barringtonia racemosa*
Boscia albitrunca	*Brachystegia spiciformis*
Breonadia salicina	*Bruguiera gymnhorrhiza*
Cassipourea swaziensis	*Catha edulis*
Ceriops tagal	*Cleistanthus schlectheri* var. *schlechteri*
Colubrina nicholsonii	*Combretum imberbe*
Curtisia dentata	*Elaedendron (Cassine) transvaalensis*
Erythrophysa transvaalensis	*Euclea pseudebenus*
Ficus trichopoda	*Leucadendron argenteum*
Lumnitzera racemosa var. *racemosa*	*Lydenburgia abottii*
Lydenburgia cassinoides	*Mimusops caffra*
Newtonia hildebrandtii var. *hildebrandtii*	*Ocotea bullata*
Ozoroa namaensis	*Philenoptera violacea* (*Lonchocarpus capassa*)
Pittosporum viridiflorum	*Podocarpus elongatus*
Podocarpus falcatus	*Podocarpus henkelii*
Podocarpus latifolius	*Protea comptonii*
Protea curvata	*Prunus africana*
Pterocarpus angolensis	*Rhizophora mucronata*
Sclerocarya birrea subsp. *caffra*	*Securidaca longependunculata*
Sideroxylon inerme subsp. *inerme*	*Tephrosia pondoensis*
Warburgia salutaris	*Widdringtonia cedarbergensis*
Widdringtonia schwarzii	

Boscia albitrunca has a geographical distribution that coincides with the study area.

Appendix 3: Checklist of plant species recorded during previous botanical surveys in the study area and surrounds.

This checklist has been compiled from data obtained from the SANBI website (http://posa.sanbi.org/searchspp.php) and includes species from quarter degree grid in which the site is located as well as surrounding grids in which similar vegetation types are found. The checklist provides an indication of the species that occur in the general area and is not a checklist for the site itself.

*
Eragrostis tef
*Pennisetum villosum
*Puccinellia distans
*Sorghum halepense
Allophyllus decipiens
Aptosimum procumbens (Lehm.) Steud.
Aptosimum spinescens (Thunb.) F.E.Weber
Arachnioides webbiana subsp. foliosa
Arctotis leiocarpa Harv.
Aristida adscensionis
Aristida congesta subsp. barbicollis
Aristida congesta subsp. congesta
Aristida vestita Thunb.
Asparagus striatus (L.f.) Thunb.
Asparagus suaveolens Burch.
Athanasia minuta (L.f.) Källersjö subsp. minuta
Atriplex vestita (Thunb.) Aellen var. appendiculata Aellen
Barleria rigida
Bassia salsoloides (Fenzl) A.J.Scott
Berkheya eriobasis (DC.) Roessler
Brunsvigia radulosa Herb.
Bulbostylis humilis (Kunth) C.B.Clarke
Calobota spinescens (Harv.) Boatwr. & B.-E.van Wyk
Campylopus robillardei Besch.
Cenchrus ciliaris L.
Chaenostoma halimifolium Benth.
Cheilanthes eckloniana (Kunze) Mett.
Chloris virgata Sw.
Chrysocoma ciliata L.
Clutia impedita
Colchicum asteroides (J.C.Manning & Goldblatt) J.C.Manning & Vinn.
Commelina africana L. var. africana
Crassula corallina Thunb. subsp. corallina
Cucumis africanus L.f.
Cucumis heptadactylus Naudin
Cucumis myriocarpus Naudin subsp. leptodermis (Schweick.) C.Jeffrey & P.Halliday
Cullen tomentosum (Thunb.) J.W.Grimes
Cyanella lutea L.f.
Cynodon incompletus Nees
Daubenya comata (Burch. ex Baker) J.C.Manning & A.van der Merwe
Dianthus micropetalus Ser.
Dicoma capensis Less.
Digitaria erianthe
Dimorphotheca cuneata (Thunb.) Less.
Dimorphotheca zeyheri Sond.
Dipcadi viride (L.) Moench
Disa pulchra
Empodium elongatum
Enneapogon desvauxii P.Beauv.
Enneapogon scaber Lehm.
Enneapogon scoparius Stapf
Eragrostis bergiana (Kunth) Trin.
Eragrostis bicolor Nees
Eragrostis chloromelas Steud.
Eragrostis curvula (Schrad.) Nees
Eragrostis homomalla Nees
Eragrostis lehmanniana Nees var. lehmanniana
Eragrostis nindensis
Eragrostis obtusa Munro ex Ficalho & Hiern
Eragrostis procumbens Nees
Eragrostis truncata Hack.
Erucastrum strigosum (Thunb.) O.E.Schulz
Eulophia foliosa
Euphorbia aequoris N.E.Br.
Euphorbia arida N.E.Br.
Euphorbia pugniformis
Felicia burkei (Harv.) L.Bolus
Felicia filifolia (Vent.) Burtt Davy subsp. filifolia
Felicia muricata (Thunb.) Nees subsp. muricata
Fingerhuthia africana Lehm.
Gazania jurineifolia DC. subsp. jurineifolia
Gazania krebsiana Less. subsp. arctotoides (Less.) Roessler
Geigeria filifolia Mattf.
Geigeria ornativa O.Hoffm. subsp. ornativa
Gisekia pharnacioides L. var. pharnacioides
Gladiolus dalenii subsp. dalenii
Gladiolus ecklonii

Gladiolus permeabilis D.Delaroche subsp. edulis (Burch. ex Ker Gawl.) Oberm.
Gnidia polycephala (C.A.Mey.) Gilg
Grewia flava
Haworthia venosa (Lam.) Haw. subsp. tessellata (Haw.) M.B.Bayer
Helichrysum asperum (Thunb.) Hilliard & B.L.Burtt var. asperum
Helichrysum dregeanum Sond. & Harv.
Helichrysum micropoides
Helichrysum zeyheri Less.
Heliophila minima (Stephens) Marais
Heliotropium ciliatum Kaplan
Heliotropium lineare (A.DC.) Gürke
Hermannia burkei Burtt Davy
Hermannia cuneifolia Jacq. var. cuneifolia
Hermannia erodioides (Burch. ex DC.) Kuntze
Hermannia pulchella L.f.
Hertia kraussii (Sch.Bip.) Fourc.
Hertia pallens (DC.) Kuntze
Heteropogon contortus (L.) Roem. & Schult.
Huernia humilis (Masson) Haw.
Hymenophyllum tunbridgense
Hypericum lalandii
Hypertelis salsoloides var. salsoloides
Indigastrum argyraeum (Eckl. & Zeyh.) Schrire
Jamesbrittenia filicaulis
Kniphofia ensifolia subsp. ensifolia
Ledebouria apertiflora
Lepidostephium denticulatum
Lessertia annularis Burch.
Leysera tenella DC.
Limeum sulcatum (Klotzsch) Hutch. var. sulcatum
Limosella africana var. africana
Lobelia flaccida subsp. flaccida
Lotononis platycarpa (Viv.) Pic.Serm.
Lycium horridum Thunb.
Lycium pumilum Dammer
Manulea fragrans Schltr.
Melianthus dregeanus
Melica decumbens Thunb.
Melolobium candicans (E.Mey.) Eckl. & Zeyh.
Microloma armatum (Thunb.) Schltr. var. armatum
Monopsis scabra
Moraea falcifolia
Nemesia fruticans (Thunb.) Benth.
Oligomeris dipetala (Aiton) Turcz. var. dipetala
Ornithogalum nannodes F.M.Leight.
Ornithoglossum vulgare B.Nord.
Oropetium capense Stapf
Oscularia deltoides (L.) Schwantes
Osteospermum leptolobum (Harv.) Norl.
Osteospermum spinescens Thunb.
Osyris lanceolata Hochst. & Steud.
Othonna pavonia E.Mey.
Oxalis depressa Eckl. & Zeyh.
Pachypodium succulentum (Jacq.) Sweet
Panicum coloratum L. var. coloratum
Panicum impeditum Launert
Pelargonium aestivale
Pelargonium pseudofumarioides
Pelargonium tragacanthoides Burch.
Peliostomum leucorrhizum E.Mey. ex Benth.
Peliostomum origanoides E.Mey. ex Benth.
Pentaschistis airoides (Nees) Stapf subsp. airoides
Pentaschistis setifolia
Pentzia calcarea Kies
Pentzia elegans DC.
Pentzia globosa
Pentzia incana (Thunb.) Kuntze
Pentzia lanata
Pentzia quinquefida (Thunb.) Less.
Pentzia spinescens Less.
Phymaspermum aciculare
Phymaspermum parvifolium (DC.) Benth. & Hook. ex B.D.Jacks.
Polygala ephedroides Burch.
Pseudocrossidium crinitum
Psilocaulon coriarium (Burch. ex N.E.Br.) N.E.Br.
Pteronia glauca Thunb.
Pteronia glaucescens DC.
Pteronia sordida N.E.Br.
Puccinellia acroxantha C.A.Sm. & C.E.Hubb.
Puccinellia distans (L.) Parl.
Radyera urens (L.f.) Bullock
Riccia albornata
Riccia nigrella DC.
Rosenia humilis (Less.) K.Bremer
Rosenia oppositifolia
Rumex lanceolatus Thunb.
Salsola calluna Fenzl ex C.H.Wright
Salsola dealata
Salsola glabrescens Burtt Davy
Salsola humifusa
Salvia verbenaca L.
Satyrium longicaude var. longicaude
Sebaea pentandra E.Mey. var. pentandra
Selago albida Choisy

Selago albida Choisy
Selago paniculata Thunb.
Selago saxatilis E.Mey.
Senecio isatideus
Sesamum capense Burm.f.
Solanum retroflexum
Sporobolus discosporus
Sporobolus fimbriatus (Trin.) Nees
Sporobolus ioclados (Trin.) Nees
Stachys cuneata Banks ex Benth.
Stachys linearis
Stapelia grandiflora Masson var. grandiflora
Stipagrostis ciliata (Desf.) De Winter var. capensis (Trin. & Rupr.) De Winter
Stipagrostis namaquensis (Nees) De Winter
Stipagrostis obtusa (Delile) Nees
Syringodea concolor (Baker) M.P.de Vos
Tetragonia fruticosa L.
Themeda triandra
Thesium congestum
Tortula atrovirens
Tragus berteronianus Schult.
Tragus koelerioides
Tragus racemosus (L.) All.
Trichostomum brachydontium
Tripteris aghillana DC. var. aghillana
Urochloa panicoides P.Beauv.
Wahlenbergia nodosa (H.Buek) Lammers
Zaluzianskya karrooica Hilliard
Zygophyllum microcarpum Licht. ex Cham. & Schltdl.

Appendix 4: Species protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004)
(as updated in R. 1187, 14 December 2007)

CRITICALLY ENDANGERED SPECIES
Flora
Adenium swazicum
Aloe pillansii
Diaphananthe millarii
Dioscorea ebutsniorum
Encephalartos aemulans
Encephalartos brevifoliolatus
Encephalartos cerinus
Encephalartos dolomiticus
Encephalartos heenanii
Encephalartos hirsutus
Encephalartos inopinus
Encephalartos latifrons
Encephalartos middelburgensis
Encephalartos nubimontanus
Encephalartos woodii

ENDANGERED SPECIES
Flora
Angraecum africae
Encephalartos arenarius
Encephalartos cupidus
Encephalartos horridus
Encephalartos laevifolius
Encephalartos lebomboensis
Encephalartos msinganus
Jubaeopsis caffra
Siphonochilus aethiopicus
Warburgia salutaris
Newtonia hilderbrandi

VULNERABLE SPECIES
Flora
Aloe albida
Encephalartos cycadifolius
Encephalartos Eugene-maraisii
Encephalartos ngovanus
Merwilla plumbea
Zantedeschia jucunda

PROTECTED SPECIES
Flora
Adenia wilmsii
Aloe simii
Clivia mirabilis
Disa macrostachya
Disa nubigena
Disa physodes
Disa procera
Disa sabulosa
Encephelartos altensteinii
Encephelartos caffer
Encephelartos dyerianus
Encephelartos frederici-guilielmi
Encephelartos ghellinckii
Encephelartos humilis
Encephelartos lanatus
Encephelartos lehmannii
Encephelartos longifolius
Encephelartos natalensis
Encephelartos paucidentatus
Encephelartos princeps
Encephelartos senticosus
Encephelartos transvenosus
Encephelartos trispinosus
Encephelartos umbeluziensis
Encephelartos villosus
Euphorbia clivicola
Euphorbia meloformis
Euphorbia obesa
Harpagophytum procumbens
Harpagophytum zeyherii
Hoodia gordonii
Hoodia currorii
Protea odorata
Stangeria eriopus

PROPOSED PV2-4PHOTOVOLTAIC ENERGY PLANTS ON THE FARM DU PLESSIS DAM NEAR DE AAR, NORTHERN CAPE

Avian impact assessment

Andrew Jenkins & Johan du Plessis, May 2013

AVISENSE CONSULTING

CONTENTS

1. EXECUTIVE SUMMARY

This study contains a review of the relevant literature on the impacts on avifauna of solar energy facilities and their associated electrical infrastructure, and identifies potential impacts of the proposed PV2-4 Photovoltaic (PV) Energy Plants on the avifauna of the De Aar area, Northern Cape. The proposed plants are located on the same farm as an approved 19.9MWfacility (PV1) which was proposed by the same applicant and has already been authorized. The expected impacts are: habitat destruction by the construction of the facilities themselves and their associated power lines or substation/s, disturbance by construction and maintenance activities and possibly by the operation of the facilities, and possible displacement or disturbance of sensitive species, and mortality caused by collision with the associated power line network, and electrocution of avifauna on the required power line and substation infrastructure. In addition, some birds may interfere with the efficient running of the proposed PV installations.

The broader impact zone of the proposed PV facilities is contained within an extensive tract of flat Nama Karoo, traversed by some minor drainage lines, while the immediate vicinity features degraded natural veld with some anthropogenic influences. The area potentially supports up to 220 bird species, including 69 endemic or near-endemic species, 15 red-listed species, and four species red-listed endemics. The birds of greatest potential relevance and importance in terms of the possible impacts of the proposed PV development are likely to be resident or seasonal influxes of threatened, large terrestrial birds – Blue Crane *Anthropoides paradiseus*, Ludwig's Bustard *Neotis ludwigii*, Kori Bustard *Ardeotis kori* and possibly Blue Korhaan *Eupodotis caerulescens*, locally resident or passing raptors, especially red-listed species - Martial Eagle *Polemaetus bellicosus*, Tawny Eagle *Aquila rapax* and Lesser Kestrel *Falco naumanni*, local populations of endemic, and possibly red-listed passerines, and possibly over-flights of commuting wetland birds, especially flamingos. Pigeons, crows, weavers, sparrows and some raptor species may perch, roost, forage or even nest on or around the facilities and cause fouling problems.

When assessed in isolation, and given the relative homogeneity of the habitat within and surrounding the site, and its close proximity to the town of De Aar and the associated, existing levels of disturbance prevalent in the area, this proposed complex of solar energy plants is considered unlikely to have any significant, long-term impacts on the local avifauna. However, the considerable spatial extent of this development suggests that it may be an important contributor to the potentially significant, cumulative impacts imposed by this and a number of other planned renewable energy projects on the natural environment of the De Aar area.

A comprehensive programme is put forward to fully monitor and research the actual impacts of this PV proposal on the broader avifauna of the area, from pre-construction and into the operational phase of the development, and the first set of data collected as part of this programme is presented.

2. INTRODUCTION

Mulilo Renewable Energy (Pty) Ltd is planning to construct three photovoltaic (PV) power generation facilities (project name 'Du Plessis DamPV2-4') on portions of the farm Du Plessis Dam 179, just north-east of De Aar, Northern Cape Province, South Africa. Aurecon South Africa (Pty) Ltd were appointed to do the Environmental Impact Assessment (EIA) study, and subsequently appointed *AVISENSE* Consulting cc to conduct the specialist avifaunal assessment. The present report was compiled by Dr Andrew Jenkins and Johan du Plessis. Dr Jenkins is an established ornithologist, with over 20 years of experience in ornithology and impact assessment work. He has been involved in many power line, and wind and solar farm EIA and EMP studies in South Africa, and also does academic research on raptors, bustards and cranes in various parts of the country. Johan du Plessis holds an MSc degree in Zoology from the University of Stellenbosch. He has over six years of experience as a field biologist, and has assisted with field data collection in support of various zoological surveys and EIA studies, including avifaunal monitoring at various wind energy facilities throughout South Africa.

3. DECLARATION OF INDEPENDENCE

Andrew Jenkins and Johan du Plessis (*AVISENSE* Consulting) areindependent consultants to Aurecon South Africa (Pty) Ltd and Mulilo Renewable Energy (Pty) Ltd. They have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were 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 these specialists in performing such work.

4. TERMS OF REFERENCE

The terms of reference for the full EIA, as supplied by Aurecon, were to:

- Review the latest literature on bird-solar power interactions as a desk-top exercise.
- Undertake the requisite field work to directly assess the habitats present within the inclusive impact zone, and to determine the *in situ* avifauna.
- Integrate the on-site information with bird atlas (Southern African Bird Atlas Project - SABAP - 1 & 2) and any other relevant data available for the general area, to develop and inclusive, annotated list of the birds likely to occur on the site, highlighting red-listed species, endemic, restricted-range or other species of particular concern that may occur in the study area.
- Identify, describe and assess potential direct and indirect and cumulative impacts resulting from the proposed development both on the footprint and the immediate surrounding area during construction and operation.
- Recommend mitigation measures to reduce or eliminate potential negative impacts on avifauna, and improve positive impacts.

5. LIMITATIONS AND ASSUMPTIONS

Any inaccuracies or deficiencies in the primary sources of information used in the compilation of this report could limit its value. The SABAP1 data (see below) for the De Aar area are now >15 years old (Harrison *et al.* 1997), and comprise only 27 bird atlas cards for the relevant quarter-degree square, while there is presently only five SABAP 2 atlas card for the relevant pentad. No more reliable and/or more recent formal data on bird species presence and abundance in the study area currently exist.

The site visit (conducted on 7 May and 11 May 2013), in combination with previous visits to the immediate area for EIA work on neighbouring or associated renewable energy projects (Jenkins 2010, 2011, 2012), goes some way towards remedying this knowledge deficiency. However, with limited time in the field, and no seasonal spread, it is possible that important components of the local avifauna – nest sites, localized areas of key habitat for rare or threatened species – were missed.

Given that there are currently no solar energy facilities operative in South Africa, there are no existing data on the environmental effects of these installations in this country.

6. STUDY METHODOLOGY

6.1 Approach

The study included the following steps:

- A review was done of available published and unpublished literature pertaining to bird interactions with solar energy facilities and associated power infrastructure, summarizing the issues involved and the current level of knowledge in this field. Various information sources (listed below), including data on the birdlife of the area and previous studies of bird interactions with solar energy facilities and electricity infrastructure, were examined.
- A short visit to the development area to determine first-hand the avian habitats present, and to start the process of data collection to quantify aspects of the avifauna as part of a monitoring project spanning the pre-construction to operational phases of the proposed development (see below).
- Compilation of an inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed PV facilities was compiled using a combination of the existing distributional data, species seen during the site visit, and previous experience of the avifauna of the general area.
- Compilation of a short-list of priority bird species (defined in terms of conservation status and endemism) which could be impacted by the proposed PV facilities was extracted from the total bird list. These species were subsequently considered as adequate surrogates for the local avifauna in general, and mitigation of impacts on these species was considered likely to accommodate any less important bird populations that may also potentially be affected.

- Construction of a matrix of possible impacts on the local avifauna was drawn up for the proposed PV facilities, and the significance of these impacts was assessed in terms of the available suite of mitigation options.

6.2 Data sources used

The following data sources and reports were used in the compilation of this report:

- Bird distribution data of the SABAP (Harrison *et al.* 1997) were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the SABAP 1 quarter-degree square covering the proposed PV facilities and its associated infrastructure(3024CADe Aar), and for the relevant SABAP 2 pentad (3035_2400). A composite list of species likely to occur in the impact zone of the PV facilities was drawn up as a combination of these data, refined by a more specific assessment of the actual habitats affected, based on general knowledge of the birds of the region (Appendix 1).
- The conservation status and endemism of all species considered likely to occur in the area was determined from the national Red-list for birds (Barnes 2000), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Information on nesting raptors and large bird collision rates on the nearby Eskom Hydra-Droërivier 1-3 and Hydra-Proteus 400 kV transmission lines from the Eskom Electric Eagle Project (Jenkins *et al.* 2007, Jenkins et al. 2013), and recent bustard and crane collision surveys (Jenkins *et al.* 2009, Jenkins *et al.* 2011).
- Lesser Kestrel roost counts for De Aar from the Endangered Wildlife Trust's Migrating Kestrel Project (A.J. Van Zyl pers. comm., https://www.ewt.org.za/programmes/BoPP/kestrel.html).

7. OVERVIEW OF THE PROPOSAL

The Du Plessis Dam Energy Facilities are proposed for the farm Du Plessis Dam 179, near the town De Aar, Northern Cape, and in addition to an already authorized 19.9 MW PV plant on a different portion of the same property. The new proposal is for three additional, but encompassing, 75MW PV energy plants (Fig. 1) with a combined extent of approximately 854 ha. Additional electrical infrastructure will include three dedicated substations i.e. one for each of the proposed PV facilities, all of which will feed into a forth three-bay substation via a 132 kW overhead transmission line. The entire facility will then be connected to the De Aar Substation via a 132 kV overhead transmission line, running in one of two proposed transmission corridors. The proposed alternative to the preferred project (Fig. 1) extends and combines the three proposed 75MW plants and the already authorized 19.9 MW plant into a single 400 MW facility with a total extent of approximately 1068 ha. Additional proposed infrastructure includes a road network and a construction camp.

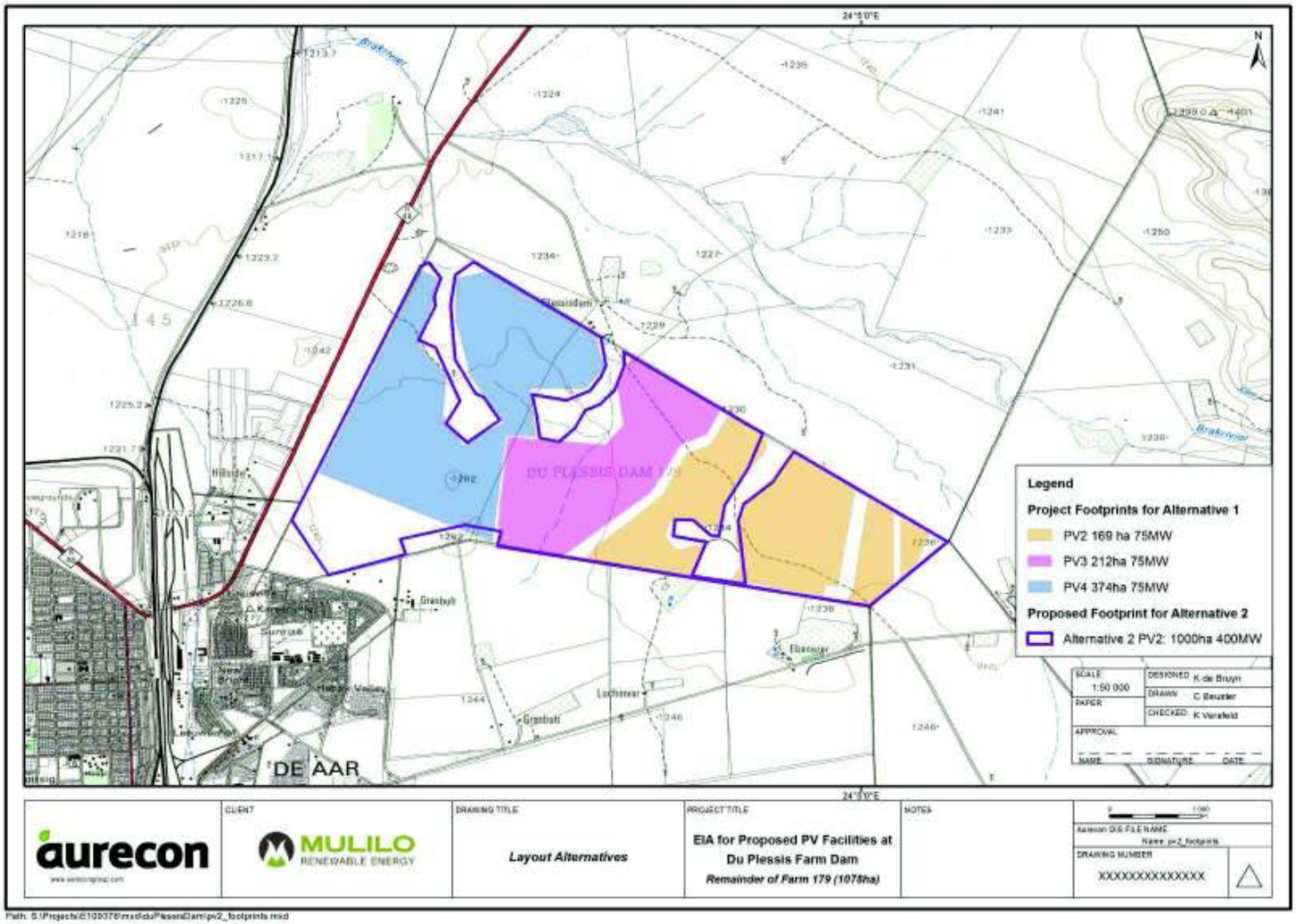

Figure1. The preferred location and layout of the Du Plessis DamPV2-4 Energy Facilities, in relation to the entire contracted property, and the town of De Aar.

8. DESCRIPTION OF THE AFFECTED ENVIRONMENT

8.1 Vegetation of the study area

The study area is located in the Upper Karoo Bioregion of the Nama Karoo Biome (Mucina & Rutherford 2006). The natural vegetation of both location options is dominated by Northern Upper Karoo – dry Karoo shrubland with drought resistant grasses and scattered low trees (Mucina & Rutherford 2006).). Altitude on the site varies very little (1230-1370 metres above sea level).The area receives about 200 mm of rain per annum, most of which falls in autumn (February-March). Temperatures range from a mean winter minimum of about 0.3ºC, to a mean summer maximum of about 30ºC.

8.2 Avian microhabitats

These comprise mainly degraded areas of grassy Karoo veld, with limited amounts of taller vegetation and low trees (including alien spp.) along drainage lines, at least one small artificial waterbody and possibly some ephemeral wetlands present in wet years. High stocking rates and grazing pressure has resulted in lower vegetation and a generally more open habitat than would naturally occur in the area. The site is closely adjacent to the town of De Aar and is already subject to significant levels of human disturbance. It is also proximal to the Eskom Hydra substation and a number of major power transmission lines run close to or through the site, including the new Gamma-Perseus 765 kV line. Land-use is primarily small stock and game farming, and the area includes a network of minor farm roads or tracks.

8.3 Avifauna of the impact area

Up to 220 bird species could occur within the anticipated, broader impact zone of the solar energy facilities (Appendix 1), including 69 endemic or near-endemic species, 15 red-listed species, and four species – Ludwig's Bustard *Neotis ludwigii*, Blue Korhaan *Eupodotis caerulescens*, Blue Crane *Anthropoides paradiseus* and Black Harrier *Circus maurus* – which are both endemic and red-listed (Barnes 1998, 2000, Table 1). The site falls within the Platberg-Karoo Conservancy Important Bird Area (Barnes 1998), which supports critical or regionally significant populations of a number of potentially collision prone or otherwise sensitive species.

The birds of greatest potential relevance and importance in terms of the possible impacts of the PV facilities are likely to be local populations of endemic passerines (including Karoo Long-billed Lark *Certhilauda subcoronata*, Rufous-eared Warbler *Malcorus pectoralis*, and Black-headed Canary *Serinus alario*), visiting or resident Blue Korhaan, Karoo Korhaan *Eupodotis vigorsii*, Northern Black Korhaan *Afrotis afroides* and Blue Crane, and locally resident or passing raptors, especially red-listed species - Martial Eagle *Polemaetus bellicosus*, Tawny Eagle *Aquila rapax*, Lesser Kestrel *Falco naumanni*, and possibly Peregrine Falcon *Falco peregrines*, Lanner Falcon *Falco biarmicus*, and regional endemics such as Jackal Buzzard *Buteo rufofuscus* and Southern Pale Chanting Goshawk *Melierax canorus*. Surveys of large raptors nesting in Eskom transmission pylons in this area (Jenkins *et al.* 2007, 2013) suggest that the closest site to the development area is a recently active Tawny Eagle nest on tower 33 (30° 43.466 S, 23º

58.457 E) of the Hydra-Kronos 400 kV line – 11.4 km to the south-west of the development area. Note that there may be other large eagle nests on un-surveyed pylon lines located closer to the site than this. There is also a large (up to 12 000 birds – A.J. Van Zyl pers. Comm.), Lesser Kestrel roost located around the De Aar Hospital about 4 km to the south-west of the development area, used by these Palaearctic migrants during the austral summer (October to March). Numbers of this species were seen on the site during a specialist site visit in 2012 (Harebottle 2012).

The birds most likely to proliferate and become active around the facility, possibly causing fouling problems, could include Speckled Pigeon *Columba guinea*, Greater Kestrel *Falco rupicolus*, Southern Pale Chanting Goshawk, Cape Crow *Corvus capensis*, Pied Crow *Corvus albus*, Common Starling *Sturnus vulgaris*, Cape Sparrow *Passer melanurus*, and House Sparrow *Passer domesticus*, and possibly variety of other perch-hunting hunting and insectivorous passerines.

Only 34 species were seen on the study site during the May field visit (Appendix 1), including an adult Martial Eagle seen perched on the 765 kV pylon just to north-east of the site, with an immature flying overhead, and two sightings of single Ludwig's Bustards, and two flocks of Blue Cranes, comprising nine and 16 birds. Northern Black Korhaan was present in numbers, and densities of regionally endemic passerines – e.g. Sabota Lark *Calendulauda sabota*, Large-billed Lark *Galerida magnirostris*, Eastern Clapper Lark *Mirafra fasciolata*, Spike-heeled Lark *Chersomanes albofasciata* and Rufous-eared Warbler were relatively high across much of the development area (see monitoring data in Table 3 and Appendix 2, below).

On the basis of these observations, in combination with already documented information on the avifauna of the general area, 11 priority species are recognized as key in the assessment of avian impacts of the proposed Du Plessis Dam PV Energy Facilities (Table 1). These are mostly nationally and/or globally threatened species which are known to occur, or could occur, in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the PV solar power plant project. Four species were included despite the fact that they were not recorded in either SABAP 1 or SABAP 2 data for the area, either because (a) they were seen on site, (b) the site is located within their respective distributions and the available habitat is possibly suitable, or (c) they may occasionally fly over the site *en route* between distant resource areas, and in so doing be exposed possible impacts.

Overall, the avifauna of the development site itself is entirely replaceable, at best replicating that which occurs across huge areas of the Eastern Karoo. However, the considerable spatial extent of this development suggests that it may be an important contributor to the potentially significant, cumulative impacts imposed by this and a number of other planned renewable energy projects on the natural environment of the De Aar area.

Table 1. Priority bird species considered central to the avian impact assessment process for the proposed Du Plessis DamPV Energy Facilities, selected mainly on the basis of South African (Barnes 2000) or global conservation status (www.iucnredlist.org or http://www.birdlife.org/datazone/species/), level of endemism, relative abundance on site (SABAP reporting rates, direct observation), and estimated conservation or ecological significance of the local population. Red-listed endemic species are shaded in grey.

Common name	Scientific name	SA conservation status/ (Global conservation status)	Regional endemism	Average reporting rate[1] (*n* = 32cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	Near-endemic	6.3	Moderate-High	Open Karoo	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	18.8	Moderate	Open Karoo	High	-	Moderate
Blue Korhaan		Near-threatened	-	0.0	Moderate	Grassy Karoo	High	-	Moderate
Blue Crane	*Anthropoides paradiseus*	Vulnerable	Endemic	31.3	High		High	-	Moderate
Tawny Eagle	*Aquila rapax*	Vulnerable	-	0.0	Low				
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	3.1	Moderate-High	Open Karoo, power pylons	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened (Vulnerable)	-	18.8	Moderate	Open Karoo	High	-	Moderate
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	15.6	Moderate	Open Karoo, power pylons	Moderate	-	Moderate
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	0.0	Moderate	Open Karoo, power pylons	High	Moderate	-
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	0.0			High	Moderate	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-	9.4	Low	Wetlands, flying over	High	-	-

[1] Reporting rate calculated as the % of bird lists submitted for a given area which include each species.

9. ASSESSMENT OF IMPACTS

9.1 General assessment of impacts &mitigation

9.1.1 Impacts of solar energy facilities

Habitat loss – destruction, disturbance and displacement

Perhaps the most significant potential impact on birds of any solar energy generation facility is the displacement or exclusion of threatened, rare, endemic or range-restricted species from critical areas of habitat. Given the considerable space requirements of commercially viable facilities (>50-100 ha), this effect could be significant in some instances, particularly given the possibility that the initial footprint of successful facilities may be expanded over time, and allowing for the possible cumulative effects of multiple facilities in one area.

To a lesser extent, construction and ongoing maintenance activities are likely to cause some disturbance of birds in the general surrounds of a solar facility, and especially of shy and/or ground-nesting species resident in the area. Mitigation of such effects requires that generic best-practice principles be rigorously applied - sites are selected to avoid the destruction of key habitats, and construction and final footprints, as well as sources of disturbance of key species, must be kept to an absolute minimum.

Other effects

Any vertical, reflective surfaces may confuse approaching birds with the result that numbers are killed in collisions with such surfaces. If this source of unnatural mortality is a realistic expectation of a proposed solar installation, efforts should be made to restrict access by birds into the relevant, hazardous areas of the facility. Solar installations generally feature large areas of reflective paneling. It is possible that nearby or overflying birds may be disorientated by the reflected light, and consequently be displaced from an area more extensive than just the developed footprint of the facility.Conversely, certain bird species may be attracted to the solar arrays. The possibility also exists that waterbirds will mistake the reflective surface for an expanse of water, and attempt to land on the panels, incurring injury and/or being disorientated in the process. Other species may seek to benefit from the installations, using the erected structures as prominent perches, sheltered roost sites or even nesting sites, and possibly foraging around the infrastructure in response to changes in the distribution of preferred foods (plants growing under the paneling, other animals attracted to the facility). Such scenarios might be associated with fouling of critical components in the solar array, bringing local bird populations into conflict with the facility operators. Under these circumstances, specialist advice should be sought in devising effective avian deterrents to minimize associated damage.

9.1.2 Impacts of associated infrastructure

Infrastructure commonly associated with solar energy facilities may also have detrimental effects on birds. The construction and maintenance of substations, power lines, servitudes and roadways causes both temporary and permanent habitat destruction and disturbance, and overhead power lines pose a collision and possibly an electrocution threat to certain species (Van Rooyen 2004a, Lehman *et al.* 2007, Jenkins *et al.* 2010).

Construction and maintenance of power lines and substations

Some habitat destruction and alteration inevitably takes place during the construction of power lines, substations and associated roadways. Also, power line service roads or servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, and to prevent vegetation from intruding into the legally prescribed clearance gaps between the ground and the conductors. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any given power line (e.g. King & Byers 2002).

Collision with power lines

Power lines pose a significant collision risk to birds, affecting a particular suite of collision prone species (Bevanger 1994, 1995, 1998, Janss 2000b, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins *et al.* 2010). Mitigation of this risk involves the informed selection of low impact alignments for new power lines relative to movements and concentrations of high risk species, and the use of either static or dynamic marking devices to make the lines, and in particular the earthwires, more conspicuous. While various marking devices have been used globally, many remain largely untested in terms of their efficacy in reducing collision incidence, and those that have been fully assessed have all been found to be only partially effective (Drewitt & Langston 2008, Jenkins *et al.* 2010).

Electrocution on power infrastructure

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004b, Lehman *et al.* 2007). Electrocution risk is strongly influenced by the voltage and design of the power lines erected (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energised components. Mitigation of electrocution risk involves the use of bird-safe structures (ideally with critical air gaps >2 m), the physical exclusion of birds from high risk areas of live infrastructure, and comprehensive insulation of such areas (van Rooyen 2004b, Lehman *et al.* 2007).

9.2 Project specific impacts

Specific impacts of the proposed Du Plessis Dam PV Energy Facilities are most likely to be manifested in the following ways (summarised in Table 2):

(i) Disturbance and displacement of seasonal influxes of large terrestrial birds (especially Blue Crane, Ludwig's Bustard and Kori Bustard) from nesting and/or foraging areas by construction and/or operation and/or decommissioning of the facilities, and /or mortality of these species in collisions with new power lines while commuting between resource areas.

(ii) Disturbance and displacement of resident or visiting raptors (especially Martial Eagle, Tawny Eagle and Lesser Kestrel) from foraging areas by construction and/or operation and/or decommissioning of the facilities, and /or mortality of these species in collisions with new power lines or by electrocution when perched on power infrastructure.

(iii) Disturbance and displacement of resident/breeding Karoo endemics.

(iv) Injury or mortality of wetland birds (especially flamingos) using possible flight lines in and out of resource areas in the broader vicinity, in collisions with the PV infrastructure or associated new power lines.

Generally, however, the anticipated impacts on birds of the proposed development are not considered to be of any great significance (Boxes 1.1 – 1.3, Table 3). There will be some habitat loss for Karoo endemic species (although the general area at the site is already somewhat degraded and disturbed), some species (Karoo endemics, large terrestrial species, raptors) may be displaced from a broader area either temporarily by construction and maintenance activities, or more permanently by the disruptive, reflective properties of the solar panels, and some species (large terrestrial species, raptors, commuting wetland birds) may be killed in interactions (collisions, electrocutions) with the new power infrastructure, but again, numbers affected are likely to be low.

Table 2. Impact characteristics: Du Plessis DamPV Energy Facilities – Birds.

Summary	**Construction**	**Operation**	**Decommissioning**
Project Aspect/ activity	(i) Disturbance/displacement associated with noise and movement of construction equipment and personnel. (ii) Loss of vegetation and avian habitat through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas.	(i) Loss of habitat to space occupied by solar panels and associated infrastructure, and disturbance / displacement associated with routine maintenance work. (ii) Mortality in collisions with solar panels and/or power lines, or by electrocution on new power infrastructure.	(i) Disturbance/displacement associated with noise and movement of decommissioning equipment and personnel.
Impact Type	Direct	Direct	Direct
Receptors Affected	(i) All birds on site; key species: Ludwig's Bustard, Kori Bustard, Blue Korhaan, Blue Crane, Martial Eagle, Tawny Eagle, Lesser Kestrel, Blue Crane, Karoo endemics. (ii) All birds on site; key species: Ludwig's Bustard, Kori Bustard, Blue Korhaan, Blue Crane, Martial Eagle, Tawny Eagle, Lesser Kestrel, Karoo endemics.	(iii) All birds on site; key species: Ludwig's Bustard, Kori Bustard, Blue Korhaan, Blue Crane, Martial Eagle, Tawny Eagle, Lesser Kestrel, Blue Crane, Karoo endemics. (i) All birds on site; Ludwig's Bustard, Kori Bustard, Blue Korhaan, Blue Crane, Martial Eagle, Tawny Eagle, Lesser Kestrel, Blue Crane, overflying wetland birds.	(i) All birds on site; key species: Ludwig's Bustard, Kori Bustard, Blue Korhaan, Blue Crane, Martial Eagle, Tawny Eagle, Lesser Kestrel, Blue Crane, Karoo endemics.

Box 1.1. **Pre-mitigation Construction Impact: Du Plessis Dam PV2-4 Energy Facilities – Birds**, with ratings for the alternative proposal (where these differ) in square brackets. Significance ratings ascribed as per the criteria provided by Aurecon South Africa.

(A) Habitat loss

Nature: All construction activities would result in a **negative direct** impact on the avifauna of the Du Plessis Dam site: loss of vegetation and habitat affecting Karoo endemics, raptors and large terrestrial species, through site clearance, road upgrade and establishment of the camp and assembly areas.

Impact Magnitude – Low-Medium [Medium]

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **short-term** as the ecology of the area may be altered beyond the completion of the project.
- **Probability:** Habitat will **definitely** be lost.

IMPACT SIGNIFICANCE – LOW-MEDIUM [MEDIUM]

Confidence: Certain

Reversibility: Reversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

(B) Disturbance

Nature: All construction activities would result in a **negative direct** impact on the avifauna of the Du Plessis Dam PV site; disturbance associated with noise and movement of construction equipment and personnel, affecting Karoo endemics, raptors and large terrestrial species.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is **local [regional]**.
- **Duration**: The duration will not extend beyond the **construction period**.
- **Probability:** There will **definitely** be disturbance.

IMPACT SIGNIFICANCE – [MEDIUM]

Confidence: Certain

Reversibility: Possibly reversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

Box 1.2. **Pre-mitigation Operation Impact: Du Plessis Dam PV2-4 Energy Facilities – Birds,** with ratings for the alternative proposal (where these differ) in square brackets. Significance ratings ascribed as per the criteria provided by Aurecon South Africa.

(A) Habitat loss and disturbance

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the Du Plessis Dam PV site; loss of habitat for Karoo endemics, raptors and large terrestrial species, to space occupied by solar panels and associated infrastructure, and disturbance or displacement of these birds by routine maintenance activities.

Impact Magnitude – **Low-Medium [Medium]**

- **Extent**: The extent of the impact is potentially **local**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected until the project stops operating and is fully decommissioned.
- **Probability:** Habitat will **definitely** be lost and some priority species will be disturbed/displaced.

IMPACT SIGNIFICANCE – LOW- MEDIUM [MEDIUM]

Confidence: Certain

Reversibility: Possibly reversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

(B) Mortality

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the Du Plessis Dam PV site; mortality of raptors, large terrestrials in collisions with solar panels and/or power lines, or by electrocution on new power infrastructure.

Impact Magnitude – **Medium-High**

- **Extent**: The extent of the impact is potentially **regional**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating and is fully decommissioned.
- **Probability:** It is **probable** that some individuals of priority species will be killed.

IMPACT SIGNIFICANCE – MEDIUM-HIGH

Confidence: Unsure

Reversibility: Irreversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

Box 1.3. **Pre-mitigation Decommissioning Impact: Du Plessis Dam PV2-5 Energy Facilities – Birds**, with ratings for the alternative proposal (where these differ) in square brackets. Significance ratings ascribed as per the criteria provided by Aurecon South Africa.

(A) Disturbance

Nature: All decommissioning activities would result in a **negative direct** impact on the avifauna of the Du Plessis Dam PV site; disturbance associated with noise and movement of decommissioning equipment and personnel, affecting Karoo endemics, raptors and large terrestrial species.

Impact Magnitude – Low-Medium [Medium]

- **Extent**: The extent of the impact is **local [regional]**.
- **Duration**: The duration will not extend beyond the **decommissioning period**.
- **Probability:** There will **definitely** be disturbance.

IMPACT SIGNIFICANCE – LOW-MEDIUM [MEDIUM]

Confidence: Certain

Reversibility: Reversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

Table 3. Pre- and Post- Mitigation Significance: Du Plessis Dam PV2-4 Energy Facilities - Birds; preferred *vs* alternative layout options. Significance ratings ascribed as per the criteria provided by Aurecon South Africa.

Impact	Alternative layout Pre-mitigation	Alternative layout Residual (post-mitigation)	Preferred layout Pre-mitigation	Preferred layout Residual (post-mitigation)
Construction Phase				
Habitat loss	MEDIUM	LOW-MEDIUM	LOW-MEDIUM	LOW
Disturbance	MEDIUM	LOW-MEDIUM	MEDIUM	LOW-MEDIUM
Operation Phase				
Habitat loss & disturbance	MEDIUM	MEDIUM	LOW-MEDIUM	LOW-MEDIUM
Mortality	MEDIUM-HIGH	LOW-MEDIUM	MEDIUM-HIGH	LOW-MEDIUM
Decommissioning Phase				
Disturbance	MEDIUM	LOW-MEDIUM	LOW-MEDIUM	LOW

Cumulative avifauna impacts

Key impacts	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Without Mitigation	High	Permanent	Very High (-)	Definite	Certain	Irreversible
With Mitigation	High	Permanent	High (-)	Definite	Certain	Irreversible

Note that the anticipated net impacts of this proposed development should ideally be considered in the context of accumulated impacts imposed by multiple other renewable energy projects proposed (and some already authorized and under construction) within a 20 km radius of De Aar (Fig. 2). Furthermore, the project itself comprises a number of potentially independent PV installations, each of which has its own inherent impact profile, contributing to the net aggregate impact of the whole proposed development. While the impact potential of each separate PV array must, by definition, be less than the sum of all the components together, we have assumed here that each component has the same impact as the sum, partly in the interests of conservatism and pragmatism, and partly because the assessment criteria imposed on the study do not allow for a finer scale evaluation of relative impacts.

The negative impacts resulting from all phases of this proposed development (i.e. development to the extent of individual farms) would certainly be substantially amplified by the construction and operation of multiple renewable energy projects in the area (development to the extent of broader localities or even regions). Relatively minor levels of disturbance at the individual project level (i.e. farm) would escalate to combined levels likely to cause complete and possibly long-term evacuation of the locality or region by more sensitive species. These disturbance effects would be exacerbated by the loss or degradation of markedly more habitat to a much larger aggregate construction and operational footprint, possibly resulting in the permanent loss from the affected area of key elements of the avifauna. Bearing this in mind, it is essential that the suitability of this single proposal be considered in the context of broader renewable energy development plans for De Aar and surrounding areas.

10. MITIGATION

Should the proposed PV Facilities be approved, mitigation of impacts on birds should focus on:

(i) Selecting the preferred layout option, given that this occupies a markedly smaller development footprint.

(ii) Minimizing the inclusive construction footprint of the development and abbreviating construction time.

(iii) Minimizing noise and disturbance associated with maintenance activities at the plant once it becomes operational.

(iv) Selecting the PV technology that is least likely to be mistaken for a waterbody by overflying wetland birds.

(v) Selecting the alternative 2 proposed transmission line corridor, this decision is based on the fact that this option is shorter in length and therefore decreases the risk to collision prone species.

(vi) Minimising the length of any new power lines installed and burying lines wherever possible. If lines cannot be buried, ensure that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010) along their entire length, and that all new power line infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007). Note that current understanding of power line collision risk in birds precludes any guarantee of successfully distinguishing high risk from medium or low risk sections of a new line (Jenkins *et al.* 2010). The relatively low cost of marking the entire length of a new line during construction, especially quite a short length of line in an area frequented by collision prone birds, more than offsets the risk of not marking the correct sections, causing unnecessary mortality of birds, and then incurring the much greater cost of retro-fitting the line post-construction. In situations where new lines run in parallel with existing, unmarked power lines, this approach has the added benefit of reducing the collision risk posed by the older line.

(vii) Minimising the amount of fencing used to enclose the development areas, given that these may present a collision risk for collision-prone birds.

(viii) Instituting a comprehensive impact monitoring scheme, and using the results of this scheme to inform and refine a dynamic approach to mitigation.

11. CONCLUSION

The proposed Du Plessis Dam PV Facilities are likely to have little, if any significant, long-term impact on the avifauna of the area, after mitigation. Careful and responsible implementation of the required mitigation measures should reduce construction and operational phase impacts to tolerable and sustainable levels, especially if every effort is made to monitor impacts throughout, to learn as much as possible about the effects of solar energy developments on South African avifauna, and to implement mitigation measures suggested as a result of ongoing monitoring.

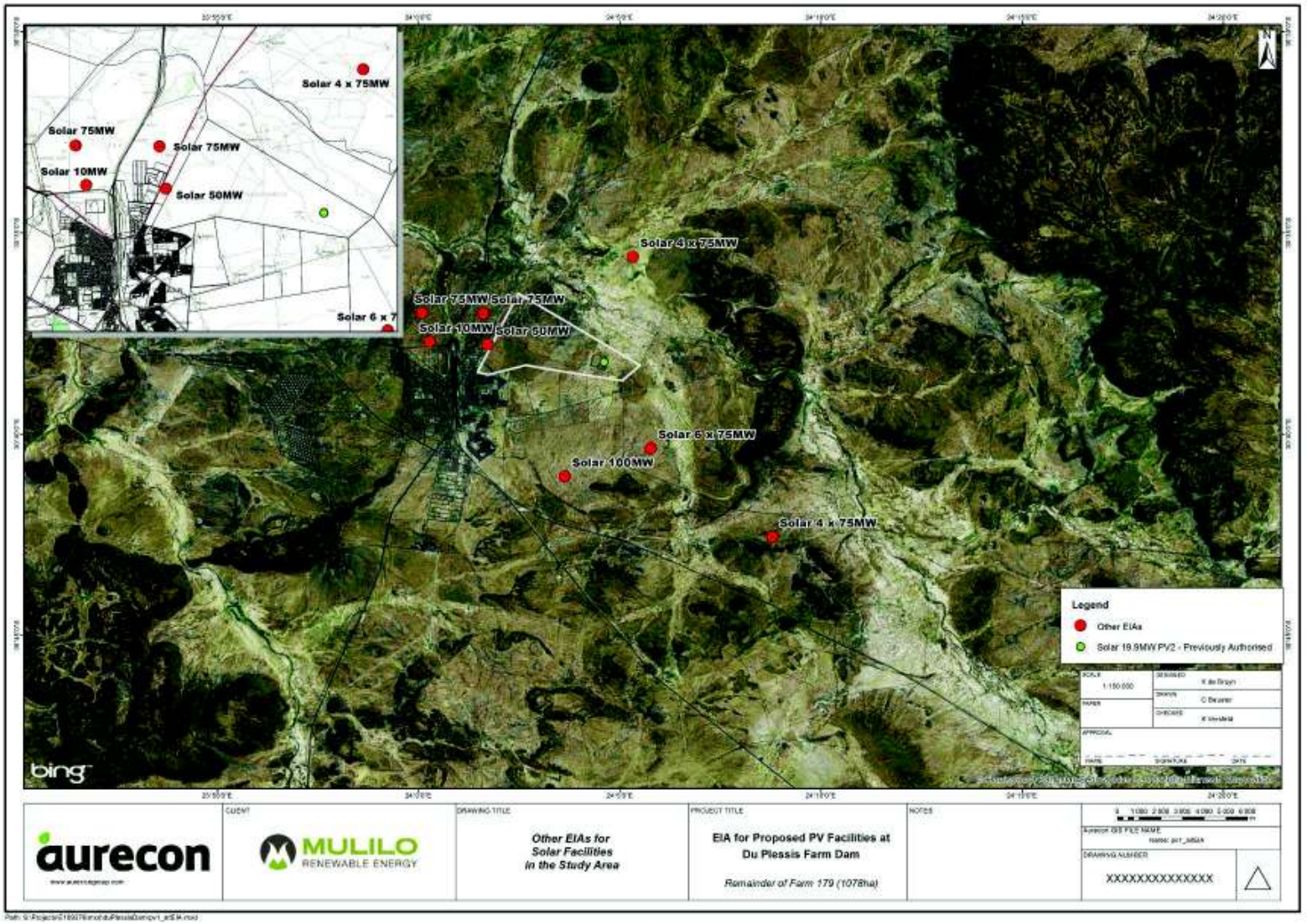

Figure 2. The location of the Du Plessis Dam PV Energy Facilities in relation to other renewable energy projects proposed for the De Aar area.

12. LONG-TERM MONITORING

12.1 Rationale for monitoring

Given that solar energy development is relatively new to South Africa, and its potential impacts on birds are generally not well understood, it is strongly recommended that attention be given to improving this understanding by initiating quantitative studies of the avifauna at proposed sites both pre- and post-construction (Smit 2012). The primary aims of such monitoring work would be to:

(i) Determine the densities of birds resident within the impact area of the solar power plant before construction of the plant, and afterwards, once the plant, or phases of the plant, become operational.

(ii) Register and as far as possible document the circumstances surrounding all avian mortalities associated with the ancillary infrastructure of the solar plant for at least six months after the plant becomes operational.

(iii) Register and as far as possible document the circumstances surrounding all other avian interactions with the solar arrays of the solar power plant for at least six months after the plant becomes operational.

Bird density and activity monitoring should focus on rare and/or endemic, potentially disturbance or collision prone species, which occur with some regularity in the area. Ultimately, the study should provide much needed quantitative information on the effects of the solar power plant on the distribution and abundance of birds, and the actual risk it poses to the local avifauna, and serve to inform and improve mitigation measures to reduce this risk.

Monitoring protocols: Avian densities before and after

A set of at least 10 walk-transect routes, each of at least 20 minutes in duration or 750 m in length, should be established in areas representative of all the avian habitats present within and around the periphery of the Du Plessis PV site. Each of these should be walked at least once every two months over the six months preceding construction, and at least once every two months over the same calendar period, at least six months after the PV plant is commissioned. The transects should be walked after 06h00 and before 09h00 in summer, and after 07h00 and before 12h00 in winter, and the species, number and perpendicular distance from the transect line of all birds seen should be recorded for subsequent analysis and comparison.

Monitoring protocols: collisions and fouling

The area within 5 m on either side of any new lengths of power line, should be checked regularly for bird casualties (Anderson *et al.* 1999, Morrison 2002). The frequency of these surveys should be informed by assessments of scavenge and decomposition rates. All suspected mortality incidents should be comprehensively documented, detailing the apparent cause of death, precise location (preferably a GPS reading), date and time at which the evidence was found, and the site of the find should be photographed with all the evidence *in situ*. All physical evidence should then be collected, bagged and carefully labeled, and refrigerated or frozen to await further examination. If any injured birds are recovered, each should be contained in a suitably-sized cardboard box, and the local conservation authority should be notified and

requested to transport casualties to the nearest reputable veterinary clinic or wild animal/bird rehabilitation centre.

These post-construction surveys should also include detailing (location, extent, size, number) of all bird products (e.g. faeces, pellets, nest structures etc) found on and around the solar panels.

12.2 Results of first monitoring iteration

Seventeen walk transects were established within (n = 9) and outside (n = 5) of the proposed development area (Fig. 4), and surveys of small terrestrial bird densities were measured along each of these transect lines as per the stipulated protocols (Table 4, Appendix 2). In combination with the data obtained in two further site visits, these initial density estimates will establish a baseline against which to estimate the numbers of Karoo endemic passerines displaced by the development, and to monitor the effect of the built and operational PV plants on the density and community structure of surrounding passerine populations.

Other results of the first monitoring iteration are integrated into this EIA report.

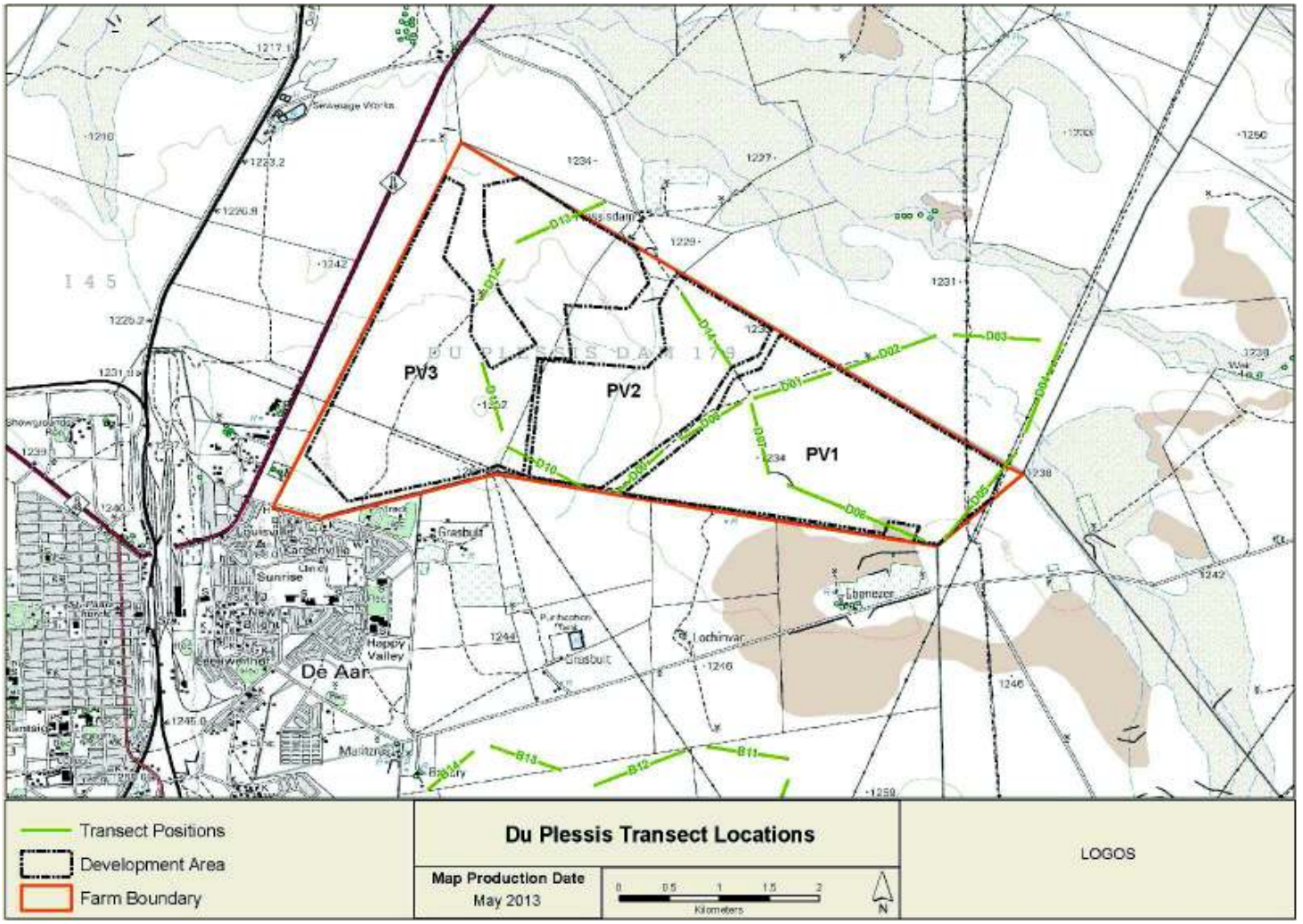

Figure 4. Layout and location of the small terrestrial bird transects walked in and around the Du Plessis Dam PV development area.

Table 4. Parameters describing the 20 min walked transects plotted (see Fig. 4) and sampled in and around the Du Plessis Dams Pan PV development area. Cloud cover: 0-8 eighths; Temp(erature): 1 = cool, 2 = mild, 3 = warm, Wind: 1= calm, 2 = breeze, 3 = wind, 4 = strong wind.

Transect number	Start time (hh:mm)	Cloud cover	Temp	Wind	Inside PV footprint?	Habitat	Gradient	Length (km)	Mean transect width (m)	*n* sightings	*n* birds	Density (birds.ha^{-1})
D01	08:05	0	1	2	Yes	Karoo	Flat	0.73	48	9	44	2.59
D02	08:30	0	1	2	No	Karoo	Flat	0.86	15	9	17	6.90
D03	09:00	0	2	2	No	Karoo	Flat	0.75	51	11	18	2.86
D04	09:26	0	2	2	No	Karoo	Flat	0.95	39	8	12	2.15
D05	09:52	0	2	2	Yes	Karoo	Flat	1.09	27	9	11	3.11
D06	10:20	0	2	2	Yes	Karoo	Flat	1.32	38	4	4	0.81
D07	10:47	0	2	2	Yes	Karoo	Flat	0.73	38	10	32	3.62
D08	08:10	0	1	2	Yes	Karoo	Flat	0.66	24	8	12	5.12
D09	08:40	0	1	2	Yes	Grassy/Karoo	Flat	0.58	40	8	10	3.43
D10	09:05	0	2	2	Yes	Grassy/Karoo	Undulating	0.77	37	9	21	3.17
D11	09:30	0	2	2	Yes	Grassy/Karoo	Undulating	0.71	58	8	15	1.97
D12	10:00	0	2	2	No	Karoo	Undulating	0.45	29	10	34	7.61
D13	10:30	0	2	2	Yes	Karoo	Flat	0.88	32	9	28	3.16
D14	11:10	0	2	2	Yes	Karoo	Flat	0.84	65	6	10	1.09
Overall								**0.81**	**39**	**8.4**	**19.1**	**3.40**

13. REFERENCES

Anderson, R., Morrison, M., Sinclair, K. & Strickland, D. 1999. Studying wind energy/bird interactions: a guidance document. National Wind Coordinating Committee, Washington.

Arcus Gibb. 2009. Photovoltaic Power Generation Facility: De Aar. Unpublished report to Mulilo Renewable Energy Solar PV De Aar (Pty) Ltd.

Barnes, K.N. (ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa, Johannesburg.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. *Ibis* 136: 412-425.

Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electric power lines. *Biological Conservation* 86: 67-76.

Gunerhan, H., Hepbasli, A. & Giresunli, U. 2009. Environmental impacts from the solar energy systems. *Energy Sources, Part A: Recovery, Utilization and Environmental Effects* 31: 131-138.

Harebottle, D.M. 2012. Construction of three photovoltaic energy facilities near De Aar, Northern Cape. Report to Aurecon (Pty) Ltd.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1&2. BirdLife South Africa, Johannesburg.

Hockey, P.A.R., Dean, W.R.J., Ryan, P.G. (Eds) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Jenkins, A.R. 2010. Prieska PV solar energy facility: Avian impact assessment. Report to DJ Environmental (Pty) Ltd.

Jenkins, A.R. 2011. Copperton wind energy facility: avian impact assessment. Report to Aurecon South Africa (Pty) Ltd.

Jenkins, A.R. 2012. Hoekplaas Photovoltaic Energy Facility: avian impact assessment. Report to Aurecon South Africa (Pty) Ltd.

Jenkins, A.R., de Goede, J.H. & van Rooyen, C. 2007. Improving the products of the Eskom Electric Eagle Project. Report to Eskom.

Jenkins, A., Gibbons, B. & Visagie, R. 2009. Long-term fixed site monitoring of wildlife interactions with power lines across a range of biomes: establishment and maintenance of a long-term bird;power line interaction monitoring site in the De Aar (Hydra) area of the eastern Karoo, Northern Cape. Report to Eskom.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. South African perspectives on a global search for ways to prevent avian collisions with overhead lines. *Bird Conservation International* 20: 263-278.

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P. 2011b. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. *Bird Conservation International* 21:303-310.

Jenkins, A.R., de Goede, J.H., Sebele, L. & Diamond, M. 2013. Brokering a settlement between eagles and industry: sustainable management of large raptors nesting on power infrastructure. *Bird Conservation International* 23: 232-246.

King, D.I. & Byers, B.E. 2002. An evaluation of powerline rights-of-way as habitat for early-successional shrubland birds. *Wildlife Society Bulletin* 30: 868-874.

Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: a global review. *Biological Conservation* 136: 159-174.

Morrison, M.L. 2002. Searcher bias and scavenging rates in bird/wind energy studies. National Renewable Energy Report SR-500-30876. NREL, Colorado.

Mucina. L. & Rutherford, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

Osborn, R.G, Higgins, K.F., Usgaard, R.E., Dieter, C.D. & Nieger, R.D. 2000. Bird mortality associated with wind turbines at the Buffalo Ridge wind resource area, Minnesota. *Amer. Midland Naturalist* 143:41-52.

RSPB. 2011. Solar Power. Unpublished briefing, March 2011.

Smit, H.A. 2012. Guidelines to minimize the impact on birds of solar facilities and associated infrastructure in South Africa. BirdLife South Africa, Johannesburg.

Tsoutsos, T., Frantzeskaki, N., Gekas, V. 2005. Environmental impacts from solar energy technologies. *Energy Policy* 33: 289-296.

Turney, D. & Fthenakis, V. 2011. Environmental impacts from the installation and operation of large-scale solar power plants. *Renewable and Sustainable Energy Reviews* 15: 3261-3270.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.D. & Colahan, B.D. (eds). 2003. Big birds on farms: Mazda CAR report 1993-2001. Avian Demography Unit, Cape Town.

Appendix 1. Inclusive, annotated list of the bird species considered likely to occur within the broader impact zone of the proposed locations for the Du Plessis Dam Energy Facilities.

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Common Ostrich	*Struthio camelus*	-	-	X					-	-	High
Common Quail	*Coturnix coturnix*	-	-	X					-	-	High
Helmeted Guineafowl	*Numida meleagris*	-	-		X				Moderate	-	High
White-faced Duck	*Dendrocygna viduata*	-	-				X		Moderate	-	-
Maccoa Duck	*Oxyura maccoa*	-	-				X		Moderate	-	-
Egyptian Goose	*Alopochen aegyptiaca*	-	-				X		High	High	-
South African Shelduck	***Tadorna cana***	**-**	**Endemic**				**X**		**High**	**-**	**-**
Spur-winged Goose	*Plectropterus gambensis*	-	-				X		High	Moderate	-
Cape Teal	*Anas capensis*	-	-				X		Moderate	-	-
African Black Duck	*Anas sparsa*	-	-				X		Moderate	-	-
Yellow-billed Duck	*Anas undulata*	-	-				X		Moderate	-	-
Cape Shoveler	*Anas smithii*	-	Endemic				X		Moderate	-	-
Red-billed Teal	*Anas erythrorhyncha*	-	-				X		Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Southern Pochard	*Netta erythropthalma*	-	-				X		Moderate	-	-
Kurrichane Buttonquail	*Turnix sylvaticus*	-	-	X					-	-	High
Greater Honeyguide	*Indicator indicator*	-	-		X				-	-	-
Lesser Honeyguide	*Indicator minor*	-	-		X				-	-	Moderate
Cardinal Woodpecker	*Dendropicos fuscescens*	-	-		X				-	-	Moderate
Acacia Pied Barbet	*Tricholaema leucomelas*	-	Near-endemic		X				-	-	Moderate
African Hoopoe	*Upupa africana*	-	-		X				-	-	Moderate
European Roller	*Coracias garrulus*	-	-	X	X				-	-	-
Malachite Kingfisher	*Alcedo cristata*	-	-				X		-	-	-
Pied Kingfisher	*Ceryle rudis*	-	-				X		-	-	-
Giant Kingfisher	*Megaceryle maximus*	-	-				X		-	-	-
Swallow-tailed Bee-eater	*Merops hirundineus*	-	-	X	X	X	X		-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
European Bee-eater	*Merops apiaster*	-	-						-	-	-
White-backed Mousebird	*Colius colius*	-	Endemic		X				-	-	Moderate
Red-faced Mousebird	*Urocolius indicus*	-	-		X				-	-	Moderate
Jacobin Cuckoo	*Clamator jacobinus*	-	-		X				-	-	Moderate
Diderick Cuckoo	*Chrysococcyx caprius*	-	-		X				-	-	Moderate
Alpine Swift	*Tachymarptis melba*	-	-					X	-	-	-
Common Swift	*Apus apus*	-	-					X	-	-	-
African Black Swift	*Apus barbatus*	-	-			X		X	-	-	-
Little Swift	*Apus affinis*	-	-			X			-	-	-
White-rumped Swift	*Apus caffer*	-	-					X	-	-	-
Barn Owl	*Tyto alba*	-	-	X	X	X			-	Moderate	Moderate
Southern White-faced Scops-Owl	*Ptilopsis granti*	-	-		X				-	-	Moderate
Cape Eagle-Owl	*Bubo capensis*	-	-			X			-	High	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Spotted Eagle-Owl	*Bubo africanus*	-	-	X	X	X			-	High	Moderate
Fiery-necked Nightjar	*Caprimulgus pectoralis*	-	-	X	X				-	-	Moderate
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	-	-	X					-	-	Moderate
Rock Dove	*Columba livia*	-	-			X		X	-	-	Moderate
Speckled Pigeon	*Columba guinea*	-	-			X		X	-	-	Moderate
Laughing Dove	***Streptopelia senegalensis***	**-**	**-**		**X**				**-**	**-**	**Moderate**
Cape Turtle-Dove	***Streptopelia capicola***	**-**	**-**		**X**				**-**	**-**	**Moderate**
Red-eyed Dove	*Streptopelia semitorquata*	-	-		X				-	-	Moderate
Namaqua Dove	*Oena capensis*	-	-	X	X				-	-	Moderate
Ludwig's Bustard	***Neotis ludwigii***	**Vulnerable**	**Near-endemic**	**X**					**High**	**-**	**Moderate**
Kori Bustard	*Ardeotis kori*	Vulnerable	-	X					High	-	Moderate
Northern Black Korhaan	***Afrotis afraoides***	**-**	**Endemic**	**X**					**Moderate**	**-**	**Moderate**
Karoo Korhaan	*Eupodotis vigorsii*	-	Endemic	X					Moderate	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Blue Korhaan	*Eupodotis caerulescens*	Near-threatened	Endemic	X					Moderate	-	Moderate
Blue Crane	***Anthropoides paradiseus***	**Vulnerable**	**Endemic**	**X**			**X**		**High**	**-**	**Moderate**
Common Moorhen	*Gallinula chloropus*	-	-				X		-	-	-
Red-knobbed Coot	*Fulica cristata*	-	-				X		-	-	-
Namaqua Sandgrouse	***Pterocles namaqua***	**-**	**Near-endemic**	**X**			**X**		**-**	**-**	**-**
African Snipe	*Gallinago nigripennis*	-	-				X		-	-	-
Marsh Sandpiper	*Tringa stagnatilis*	-	-				X		-	-	-
Common Greenshank	*Tringa nebularia*	-	-				X		-	-	-
Wood Sandpiper	*Tringa glareola*	-	-				X		-	-	-
Common Sandpiper	*Actitis hypoleucos*	-	-				X		-	-	-
Little Stint	*Calidris minuta*	-	-				X		-	-	-
Curlew Sandpiper	*Calidris ferruginea*	-	-				X		-	-	-
Ruff	*Philomachus pugnax*	-	-				X		-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Spotted Thick-knee	*Burhinus capensis*	-	-	X	X				-	-	-
Black-winged Stilt	*Himantopus himantopus*	-	-				X		-	-	-
Pied Avocet	*Recurvirostra avosetta*	-	-				X		-	-	-
Kittlitz's Plover	*Charadrius pecuarius*	-	-				X		-	-	-
Three-banded Plover	*Charadrius tricollaris*	-	-				X		-	-	-
Blacksmith Lapwing	*Vanellus armatus*	-	-				X		-	-	-
Crowned Lapwing	*Vanellus coronatus*	-	-	X					-	-	-
Double-banded Courser	*Rhinoptilus africanus*	-	-	X					-	-	-
Burchell's Courser	*Cursorius rufus*	-	Near-endemic	X					-	-	-
Whiskered Tern	*Chlidonias hybrida*	-	-				X		-	-	-
White-winged Tern	*Chlidonias leucopterus*	-	-				X		-	-	-
Black-shouldered Kite	*Elanus caeruleus*	-	-	X	X				-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Black Kite	*Milvus migrans*	-	-	X				X	-	-	-
African Fish-Eagle	*Haliaeetus vocifer*	-	-					X	-	High	-
Black-chested Snake-Eagle	*Circaetus pectoralis*	-	-					X	-	Moderate	Moderate
Black Harrier	*Circus maurus*	Near-threatened	Endemic	X			X		-	-	Moderate
African Harrier-Hawk	*Polyboroides typus*	-	-		X			X	-	-	Moderate
Southern Pale Chanting Goshawk	***Melierax canorus***	**-**	**Near-endemic**	**X**	**X**				**-**	**Moderate**	**Moderate**
Gabar Goshawk	*Melierax gabar*	-	-		X				-	-	Moderate
Rufous-chested Sparrowhawk	*Accipiter rufiventris*	-	-		X				-	-	Moderate
Steppe Buzzard	*Buteo vulpinus*	-	-	X				X	-	Moderate	Moderate
Jackal Buzzard	*Buteo rufofuscus*	-	Endemic	X				X	-	Moderate	Moderate
Tawny Eagle	*Aquila rapax*	Vulnerable	-		X			X	-	High	Moderate
Verreauxs' Eagle	*Aquila verreauxii*	-	-					X	Moderate	High	Moderate
Booted Eagle	*Aquila pennatus*	-	-					X	-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Martial Eagle	***Polemaetus bellicosus***	**Vulnerable**	**-**					**X**	**Moderate**	**High**	**Moderate**
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	X				X	High	-	Moderate
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	X	X			X	Moderate	-	Moderate
Rock Kestrel	*Falco rupicolus*	-	-	X		X			-	-	Moderate
Greater Kestrel	***Falco rupicoloides***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	X				X	High	Moderate	-
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	X				X	High	Moderate	-
Little Grebe	*Tachybaptus ruficollis*	-	-				X		-	-	-
Black-necked Grebe	*Podiceps nigricollis*	-	-				X		-	-	-
African Darter	*Anhinga rufa*	-	-				X		-	-	-
Reed Cormorant	*Phalacrocorax africanus*	-	-				X		-	-	-
White-breasted Cormorant	*Phalacrocorax lucidus*	-	-				X	X	Moderate	-	-
Little Egret	*Egretta garzetta*	-	-				X		-	-	-
Grey Heron	*Ardea cinerea*	-	-				X		Moderate	Moderate	-
Black-headed Heron	*Ardea melanocephala*	-	-	X			X		Moderate	Moderate	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Goliath Heron	*Ardea goliath*	-	-				X	X	High		
Cattle Egret	*Bubulcus ibis*	-	-				X		-	-	-
Hamerkop	*Scopus umbretta*	-	-				X	X	Moderate	-	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-					X	High	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-					X	High	-	-
Glossy Ibis	*Plegadis falcinella*	-	-				X	X	Moderate	-	-
Hadeda Ibis	*Bostrychia hagedash*	-	-		X			X	Moderate	-	-
African Sacred Ibis	***Threskiornis aethiopicus***	**-**	**-**				**X**	**X**	**Moderate**	**-**	**-**
African Spoonbill	*Platalea alba*	-	-				X	X	Moderate	-	-
Black Stork	*Ciconia nigra*	Near-threatened	-				X	X	High	Moderate	-
Abdim's Stork	*Ciconia abdimii*	-	-				X	X	Moderate	Moderate	-
White Stork	*Ciconia ciconia*	-	-				X	X	High	High	-
Fork-tailed Drongo	*Dicrurus adsimilis*	-	-		X				-	-	Moderate
Bokmakierie	*Telophorus zeylonus*	-	Near-endemic		X				-	-	Moderate
Pririt Batis	*Batis pririt*	-	Near-endemic		X				-	-	Moderate
Cape Crow	*Corvus capensis*	-	-	X	X				-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Pied Crow	***Corvus albus***	**-**	**-**	**X**	**X**	**X**			**-**	**-**	**Moderate**
White-necked Raven	*Corvus albicollis*	-	-	X		X			-	-	Moderate
Red-backed Shrike	*Lanius collurio*	-	-	X					-	-	Moderate
Lesser Grey Shrike	*Lanius minor*	-	-	X					-	-	Moderate
Common Fiscal	***Lanius collaris***	**-**	**-**	**X**	**X**				**-**	**-**	**Moderate**
Cape Penduline-Tit	*Anthoscopus minutus*	-	Near-endemic	X					-	-	Moderate
Ashy Tit	*Parus cinerascens*	-	Near-endemic	X					-	-	Moderate
Grey Tit	*Parus afer*	-	Endemic	X					-	-	Moderate
Brown-throated Martin	*Riparia paludicola*	-	-				X	X	-	-	Moderate
Barn Swallow	*Hirundo rustica*	-	-				X	X	-	-	Moderate
White-throated Swallow	*Hirundo albigularis*	-	-				X		-	-	Moderate
Pearl-breasted Swallow	*Hirundo dimidiata*	-	-	X				X	-	-	Moderate
Greater Striped Swallow	*Hirundo cucullata*	-	-				X	X	-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
South African Cliff Swallow	*Hirundo spilodera*	-	Breeding endemic	X		X		X	-	-	Moderate
Rock Martin	***Hirundo fuligula***	**-**	**-**			**X**	**X**	**X**	**-**	**-**	**Moderate**
African Red-eyed Bulbul	*Pycnonotus nigricans*	-	Near-endemic		X				-	-	Moderate
Fairy Flycatcher	*Stenostira scita*	-	Endemic		X				-	-	Moderate
Long-billed Crombec	*Sylvietta rufescens*	-	-	X	X				-	-	Moderate
Yellow-bellied Eremomela	***Eremomela icteropygialis***	**-**	**-**	**X**	**X**				**-**	**-**	**Moderate**
Karoo Eremomela	*Eremomela gregalis*	-	Endemic	X					-	-	Moderate
African Reed-Warbler	*Acrocephalus baeticatus*	-	-				X		-	-	Moderate
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	-	-				X		-	-	Moderate
Willow Warbler	*Phylloscopus trochilus*	-	-		X				-	-	Moderate
Layard's Tit-Babbler	*Parisoma layardi*	-	Endemic	X	X				-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	-	Near-endemic		X				-	-	Moderate
Orange River White-eye	*Zosterops pallidus*	-	Endemic		X				-	-	Moderate
Grey-backed Cisticola	*Cisticola subruficapilla*	-	Near-endemic	X	X				-	-	Moderate
Levaillant's Cisticola	*Cisticola tinniens*	-	-				X		-	-	Moderate
Neddicky	*Cisticola fulvicapilla*	-	-	X					-	-	Moderate
Zitting Cisticola	*Cisticola juncidis*	-	-				X		-	-	Moderate
Desert Cisticola	***Cisticola aridulus***	**-**	**-**				**X**		**-**	**-**	**Moderate**
Black-chested Prinia	*Prinia flavicans*	-	-		X				-	-	Moderate
Karoo Prinia	*Prinia maculosa*	-	Endemic	X	X				-	-	Moderate
Namaqua Warbler	*Phragmacia substriata*	-	Endemic		X				-	-	Moderate
Rufous-eared Warbler	***Malcorus pectoralis***	**-**	**Endemic**	**X**					**-**	**-**	**Moderate**
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*	-	Endemic	X					-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Eastern Clapper Lark	***Mirafra fasciolata***	**-**	**Near-endemic**	**X**					**-**	**-**	**Moderate**
Sabota Lark	***Calendulauda sabota***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Karoo Lark	*Calendulauda albescens*	-	Endemic	X					-	-	Moderate
Spike-heeled Lark	***Chersomanes albofasciata***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Karoo Long-billed Lark	*Certhilauda subcoronata*	-	Endemic	X					-	-	Moderate
Black-eared Sparrowlark	*Eremopterix australis*	-	Endemic	X					-	-	Moderate
Grey-backed Sparrowlark	*Eremopterix verticalis*	-	Near-endemic	X					-	-	Moderate
Red-capped Lark	*Calandrella cinerea*	-	-	X					-	-	Moderate
Pink-billed Lark	*Spizocorys conirostris*	-	Near-endemic	X					-	-	Moderate
Large-billed Lark	***Galerida magnirostris***	**-**	**Endemic**	**X**					**-**	**-**	**Moderate**
Cape Rock Thrush	*Monticola rupestris*	-	Endemic	X					-	-	Moderate
Sentinel Rock Thrush	*Monticola explorator*	-	Endemic	X					-	-	Moderate
Short-toed Rock-Thrush	*Monticola brevipes*	-	Near-endemic			X			-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Karoo Thrush	*Turdus smithi*	-	Endemic		X				-	-	Moderate
Chat Flycatcher	*Bradornis infuscatus*	-	Near-endemic	X					-	-	Moderate
Marico Flycatcher	*Bradornis mariquensis*	-	Near-endemic	X	X				-	-	Moderate
Fiscal Flycatcher	*Sigelus silens*	-	Endemic		X				-	-	Moderate
Spotted Flycatcher	*Muscicapa striata*	-	-		X				-	-	Moderate
Cape Robin-Chat	*Cossypha caffra*	-	-		X				-	-	Moderate
Kalahari Scrub-Robin	*Cercotrichas paena*	-	Near-endemic	X	X				-	-	Moderate
Karoo Scrub-Robin	***Cercotrichas coryphoeus***	**-**	**Endemic**	**X**	**X**				**-**	**-**	**Moderate**
African Stonechat	*Saxicola torquatus*	-	-	X					-	-	Moderate
Mountain Wheatear	*Oenanthe monticola*	-	Near-endemic	X		X			-	-	Moderate
Capped Wheatear	***Oenanthe pileata***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Sickle-winged Chat	***Cercomela sinuata***	**-**	**Endemic**	**X**					**-**	**-**	**Moderate**
Karoo Chat	*Cercomela schlegelii*	-	Near-endemic	X					-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Tractrac Chat	*Cercomela tractrac*	-	Near-endemic	X					-	-	Moderate
Familiar Chat	*Cercomela familiaris*	-	-	X					-	-	Moderate
Ant-eating Chat	***Myrmecocichla formicivora***	**-**	**Endemic**	**X**					**-**	**-**	**Moderate**
Pale-winged Starling	*Onychognathus nabouroup*	-	Near-endemic			X		X	-	-	Moderate
Cape Glossy Starling	*Lamprotornis nitens*	-	-		X				-	-	Moderate
Pied Starling	***Spreo bicolor***	**-**	**Endemic**			**X**		**X**	**-**	**-**	**Moderate**
Wattled Starling	*Creatophora cinerea*	-	-	X	X			X	-	-	Moderate
Common Starling	*Sturnus vulgaris*	-	-		X	X			-	-	Moderate
Malachite Sunbird	*Nectarinia famosa*	-	-		X				-	-	Moderate
Southern Double-collared Sunbird	*Cinnyris chalybeus*	-	Endemic		X				-	-	Moderate
Dusky Sunbird	*Cinnyris fuscus*	-	Near-endemic	X	X				-	-	Moderate
Scaly-feathered Finch	*Sporopipes squamifrons*	-	Near-endemic	X					-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
White-browed Sparrow-Weaver	*Plocepasser mahali*	-	-	X	X				-	-	Moderate
Cape Weaver	***Ploceus capensis***	**-**	**Endemic**		**X**		**X**		**-**	**-**	**Moderate**
Southern Masked-Weaver	*Ploceus velatus*	-	-		X		X		-	-	Moderate
Red-billed Quelea	***Quelea quelea***	**-**	**-**	**X**	**X**		**X**	**X**	**-**	**-**	**Moderate**
Southern Red Bishop	***Euplectes orix***	**-**	**-**				**X**		**-**	**-**	**Moderate**
African Quailfinch	*Ortygospiza atricollis*	-	-	X					-	-	Moderate
Red-headed Finch	***Amadina erythrocephala***	**-**	**Near-endemic**	**X**	**X**				**-**	**-**	**Moderate**
Common Waxbill	*Estrilda astrild*	-	-				X		-	-	Moderate
Red-billed Firefinch	*Lagonosticta senegala*	-	-		X				-	-	Moderate
Pin-tailed Whydah	*Vidua macroura*	-	-		X				-	-	Moderate
House Sparrow	*Passer domesticus*	-	-		X				-	-	Moderate
Cape Sparrow	***Passer melanurus***	**-**	**Near-endemic**	**X**	**X**				**-**	**-**	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Southern Grey-headed Sparrow	*Passer diffusus*	-	-	X	X				-	-	Moderate
African Pied Wagtail	*Motacilla aguimp*	-	-				X		-	-	Moderate
Cape Wagtail	***Motacilla capensis***	**-**	**-**				**X**		**-**	**-**	**Moderate**
Cape Longclaw	*Macronyx capensis*	-	Endemic	X					-	-	Moderate
African Rock Pipit	*Anthus cinnamomeus*	-	Endemic	X					-	-	Moderate
Plain-backed Pipit	*Anthus leucophyrs*	-	-	X					-	-	Moderate
Buffy Pipit	*Anthus vaalensis*	-	-	X					-	-	Moderate
African Pipit	***Anthus cinnamomeus***	**-**	**-**			**X**			**-**	**-**	**Moderate**
Long-billed Pipit	***Anthus similis***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Cape Canary	*Serinus canicollis*	-	Endemic	X					-	-	Moderate
Black-headed Canary	*Serinus alario*	-	Endemic	X					-	-	Moderate
Black-throated Canary	*Crithagra atrogularis*	-	-	X					-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines	Rocky koppies	Dams & ephemeral waterbodies	Fly over	Collision	Electrocution	Disturbance / habitat loss
Yellow Canary	*Crithagra flaviventris*	-	Near-endemic	X					-	-	Moderate
White-throated Canary	*Crithagra albogularis*	-	Near-endemic	X					-	-	Moderate
Lark-like Bunting	***Emberiza impetuani***	**-**	**Near-endemic**	**X**					**-**	**-**	**Moderate**
Cinnamon-breasted Bunting	*Emberiza tahapisi*	-	-	X					-	-	Moderate
Cape Bunting	*Emberiza capensis*	-	Near-endemic	X					-	-	Moderate

Appendix 2. Species, numbers and densities of birds observed during 20 min walked transects in and around the Du Plessis Dam PV development area in May 2013.

Transect number	Transect length	Species	*n* sightings	*n* birds	Mean transect width (m)	Density (Birds.ha^{-1})
D01	0.73	Eastern Clapper Lark	1	1	30.0	0.46
		Lark-like Bunting	1	1	10.0	1.37
		Red-headed Finch	1	5	12.0	5.72
		Rufous-eared Warbler	2	2	90.0	0.31
		Sickle-winged Chat	2	4	17.5	3.14
		Southern Red Bishop	2	31	2.6	164.96
D02	0.86	Ant-eating Chat	1	2	10.0	2.32
		Cape Wagtail	1	1	2.0	5.80
		Capped Wheatear	2	2	30.0	0.77
		Lark-like Bunting	1	1	2.0	5.80
		Sickle-winged Chat	1	1	10.0	1.16
		Spike-heeled Lark	3	10	4.2	27.60
D03	0.75	African Pipit	1	1	2.0	6.64
		Ant-eating Chat	1	2	50.0	0.53
		Capped Wheatear	1	1	100.0	0.13
		Large-billed Lark	1	1	80.0	0.17
		Rufous-eared Warbler	4	3	53.3	0.75
		Spike-heeled Lark	3	9	13.3	8.96
D04	0.95	African Pipit	1	1	80.0	0.13
		Capped Wheatear	1	1	60.0	0.17
		Common Fiscal	1	1	2.0	5.24
		Rufous-eared Warbler	2	4	15.0	2.80
		Sabota Lark	1	1	20.0	0.52
		Sickle-winged Chat	1	1	80.0	0.13
		Spike-heeled Lark	1	3	3.3	9.44
D05	1.09	Ant-eating Chat	1	1	120.0	0.08
		Common Fiscal	1	1	10.0	0.92
		Eastern Clapper Lark	1	1	6.0	1.53
		Rufous-eared Warbler	2	2	6.0	3.07
		Sickle-winged Chat	2	3	15.3	1.80
		Spike-heeled Lark	1	2	3.0	6.13
		Yellow-bellied Eremomela	1	1	40.0	0.23
D06	1.32	African Pipit	2	2	15.0	1.01
		Cape Weaver	1	1	100.0	0.08
		White-throated Canary	1	1	20.0	0.38
D07	0.73	Cape Sparrow	1	2	20.0	1.37

Transect number	Transect length	Species	*n* sightings	*n* birds	Mean transect width (m)	Density (Birds.ha^{-1})
		Capped Wheatear	1	1	40.0	0.34
		Common Fiscal	1	1	40.0	0.34
		Karoo Scrub-Robin	1	3	26.7	1.55
		Lark-like Bunting	1	1	40.0	0.34
		Red-billed Quelea	1	10	1.0	137.47
		Red-headed Finch	1	1	20.0	0.69
		Sickle-winged Chat	1	2	40.0	0.69
		Southern Red Bishop	2	11	2.7	55.45
D08	0.66	African Pipit	1	1	20.0	0.76
		Cape Sparrow	1	2	10.0	3.04
		Red-headed finch	1	2	10.0	3.04
		Rufous-eared Warbler	3	3	26.7	1.71
		Sabota Lark	1	1	10.0	1.52
		Spike-heeled lark	1	3	13.3	3.42
D09	0.58	Black-eared Sparrowlark	1	1	40.0	0.43
		Common Fiscal	1	1	20.0	0.86
		Easterm Clapper Lark	1	1	20.0	0.86
		Rufous-eared Warbler	2	2	50.0	0.69
		Sickle-Winged Chat	2	3	33.3	1.54
		Spike-heeled lark	1	2	20.0	1.72
D10	0.77	Ant-eating Chat	1	4	20.0	2.59
		Cape Sparrow	1	2	20.0	1.29
		Common Fiscal	1	2	20.0	1.29
		Easterm Clapper Lark	3	5	16.0	4.04
		Rock Martin	1	2	10.0	2.59
		Southern Red Bishop	1	4	2.5	20.69
		Spike-heeled lark	1	2	30.0	0.86
D11	0.71	Easterm Clapper Lark	3	5	36.0	1.97
		Lark-like Bunting	2	5	4.0	17.72
		Rufous-eared Warbler	1	2	10.0	2.83
		Sabota lark	1	1	60.0	0.24
		Spike-heeled lark	1	2	30.0	0.94
D12	0.45	Cape Sparrow	2	6	20.0	6.62
		Lark-like Bunting	4	21	4.3	108.10
		Rufous-eared Warbler	1	1	20.0	1.10
		southern Red Bishop	1	2	10.0	4.41
		Spike-heeled lark	1	2	10.0	4.41
		Yellow-Bellied Eremomela	1	2	10.0	4.41
D13	0.88	Cape Sparrow	1	2	20.0	1.13

Transect number	Transect length	Species	*n* sightings	*n* birds	Mean transect width (m)	Density (Birds.ha^{-1})
		Easterm Clapper Lark	1	1	40.0	0.28
		Lark-like Bunting	1	2	20.0	1.13
		Rufous-eared Warbler	2	2	35.0	0.65
		Sickle-Winged Chat	1	1	40.0	0.28
		Southern Red Bishop	1	8	2.5	36.18
		Spike-heeled lark	2	12	3.3	40.70
D14	0.84	Ant-eating Chat	1	3	33.3	1.07
		Rock Martin	2	3	46.7	0.76
		Rufous-eared Warbler	2	2	20.0	1.19
		Sickle-Winged Chat	1	2	50.0	0.47

AURECON SOUTH AFRICA (PTY) LTD

PROPOSED PV SOLAR ENERGY FACILITIES ON DU PLESSIS DAM FARM NEAR DE AAR

Soil and Agricultural Assessment Report

Issue Date: 28th August 2013
Revision No.: 1.3
Project No.: 12014

Date:	28th August 2013
Document Title:	Proposed PV Solar Energy Facilities on Du Plessis Dam Farm Near De Aar: Soil and Agricultural Assessment Report
Author:	Kurt Barichievy (*Pr.Sci.Nat.*)
Revision Number:	# 1.3
Checked by:	Tarryn Curtis
Approved:	Kurt Barichievy (*Pr.Sci.Nat.*)
Signature:	
For:	Aurecon South Africa
"COPYRIGHT IS VESTED IN SiVEST IN TERMS OF THE COPYRIGHT ACT (ACT 98 OF 1978) AND NO USE OR REPREPRODUCTION OR DUPLICATION THEREOF MAY OCCUR WITHOUT THE WRITTEN CONSENT OF THE AUTHOR"	

Declaration

I, Kurt Barichievy, declare that I –

- act as an independent specialist consultant for the **soil and agricultural assessment report for the proposed PV Solar Energy Facilities on Farm Du Plessis near De Aar, Northern Cape Province**;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006; and
- will provide the competent authority with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not.

Mr. K. R. Barichievy *Pr.Sci.Nat*
Scientist
SiVEST Civil Engineering Division

CONTENTS

LIST OF FIGURES

1. INTRODUCTION AND TERMS OF REFERENCE

Aurecon South Africa (Pty) Ltd (Aurecon) on behalf of **Mulilo Renewable Energy (Pty) Ltd** (Mulilo) requested a baseline assessment of the soil, land use and agricultural characteristics for the areas affected by the proposed construction of three separate solar energy facilities, on Du Plessis Dam Farm (Remainder of Farm 179), near De Aar in the Northern Cape.

The primary objective of this assessment is to provide specialist soil and agricultural input into the overarching EIA Report. In order to achieve this objective, a study of the climate, soils, terrain, land capability, geology, current agricultural practices and agricultural potential was carried out. This report serves to summarise such a study, present the relevant results and mitigate the predicted impacts on local soil and agricultural resources.

A detailed soil and agricultural report was undertaken for Du Plessis Dam Farm in January 2012, as part of a larger environmental assessment (**SiVEST, 2012**). Environmental Authorisation for a 19.9 MW Photovoltaic (PV) solar energy facility, known as Du Plessis PV1, and associated infrastructure was granted for this project in late September 2012. Mulilo now plans to construct three additional PV facilities on Du Plessis Dam Farm. The area previously approved for PV1 (approximately 64 ha) will be included in the proposed layouts for the additional PV facilities as an attempt to maximise the generation capacity of the farm (**Aurecon, 2013**).

This assessment intends to supplement this previous soil and agricultural study, and along with the other specialist studies, hopes to minimise the predicted potential impacts on the receiving environment. The terms of reference of this study are to:

- Undertake a detailed soil assessment of the sites, incorporating a radius of 50m surrounding the site, on a scale of 1:10 000 or finer. The soil assessment should include:
    - Identification of the soil forms present on sites;
    - The size of the area where a particular soil form is found;
    - GPS readings of soil survey points;
    - The depth of the soil at each survey point;
    - Soil colour;
    - Limiting factors;
    - Clay content;
    - Size of the site;
    - Slope of the site; and
    - A detailed map indicating the locality of the soil forms within the specified areas.
- Provide the exact locality of the site;
- Describe current activities on the sites, developments and buildings;
- Describe surrounding developments/ land uses and activities in a radius of 500m of the sites, access routes and the condition thereof, the current status of the land (including erosion, vegetation and a degradation assessment) and possible land use options for the sites;
- Describe water availability, source and quality (if available);
- Detailed descriptions of why agriculture should or should not be the land use of choice;
- Undertake an assessment of the potential impacts on agriculture at the site in terms of the scale of impact (local, regional, national), magnitude of impact (low, medium or high) and the

duration of the impact (construction, up to 10 years after construction, more than 10 years after construction). The assessment is to indicate the potential cumulative impacts;
- Describe potential mitigation measures to reduce or eliminate the potential agricultural impacts identified;
- Provide a shape file containing the soil forms and relevant attribute data as depicted on the map; and
- Provide an erosion management plan for monitoring and rehabilitating of erosion events associated with the facility.

1.1 Brief Description of the Project and Study Area

The purpose of this section is to provide basic site information for later reference. Please note that a more detailed description of the site's characteristics are provided in **Sections 4 through 7** of this report.

The Northern Cape Province is considered to be one of the most suitable regions for the establishment of solar PV facilities due to the overriding climatic and environmental conditions. Accordingly, Du Plessis Dam Farm located outside of De Aar has been identified as a potential site. The Du Plessis Dam Farm (Remainder of Farm 179) covers approximately 1236ha and has the following mid-point co-ordinate: 30º37"45.70"S 24º03"13.35"E.

As indicated, the revised project includes the construction of three PV facilities, each with a generation capacity of 75MW AC on Du Plessis Dam Farm. The combined extent of the three proposed facilities, for Layout Alternative 1, would be approximately 755ha as summarised in **Table 1,** below.

Table 1: Summary of the PV Facilities on Du Plessis Dam Farm (Layout Alternative 1) (**Aurecon, 2013**)

Facility	Footprint (ha)	Capacity (MW)	Mid-Point Co-Ordinates
PV 2	273	75	30°38'11.38"S; 24° 4'22.75"E
PV 3	212	75	30°37'53.03"S; 24° 3'28.26"E
PV 4	374	75	30°37'27.44"S; 24° 2'31.14"E

The farm is situated in the Emthanjeni Local Municipality and is zoned as agricultural land. The farm borders the north eastern corner of De Aar (**Figure 3**) and consists of flat grassy plains which are used as unimproved grazing land for cattle production. Access to the site is obtained via the R48 and there are few internal farm roads. Water is the major limiting factor to local agricultural enterprises and the farm does not contain, nor does it directly border, a perennial river / freshwater impoundment which could be used as a source of irrigation water.

1.2 Description of Proposed Activities and Technical Details

The technical details provided in this section are primarily extracted from the Draft Scoping Report produced by Aurecon (**2013**).

Each of the three proposed PV facilities would consist of the following:

- **Solar energy facility:** A photovoltaic component comprising of numerous arrays of PV panels and associated support infrastructure to generate up to 75MW per facility, through the photovoltaic effect.
- **Transmission lines:** 132kV overhead transmission lines to connect each facility to the central onsite substation or an existing Eskom substation.
- **Facility substations:** An onsite 132kV, 3 bay central substation.
- **Boundary fence:** Each 75MW facility will be fenced for health, safety and security reasons **(Aurecon, 2013)**.

It is proposed that the following infrastructure be shared between the three facilities to lessen the impact on the surrounding environment:

- **Central substation:** One central 132kV substation and connection to the Eskom grid. This central substation will connect the PV facilities with Eskom's De Aar substation via either an existing overhead 132kV Eskom line or the previously authorised 132kV overhead transmission line directly to De Aar substation.
- **Roads:** Access road and internal access roads for servicing and maintenance of the site.
- **Water supply infrastructure:** It is proposed that potable water will be obtained from the Emthanjeni Municipality. Water will be transferred to the site via the municipal pipeline from the nearest municipal supply point and will be contained onsite in a jo-jo tank. However, the Municipality would need to confirm availability of capacity to do so.
- **Stormwater infrastructure:** Including drainage channels, berms, detention areas and kinetic energy dissipaters.
- **Buildings:** Buildings would likely include onsite substations, a connection building, control building, guard cabin, an electrical substation and solar resource measuring substation. Each of the project components are described in further detail below **(Aurecon, 2013)**.

Two proposed PV layouts for the Alternatives have been tabled:

Layout Alternative 1

This alternative consists of the three proposed 75MW PV facilities and associated infrastructure as indicated in Figure 4 (referred to as PV2, PV3 and PV4) (**Aurecon, 2013**).

Layout Alternative 2

This alternative consists of one 400MW PV facility, covering 1000 ha. The layout for this alternative was developed by extending and combining the proposed 75MW facilities. This alternative is thus not limited to the DOE's 75MW cap per project. By increasing the capacity it has the benefit of utilising industries at scale thereby reducing associated development and construction costs which reduces lending rates and essentially lower the tariff of electricity sold (**Aurecon, 2013**).

1.2.1 Single axis tracking PV technology

Photovoltaic solar energy facilities use light energy from the sun to generate electricity through a process known as the PV effect. The PV cells absorb light energy which energises the electrons to produce electricity. **Figure 1** depicts a typical PV facility in a landscape similar to De Aar. The proposed PV panels are approximately 2m wide and 1m long. These panels are arranged into modules that are durable and can last up to 25 years, due to the sturdiness of the structure and few

moving parts. The PV modules (which will include a number of PV panels) will be physically mounted to a galvanized steel rotation tube, single axis tracking system to ensure ground connection from the module frames to the structure. The PV modules, fixed to the tracking system, are arranged into tracker blocks as indicated in **Figure 2**. These tracker blocks will be uniformly aligned to facilitate efficient sun-tracking. The dimensions of a tracker block range between 88m and 113m in an east to west direction and 35m to 38m in a north-south direction (**Mulilo, 2013** cited in **Aurecon, 2013)**.

The supports of the frame will be fixed on top of the steel piles. Since there is existence of rock (dolerite and siltstone) at shallow depths, the steel piles would be embedded into a concrete pile. However, the final design of the foundations will depend on the geotechnical conditions of the site which will be determined at a later stage **(Aurecon, 2013)**.

Figure 1: Example of a PV facility in a landscape similar to De Aar (image courtesy of Mulilo, cited in **Aurecon, 2013)**.

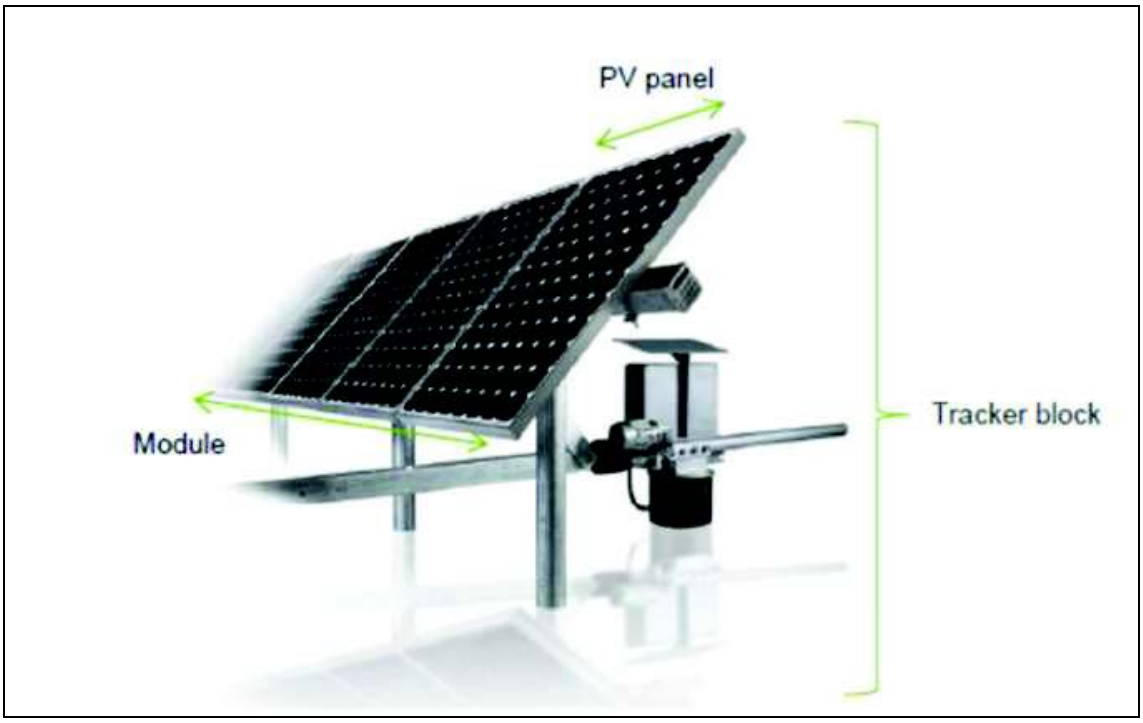

Figure 2: Single axis tracking system (image courtesy of Mulilo cited in **Aurecon, 2013**)

1.2.2 Transmission lines and substations

It is envisaged that each PV facility would require an onsite substation specific to each PV facility i.e. three onsite substations. These substations would feed into one central onsite substation by means of onsite overhead 132kV transmission lines. Based on the uncertainties regarding the capacity of Eskom's substations and transmission lines, it is proposed to assess a transmission line corridor instead of assessing the preliminary layouts subject to numerous changes **(Aurecon, 2013)**.

Alternative 1 transmission corridor

The proposed transmission corridor (alternative 1) would be approximately 10km in length. The width of the first section of the corridor is 31m and the second section is 160m. The first section of the corridor is from the De Aar substation travelling north for approximately 1.7km before turning south-east, crossing the R48, and then entering Du Plessis Dam Farm (**Figure 5**). The second section of the corridor would follow the southern boundary of the farm. The proposed corridor would house overhead transmission lines and substations to connect the proposed PV facilities to existing Eskom infrastructures **(Aurecon, 2013)**.

Alternative 2 transmission corridor

The proposed transmission corridor (alternative 2) would be approximately 8km in length. The width of the entire alternative 2 corridor is 31m. As mentioned above, the first section of alternative 1 and alternative 2 transmissions line corridors overlap. The second section of the corridor would follow the layout of the approved transmission line as indicated in **Figure 5**. The proposed corridor would house overhead transmission lines and substations to connect the proposed PV facilities to existing Eskom infrastructures **(Aurecon, 2013)**.

1.2.3 Additional infrastructures (road, buildings, stormwater, water pipeline)

An access road (6m in width and 6.8km long), including internal access roads, would be constructed to access the PV facilities from the R48. Where possible, the layout of the road will coincide with the existing dirt tracks. The proposed access and internal roads are shown in **Figure 6**. The natural water flow of the site will be interrupted by the execution of planned roads, and therefore new storm water drainage channels will be designed to facilitate natural water flow. The storm water drainage channels will guide water flow to one of several discharge points where riprap areas will slow down the velocity of water and disperse the flow to avoid any possible erosion issue at that discharge point. It is proposed that potable water be obtained from the Emthanjeni Municipality via a proposed underground pipeline (5km in length) from the nearest municipal supply point and will be contained onsite in a jo-jo tank. The Municipality still needs to confirm available capacity to facilitate this water requirement. **(Aurecon, 2013)**.

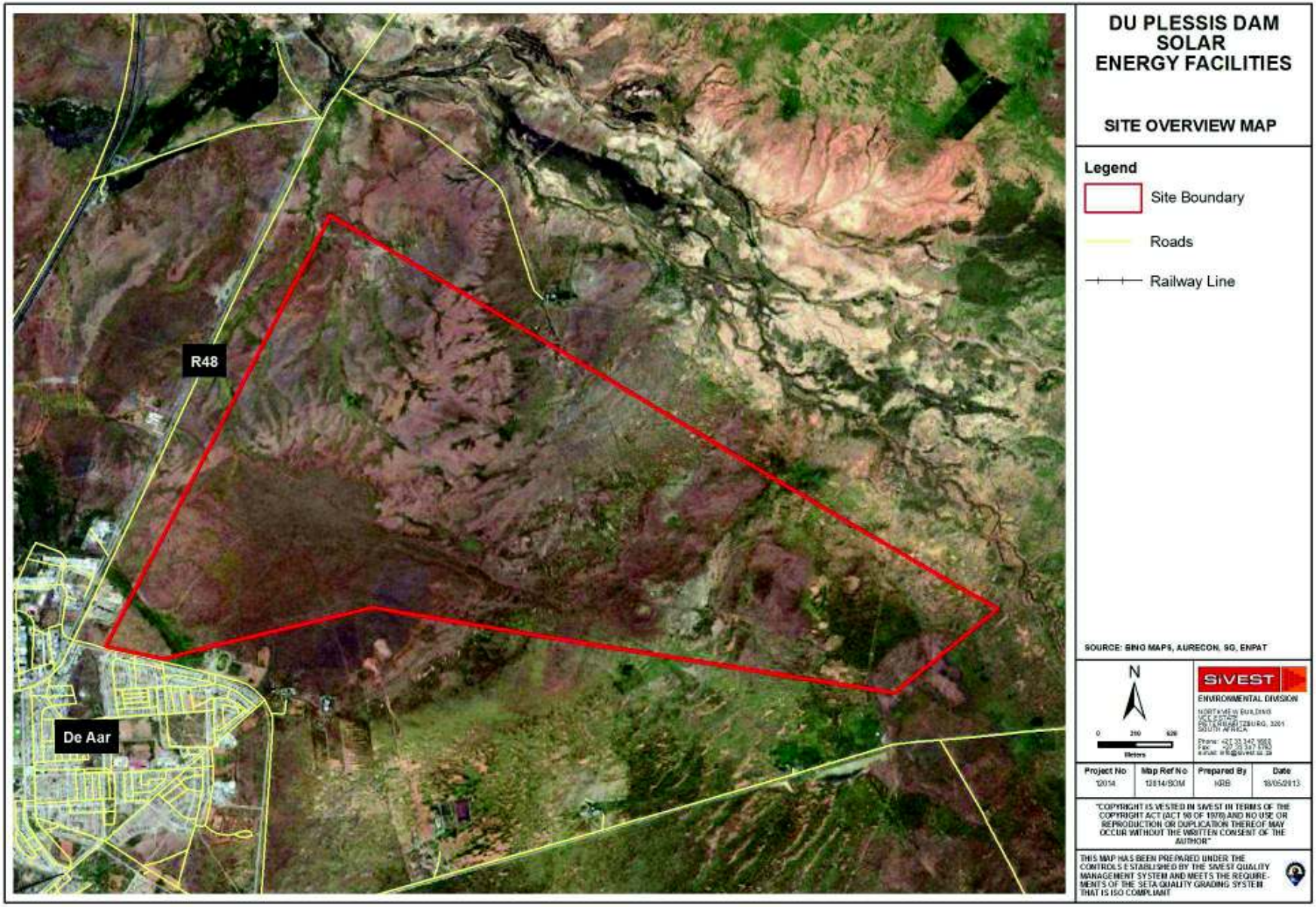

Figure 3: Site overview map

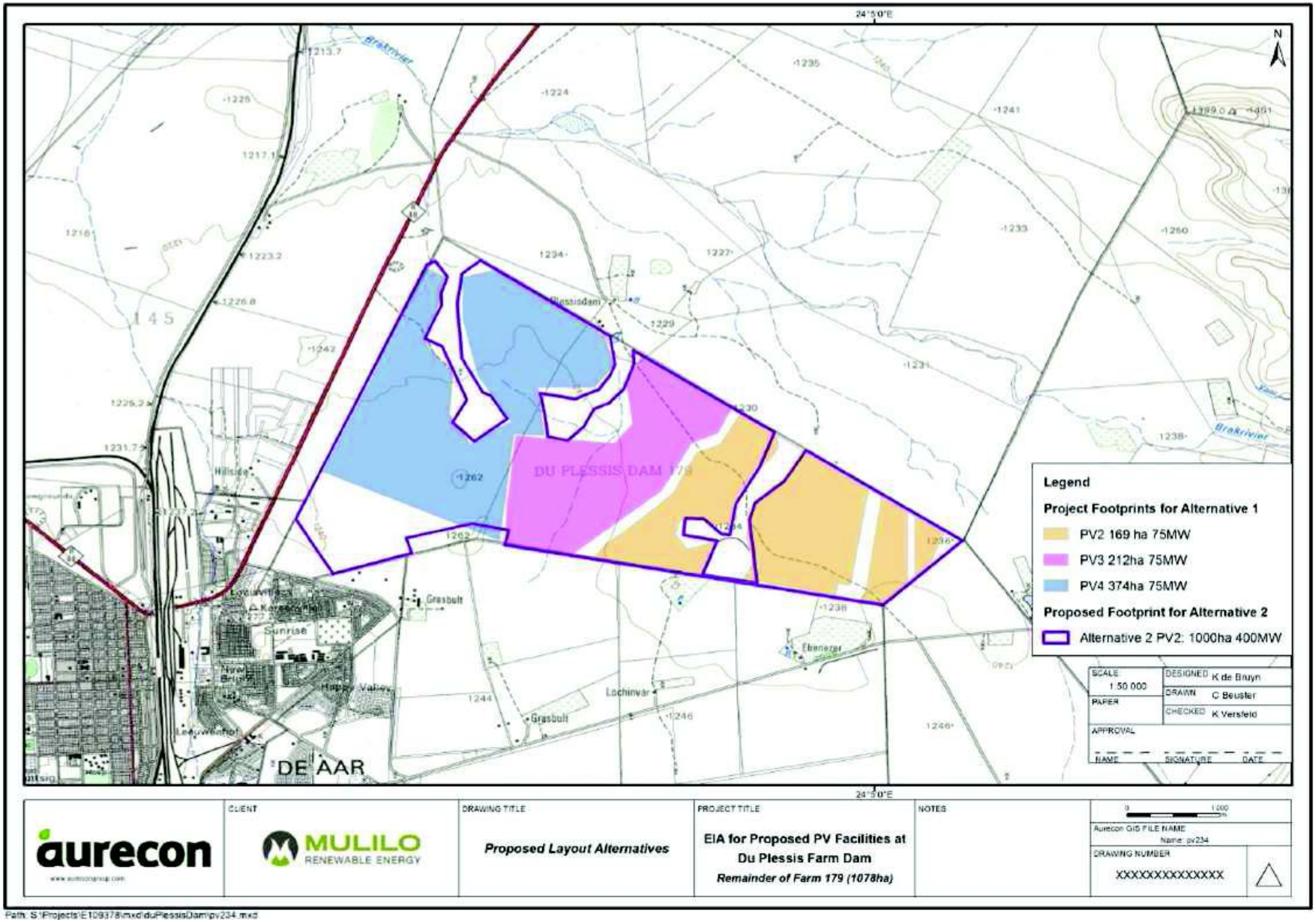

Figure 4: Proposed layout alternatives (**Aurecon, 2013**)

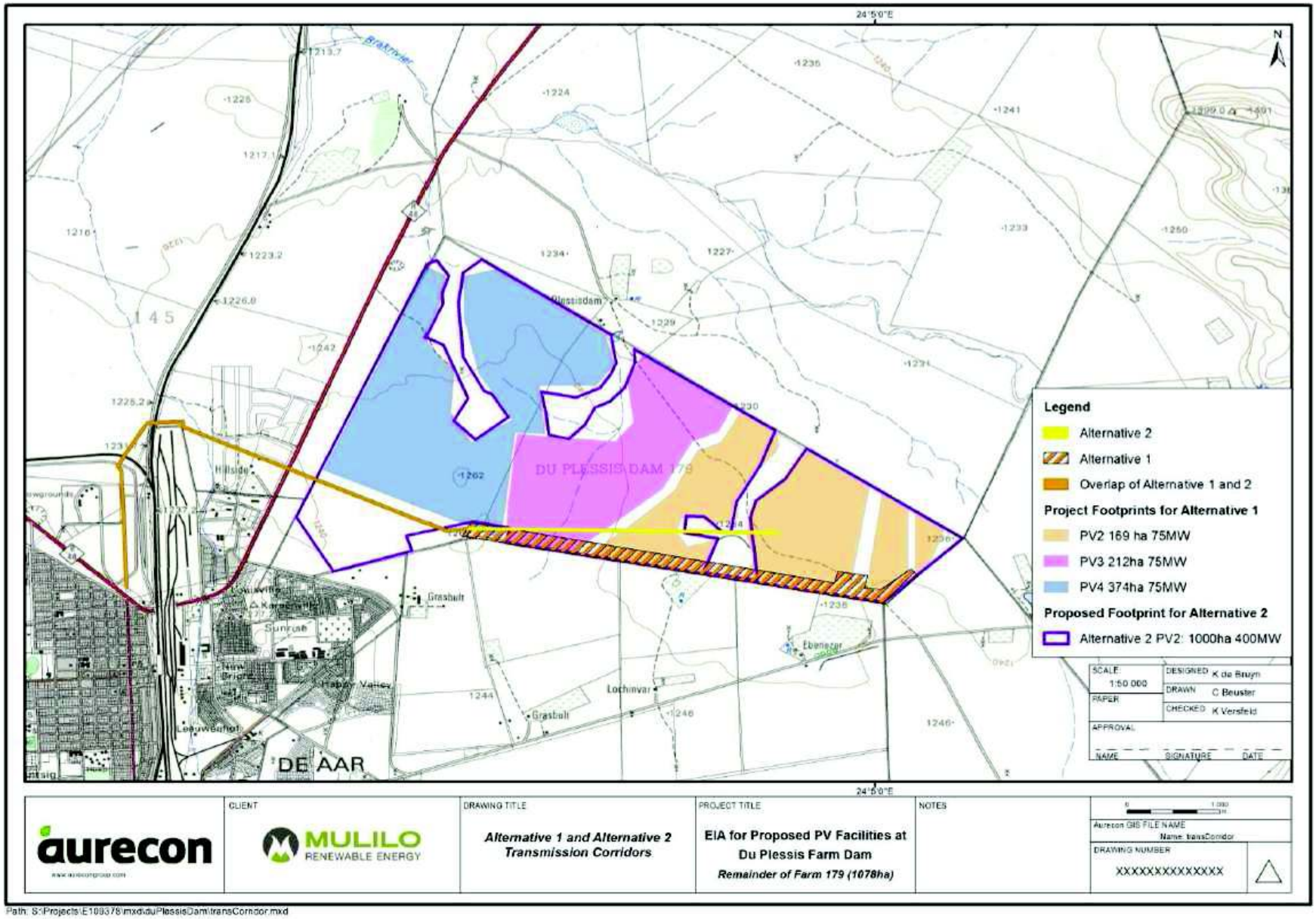

Figure 5: Proposed transmission corridors (**Aurecon, 2013**)

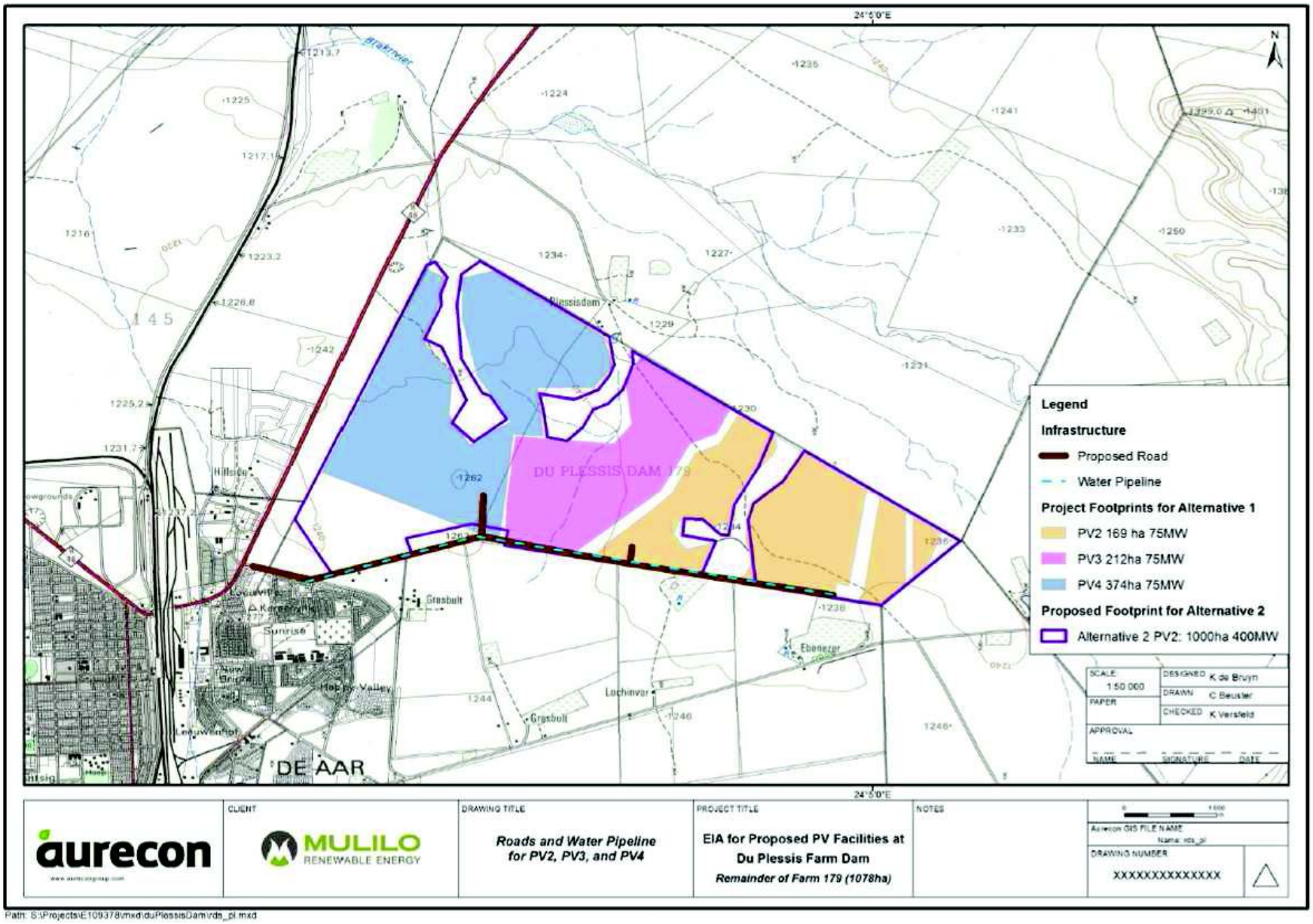

Figure 6: Proposed road and water pipeline (**Aurecon, 2013**)

2. METHODOLOGY

The following methodology was followed in order to ascertain the *status quo* of soil and agricultural resources within the study area. Further, to outline the predicted impacts resulting from the proposed development and activities in the in the study area.

2.1 Desktop Study

A detailed desktop assessment was undertaken for the project area. The objective of this study is to broadly evaluate the soil and land use of the sites and receiving environment by interrogating relevant climate, topographic, landuse and soil datasets. By utilising these data resources one is able to broadly assess the current soil, agricultural and land use characteristics and provide a basis for a more detailed and spatially relevant assessment.

2.2 Soil Survey

A detailed soil survey was conducted in late 2012 and May 2013. At each sample point a hand auger was used to identify and describe the diagnostic horizons to form and family level according to "Soil Classification - A Taxonomic System for South Africa" as well as noting relevant soil characteristics such as depth, texture and limiting layers. At each auger point the relevant soil and land use data were recorded and the location of the auger point captured using a handheld GPS. This information was combined to produce detailed soil polygon maps.

2.4 Agricultural Potential Assessment

In terms of this study, agricultural potential is described as an area's suitability and capacity to sustainably accommodate an agricultural land use. The soil information gained from the survey along with the land use assessment is combined with climate, water resources, crop information and topographic data in order to provide a spatial classification of the land based on its agricultural potential. A study of local agricultural practises was also carried out.

2.5 Impact Assessment

The impact assessment utilises the findings of the soil survey and agricultural potential assessment in order to determine reference conditions of the soil and agricultural resources. Potential soil and agricultural impacts, as a result of the proposed activities, are described in this Section and any major impacts/fatal flaws will be identified for consideration by the pertinent authorities.

3. DESKTOP AGRICULTURAL POTENTIAL ASSESSMENT

The objective of the desktop component of this assessment is to provide broad soil and agriculturally related characteristics of the project area. It should be clearly noted that, since the spatial information used to drive this portion of the assessment is of a reconnaissance nature, only large scale climate, land use and soil details are provided. More detailed and site specific information for the study area is provided in subsequent sections of this report (**Sections 4, 5 and 6**).

In order to ascertain the broad soil and agricultural potential characteristics of the project area relevant climate, topographic, landuse and soil datasets were sourced and interrogated. Existing high level GIS data was sourced from National GIS Datasets as well as the Environmental Potential Atlas for South Africa (ENPAT) Database for the Northern Cape Province of South Africa, compiled by the Department of Environmental Affairs and Tourism (**DEAT, 2001**).

The main purpose of ENPAT is to proactively indicate potential conflicts between development plans and critical, endangered or sensitive environments. By combining the aforementioned data resources, one is able to broadly assess the site, receiving environment, and its ability to accept change, in the form of development. More agriculturally relevant spatial information was obtained from the AGIS Database (***http://www.agis.agric.za,*** accessed 15/05/2013).

3.1 Climate

The study area has a semi-arid to arid continental climate with a summer rainfall regime i.e. most of the rainfall is confined to summer and early autumn. Mean Annual Precipitation (MAP) is approximately 300 mm per year (**Figure 7**). An MAP of 300 mm is deemed low as 500 mm is considered the minimum amount of rain required for sustainable dry land farming (**Smith, 2006**). Thus, without some form of supplementary irrigation natural rainfall for the study area is insufficient to produce sustainable harvests. This is reflected in the lack of dry land crop production within the study area De Aar typically experiences hot days and cold nights with the highest maximum temperature of approximately 40 ^{o}C and the lowest minimum temperature of approximately - 8 ^{o}C (**Table 2** and **Figure 8**). Evaporation is estimated to be in the region of 2000 mm per annum and thus the area is characterised by very severe moisture availability restrictions (**AGIS, 2013**)

In summary the climate for the study area is to severely restrictive to arable agriculture which is primarily due to the lack of rainfall and severe moisture availability restrictions.

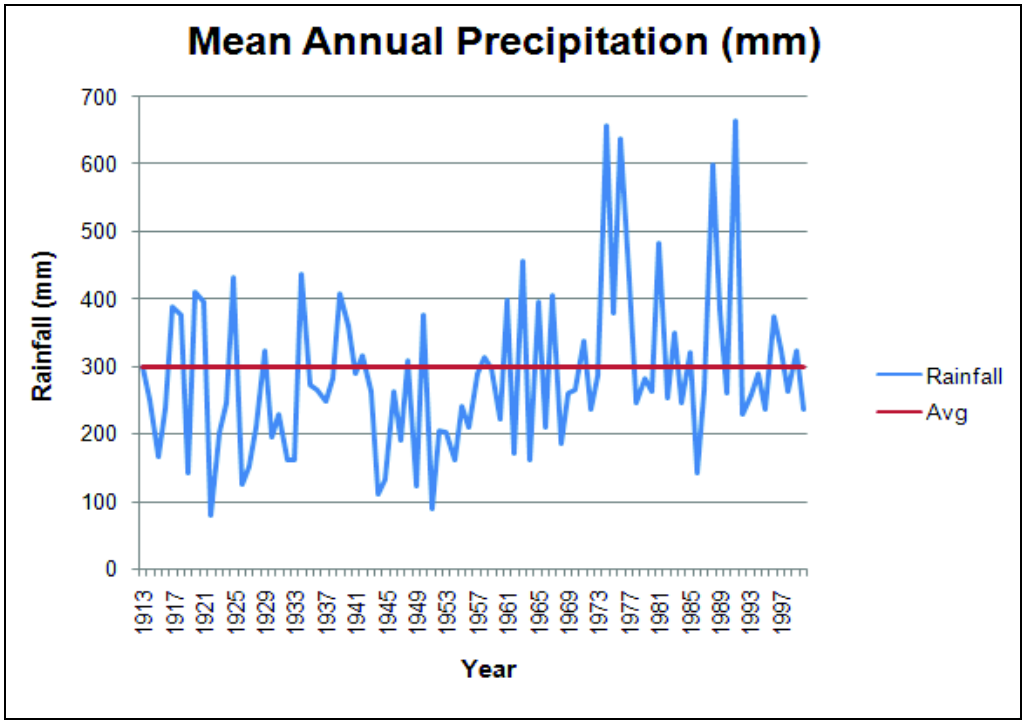

Figure 7: Long term annual rainfall (1913 – 1998) for the study area and long term average (indicated by the red line) (Source: **SAWS, 2010**)

Table 2: Monthly temperature summary for De Aar (**SAWS, 2010**)

Month	Temperature (° C) (1961 – 1990)			
	Highest Recorded	Average Daily Maximum	Average Daily Minimum	Lowest Recorded
January	40	32	16	7
February	38	31	15	4
March	37	28	13	1
April	34	24	9	-1
May	30	20	4	-5
June	26	16	1	-7
July	25	17	1	-8
August	28	19	2	-8
September	35	23	6	-5
October	36	26	9	-3
November	38	29	12	-1
December	39	31	14	3
Year	**40**	**25**	**9**	**-8**

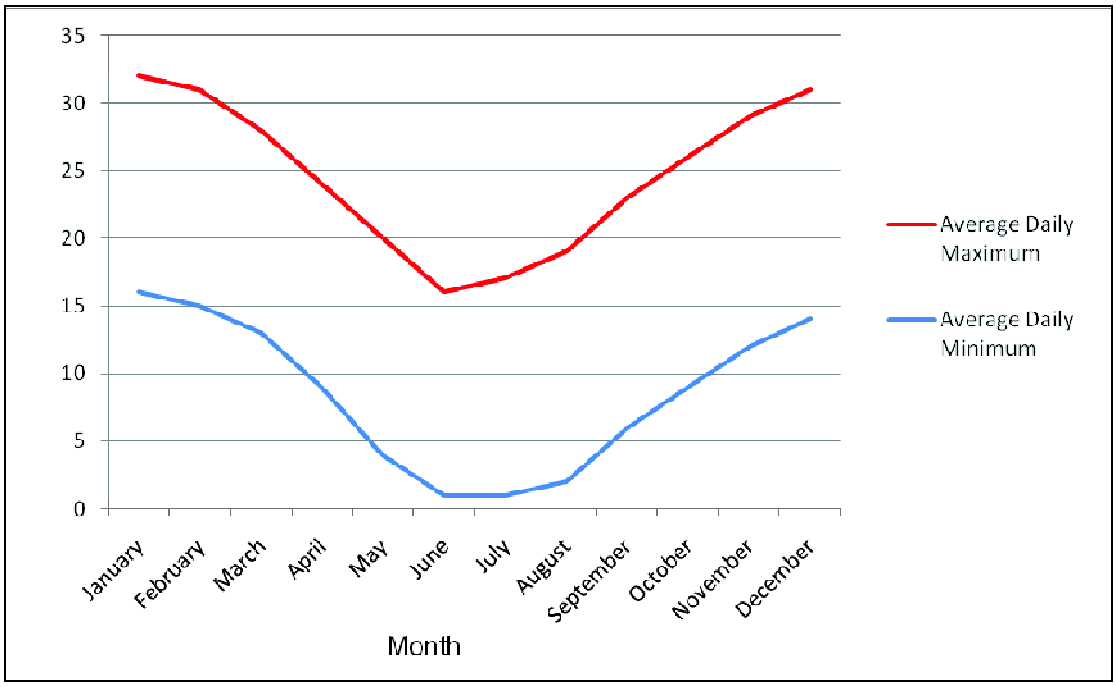

Figure 8: Average daily minimum and maximum temperatures for De Aar **(SAWS, 2010)**

3.2 Geology

The study area is completely underlain by shale (**Figure 9**). Shale, a clastic sedimentary rock, is formed by the settling and accumulation of clay rich minerals and other sediments. Due to the settling process this parent material usually takes the form parallel rock layers which lithifies over time.

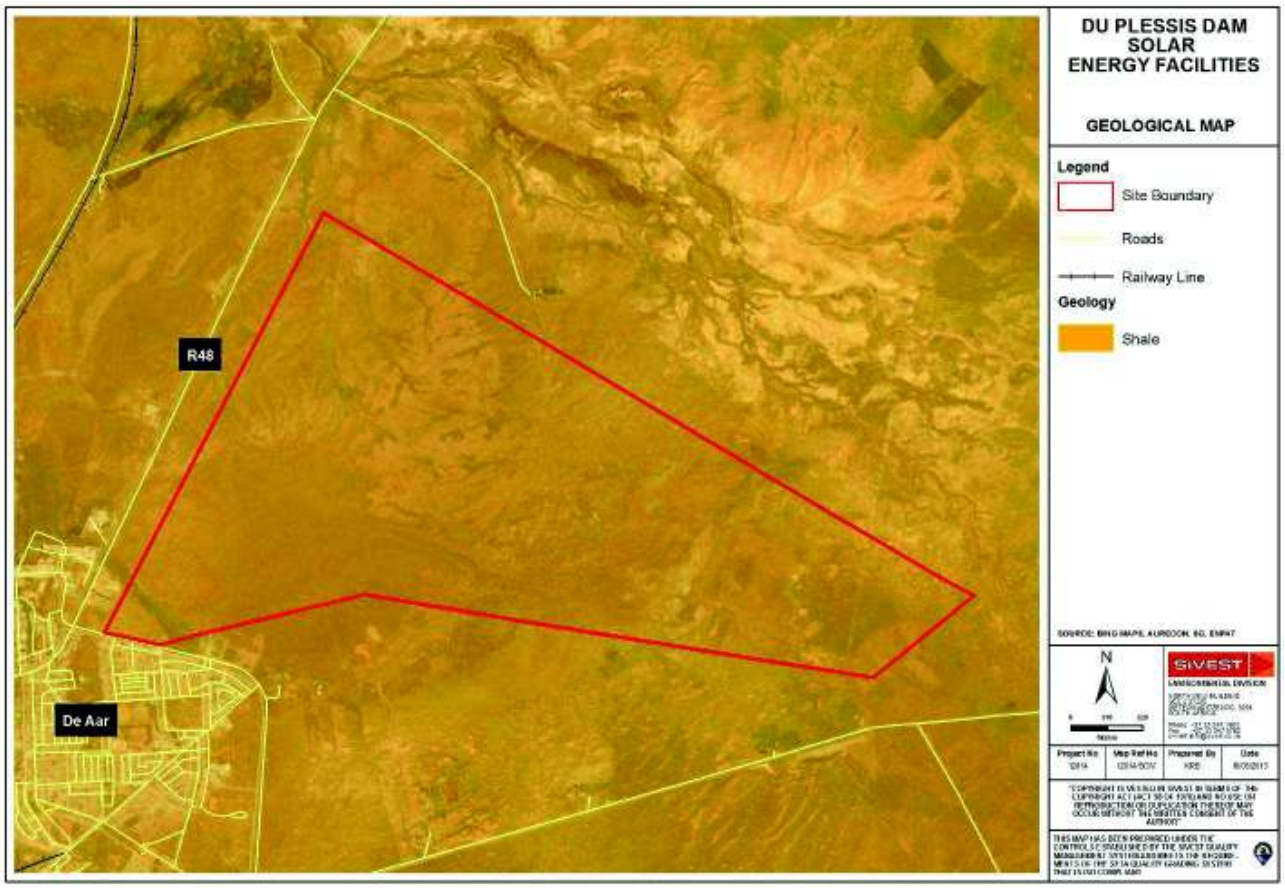

Figure 9: Geological map

3.3 Terrain

Slope or terrain is used to describe the lie of the land. Terrain influences climate, soils characteristics, and thus plays a dominant role in determining whether land is suitable for agriculture. In most cases sloping land is more difficult to cultivate and usually less productive than flatland, and is subject to higher rates of water runoff and soil erosion (**FAO, 2007**).

The study area is characterised by flat and gently sloping topography with an average gradient of less than 5% (**Figure 10**) making this area ideal for intensive agriculture with high potential for large scale mechanisation. From a developmental perspective, the flat topography will also allow for minimal earthworks and site preparation.

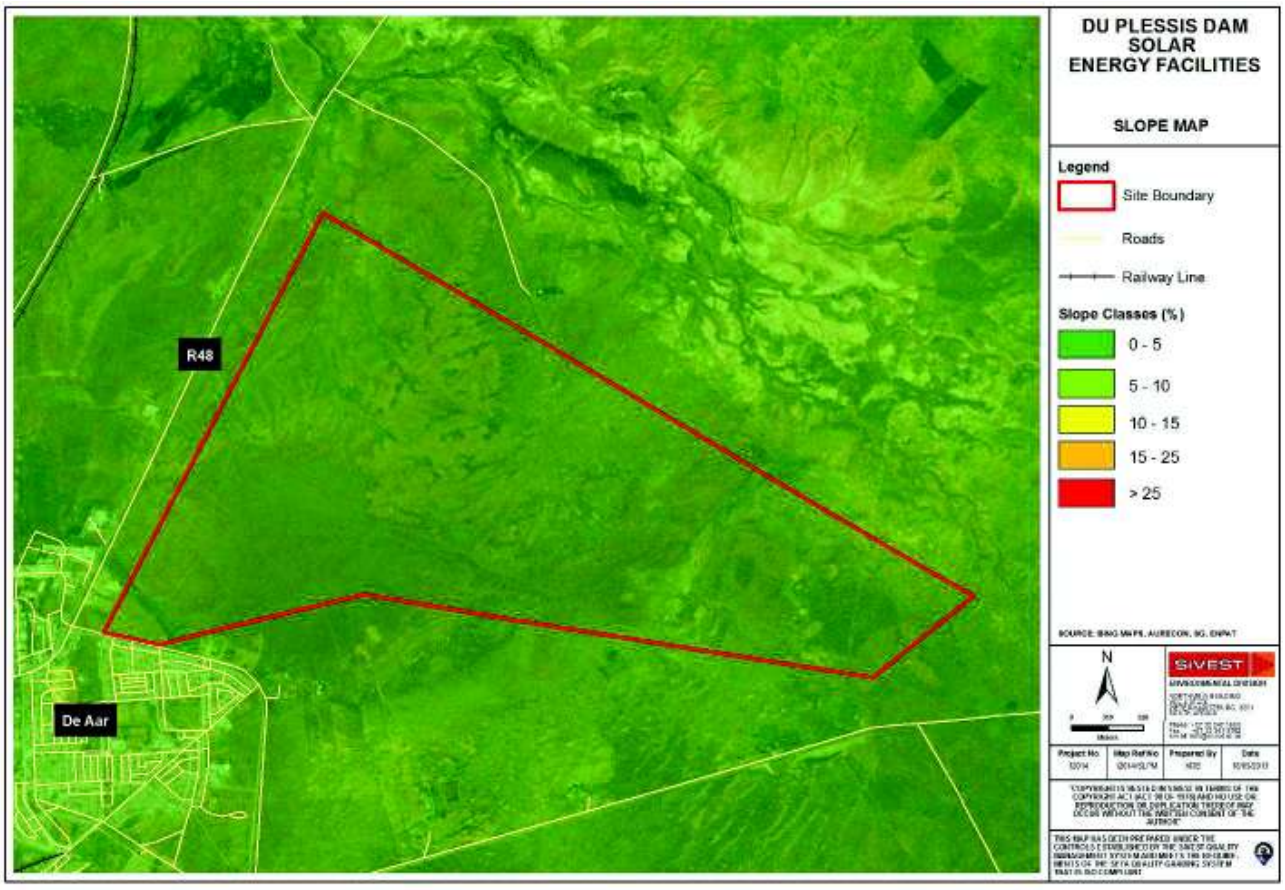

Figure 10: Slope Analysis of the study area

3.4 Land Cover

Mucina and Rutherford (**2006**), classify the site as *Northern Upper Karoo* vegetation type, which forms part of the *Nama-karoo* biome. According to the ENPAT Database and 2010 land cover data, the broad study area consists of a mix of natural veld and unimproved shrub-land which is used as grazing land for sheep, cattle and springbok (**Figure 11**). Vast grazing land is interspersed with incised river channels which flow intermittently and seasonal pans dot the landscape. According to the spatial databases there are no cultivated fields, irrigated lands which could be detrimentally impact upon by the proposed developments. Stocking rates are estimated at 1:4.5 (1 sheep per 4.5 hectares of land) for a small animal unit (sheep) and 1:18 for a large animal unit (cattle).

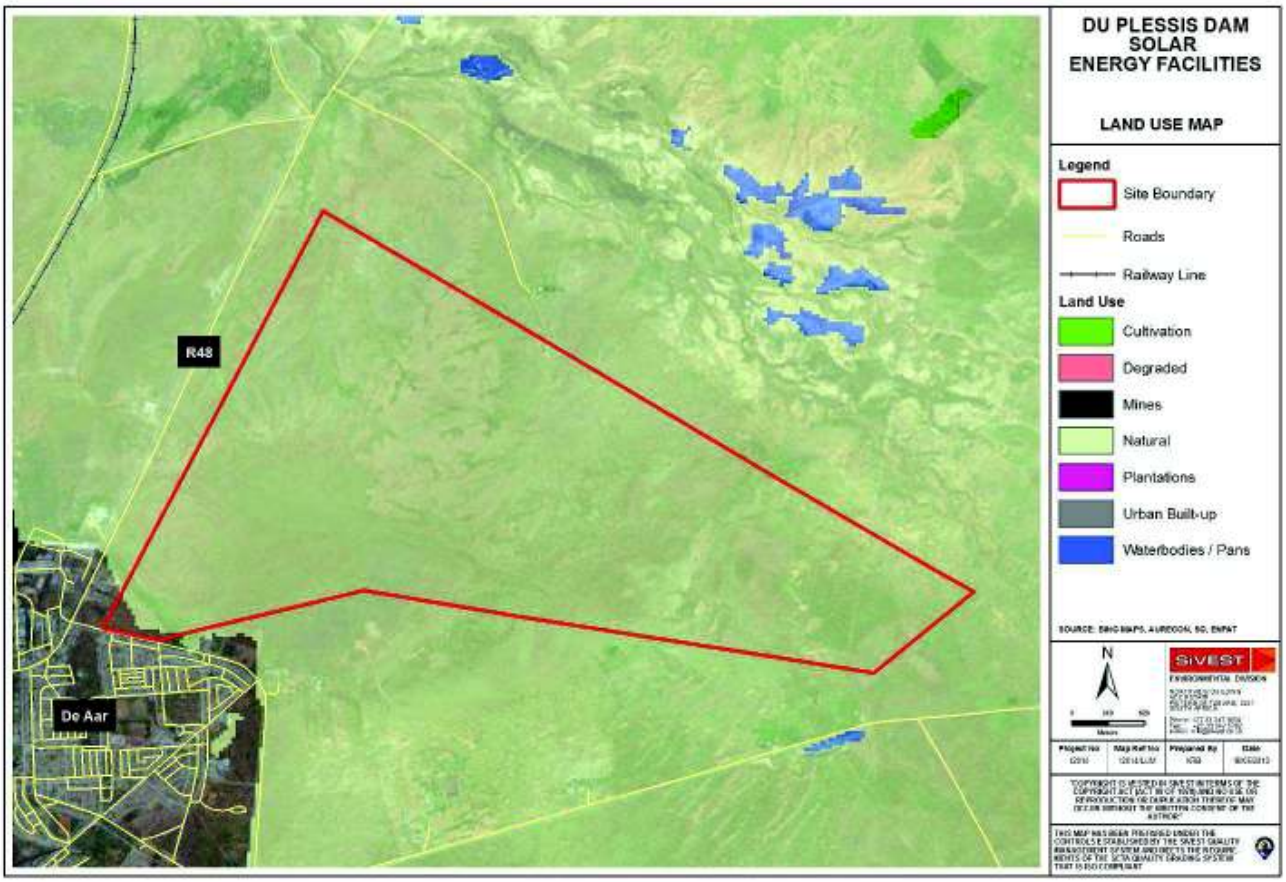

Figure 11: Land Cover Map

3.5 Soil Characteristics

The ENPAT spatial dataset for the Northern Cape Province also provides details pertaining to the broad soil type and approximate agricultural potential for the study area. **Figure 12,** provides a spatial characterisation of the major soil groups which underlie Du Plessis Dam Site. According to this dataset the site are dominated by shallow Red Apedal soils with a high base status. Apedal soils lack well formed peds other than porous micro-aggregates and are weakly structured. Apedal soils tend to be freely drained, and due to overriding climate conditions these soils will tend to be Eutrophic (high base status).

The entire study area is classified as having an effective soil depth, depth to which roots can penetrate the soil, of less than 0.45 m deep which is a limiting factor in terms of sustainable crop production (**Figure 13**).

According to the AGIS database the project area is associated with soils with a moderately low organic matter content (0.6 - 1%) and an average pH of between 7.5 and 8.4 (basic).

The ENPAT Database provides an overview of the study area's agricultural potential based on its soil characteristics, it should be noted this spatial dataset does not take prevailing climate into account. The site is characterised by soils which are not suitable for arable agriculture but remain suitable to

grazing (**Figure 14**). A severely restrictive climate rating, due to low rainfall and moisture / heat stress further reduces the agricultural potential of the project area.

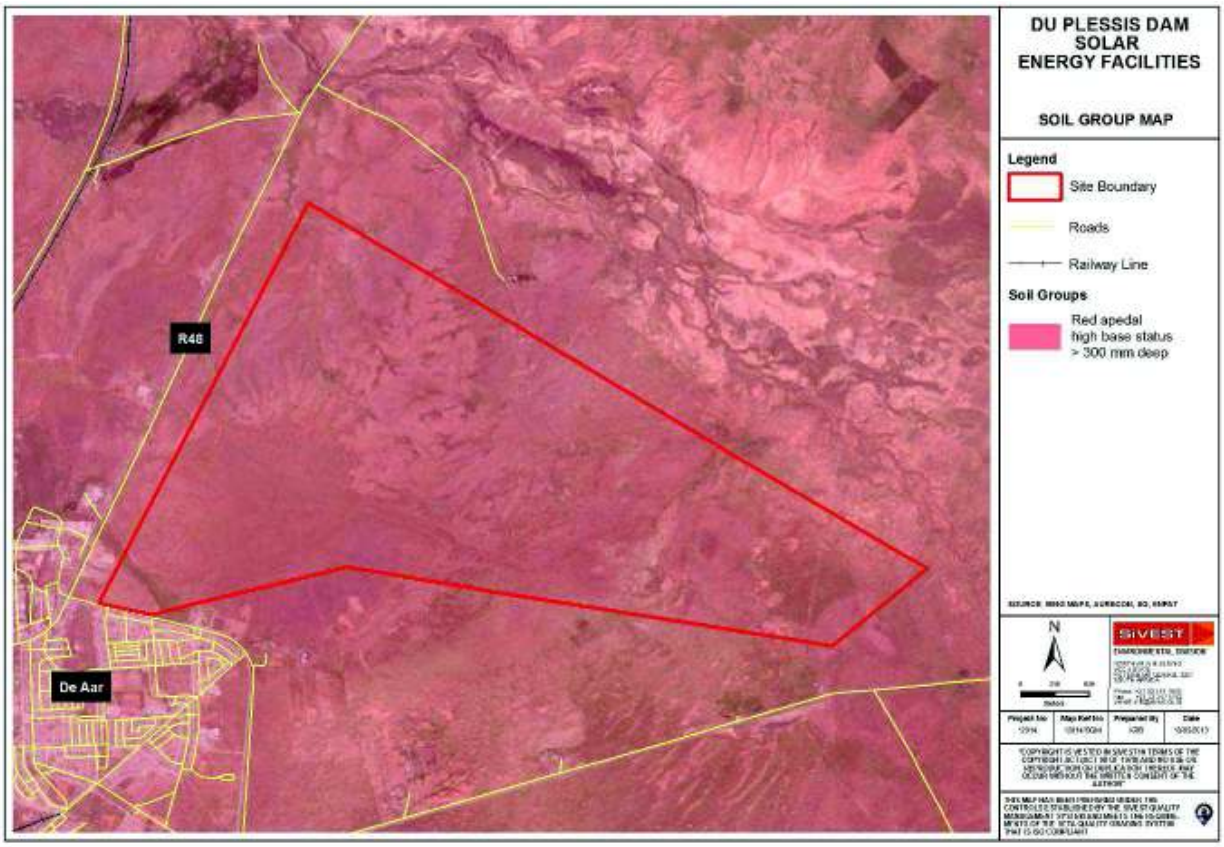

Figure 12: Broad soil type map

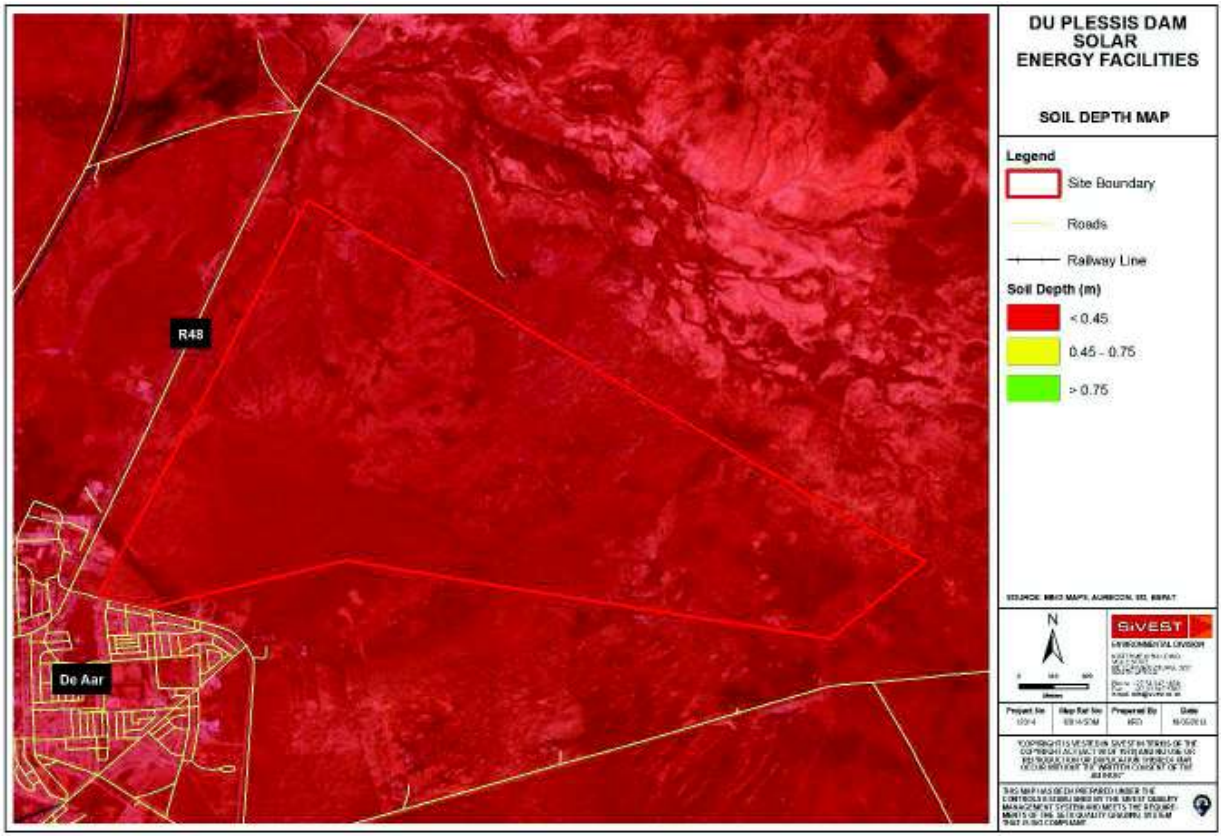

Figure 13: Soil depth map

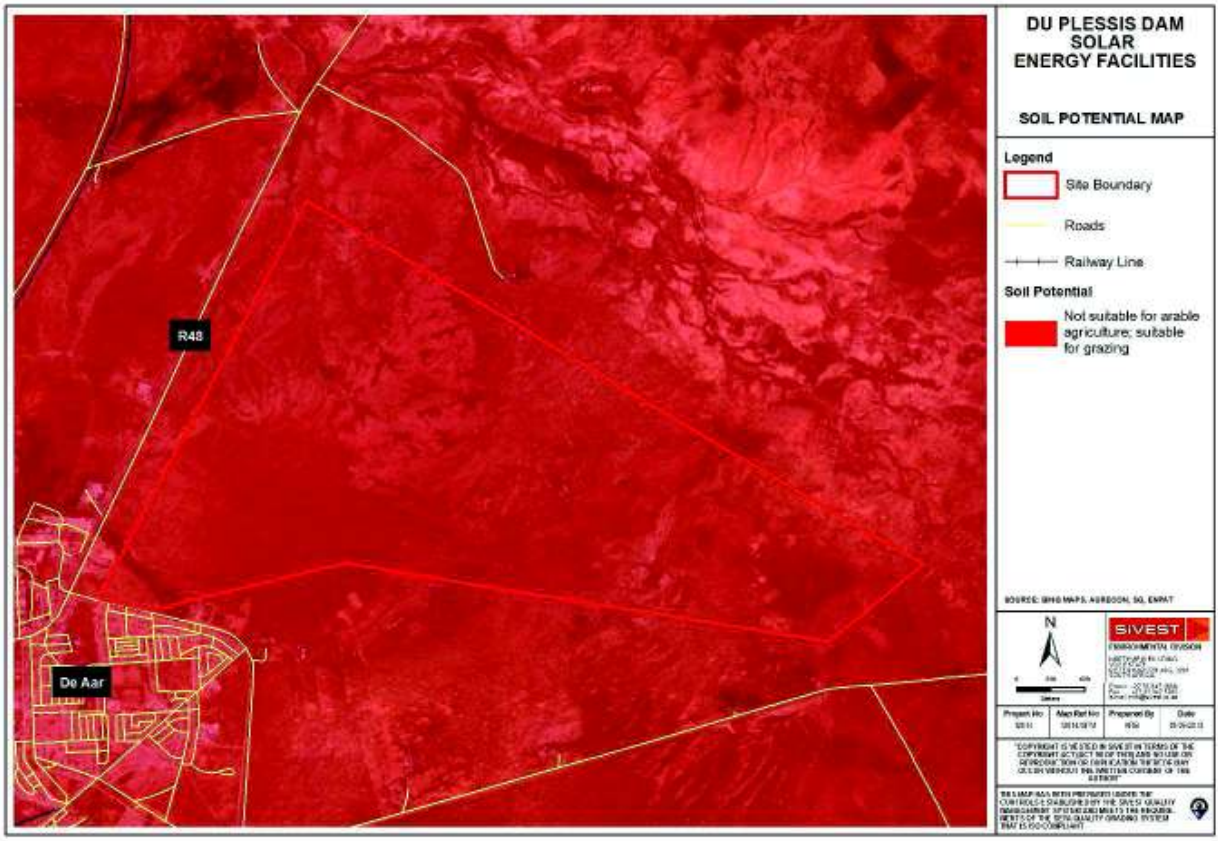

Figure 14: Soil Potential Map

3.6 Desktop Agricultural Assessment: Results Summary

By taking all the site characteristics (climate, geology, land use, slope and soils) into account, the agricultural potential for the majority of the study area is classified as being extremely low for crop production while moderate to moderately low for grazing. This poor agricultural potential rating is primarily due to restrictive climatic characteristics and soil depth limitations. The site is not classified as high potential nor is it a unique dry land agricultural resource.

4. SOIL SURVEY AND FIELD VERIFICATION

A detailed soil survey was undertaken for the Du Plessis Dam Site using a hand auger and GPS to record the location of each of the auger points. At each survey point the soil was described to form and family level according to "Soil Classification - A Taxonomic System for South Africa" (**Soil Classification Working Group, 1991**) and the following properties were noted:

- Estimation of the soils clay content,
- Permeability of upper B horizon,
- Effective rooting depth and pedological depth,
- Limiting layers,
- Soil Colour via the Munsell Soil Colour Charts,
- Signs of wetness,
- Surface rockiness,
- Surface crusting,
- Vegetation cover, and
- Detailed description of the particular area such as slope.

4.1 Soil Descriptions

This Section lists the **major soil forms** encountered during the soil survey along with a site-specific description of each soil form.

4.1.1 Mispah Form

Soil Family: Mostly 1200 (Non bleached, Calcareous), limited bleached and/or non-calcareous
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Hard Rock

Site Specific Description:
The Mispah soil form falls within the lithic soil group. Lithic soils are associated with shallow soils where parent rock is found close to the soil surface. The Mispah soil form dominates large areas of all three sites. The A-horizon varied from reddish-brown to ivory in colour and was generally 10-20 cm deep, directly overlying various hard rock materials. In many instances surface rocks are clearly visible

(**Figure 15**). Large areas of the site contained non-contiguous bands of Lithocutanic B horizons overlying hard rock which lead to areas being classified as a Mispah / Glenrosa complex.

Land Use Capability:
This soil has low agricultural potential due to the distinct lack of rooting depth and as such these soils are generally utilised for grazing land. If ripped and cultivated however, precise irrigation scheduling is imperative. These soils also exhibit high soil erosion hazard ratings thus soil conservation practices such as minimum tillage and trash blankets should be employed.

Figure 15: Shallow, rocky soils dominate large areas of the Du Plessis Dam Site

4.1.2 Glenrosa Form

Family: Mostly 1212 (A-horizon not bleached, B1 Hard, no signs of wetness and calcareous)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Lithocutanic

Site Specific Description:
Like the Mispah soil form, the Glenrosa form falls within the lithic soil group. This soil form is found throughout the surveyed areas where bands of weathering rock are found close to the soil surface. In most cases the Orthic A is approximately 10-20 cm deep and varied from dark brown to red depending on topographic position.

The shallow Orthic A horizon overlies a Lithocutanic B-Horizon, which contains a high proportion of weathering rocks (**Figure 16**). The B-Horizon is generally limiting to plant roots but gaps between the weathering rock fragments can be opened by larger tree roots and thus the land use potential of this soil can be higher than expected. The Lithocutanic B generally contained a high proportion of shale. The Lithocutanic B merges into solid rock layers which are limiting to plant roots and generally found between 20 and 50 cm below the soil surface. Surface rocks were evident across the land surface where this soil form was found. Large portions of the sites contained non-contiguous bands of Lithocutanic B horizons and hard rock which lead to large areas being classified as a Mispah and Glenrosa complex.

Agricultural Potential:

Without careful management or preparation this soil has low agricultural potential as the effective soil depth is approximately 30 cm. If these soils are cultivated, careful irrigation scheduling would be essential. This soil form also exhibits high soil erosion hazard ratings; thus soil conservation practices such as minimum tillage and trash blankets should be employed.

Figure 16: A shallow Glenrosa form encountered on the Du Plessis Dam Site

4.1.3 Swartland Form

Soil Family: Various (Bleached and Non-Bleached A, Calcareous and Non-Calcareous B)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Pedocutanic
C-Horizon: Saprolite

Site Specific Description:
The Swartland soil form falls within the duplex soil group whose defining characteristic is the enrichment of clay within the soil profile. Duplex soils are mostly found in the drier parts of South Africa and have in common the development of strong structure in the B-horizon and a marked increase in clay compared to the overlying horizon (**Fey, 2010**). This form was commonly found between rocky outcrops and provided deeper routing than the adjacent soils.

The Orthic A Horizon was generally dark brown to bleached in colour and was weakly structured. This Orthic A horizon overlies a strongly structured B-Horizon, which contains a high proportion of clay due to illuviation. The B-Horizon has a strong cutanic character which has a blocky structure (**Figure 17**). This soil can be classified as duplex in nature and in certain instances the B-Horizon was considered an impediment to root growth and water movement. The pedocutanic merged into weathering rock. Signs of calcium carbonate were often noted in the lower B horizon.

Agricultural Potential:
Duplex soils occur widely in South Africa and present a variety of management factors to farmers and engineers. This soil form, in the context of this assessment, has a moderately low agricultural potential owing to the strongly structured Pedocutanic B and duplex character of the soil horizon which curtail root growth and water movement. This soil form also exhibits high soil erosion hazard ratings; thus soil conservation practices such as minimum tillage and trash blankets should be employed. Then main cause of erosion is clay dispersion which gives rise to surface sealing and intensifies surface runoff. If cultivated the chemical properties of duplex soils will most likely also need attention. This could include sodicity and salinity correction.

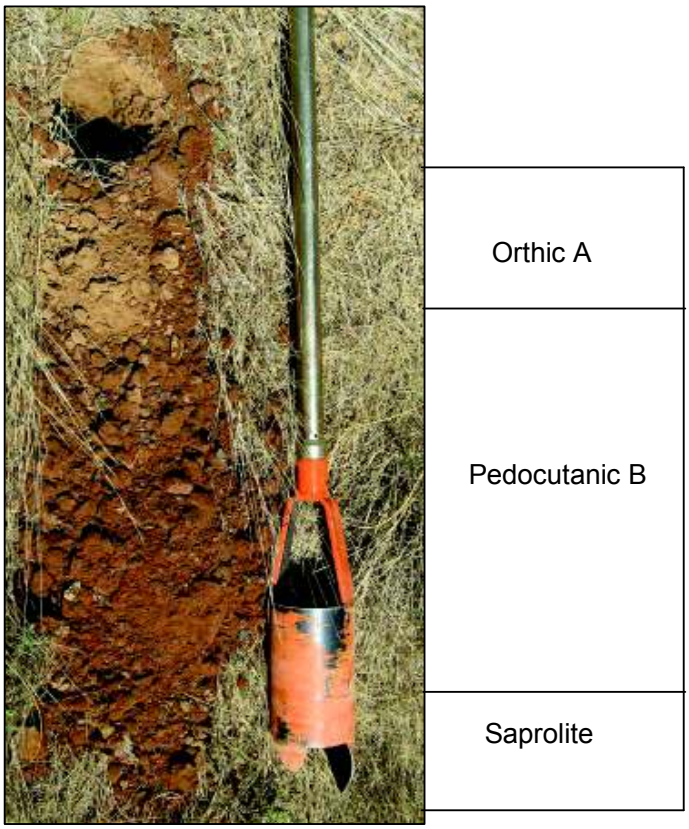

Figure 17: An example of Swartland Soil Form identified on the Du Plessis Dam Site (2121: Bleached, Non-Red B, Medium Coarse angular B, Non-Calcareous)

4.1.4 Coega Form

Family: 2000 (Calcareous A Horizon)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Hardpan Carbonate

Site Specific Description:
The Coega form is a calcic soil whose profile contains at least one carbonate-rich horizon. Carbonate retention in the soil profile is a result of an arid climate where evaporation far exceeds rainfall. When encountered on the PDA the A-horizon of this soil form was light brown, thin and calcareous. This Orthic A-horizon overlies a hard pan carbonate which was limiting to plant growth. The surface Hard Pan Carbonate horizon was not contiguous and is concentrated near the western border of the site. The effective soil depth, depth to which roots can penetrate the soil, was generally less than 0.2 m (**Figure 18**).

Agricultural Potential:
Calcic soils are associated with arid regions and thus the use of these carbonate rich soils in South Africa is limited. Limitations in terms of sustainable agricultural use include shallow rooting depth, high pH, high salinity and low Phosphorus available for plant utilisation (**Fey, 2010**). Such limitations restrict calcic soils to extensive grazing unless irrigation is available. These soils also exhibit high soil erosion

hazard ratings thus soil conservation practices such as minimum tillage and trash blankets should be employed.

Figure 18: An example of a Shallow calcic soil

4.2 Soil Summary

The soils identified on the Du Plessis Dam Site are predominantly shallow and rocky with a low agricultural potential. Rocky soils (Mispah and Glenrosa Forms) cover 71% of the surveyed area (**Figure 20**) while shallow duplex soils (Swartland) cover 24%. Most soils contained a layer that was limiting to plant growth and these layers included rock, saprolite, hard pan carbonate and strongly structured cutanic horizons.

The location and description of the sample points are provided in **Appendix A: Soil Properties**. This information was used to create a verified soil map showing homogeneous soil bodies for on the Du Plessis Dam Site (**Figure 19**). Combining the effective depth information (i.e. depth to root limiting layer) and Inverse Distance Weighting one is able to obtain a generalised soil depth for the PDA (**Figure 21**). Soils with an effective depth of greater than 50 cm were rarely observed during the soil survey.

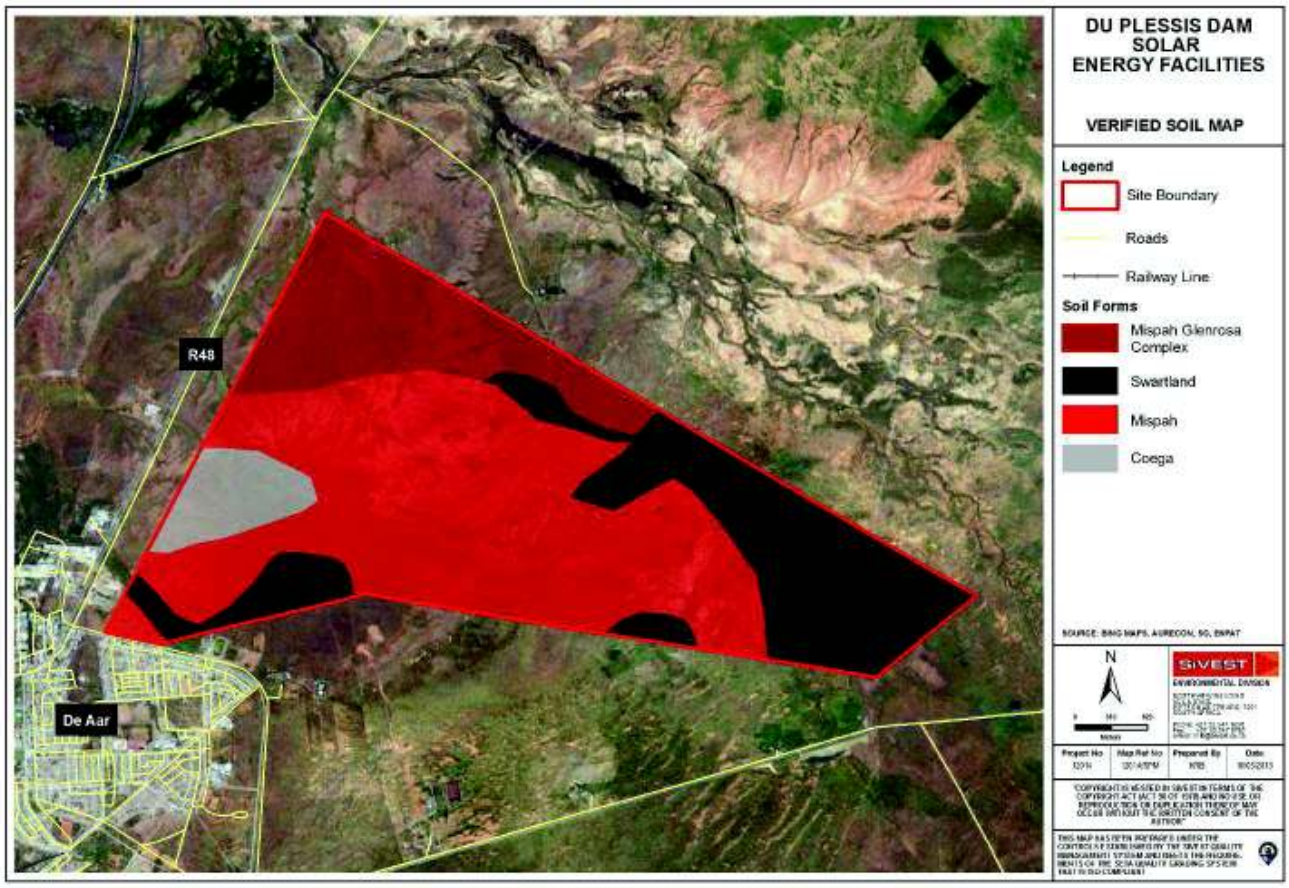

Figure 19: Verified Soil Map for Du Plessis Dam Farm

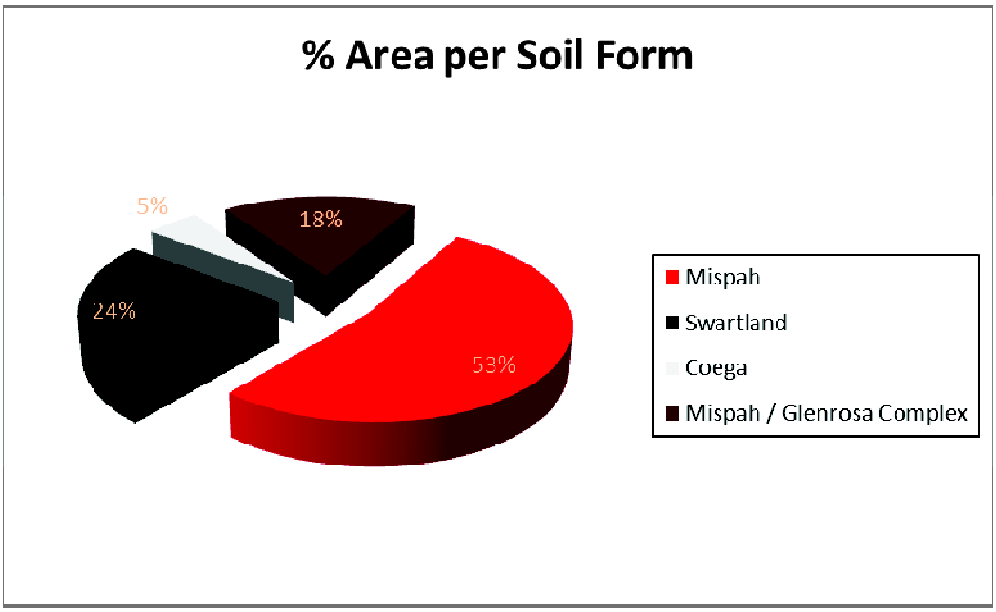

Figure 20: Graph showing the percentage area per soil form

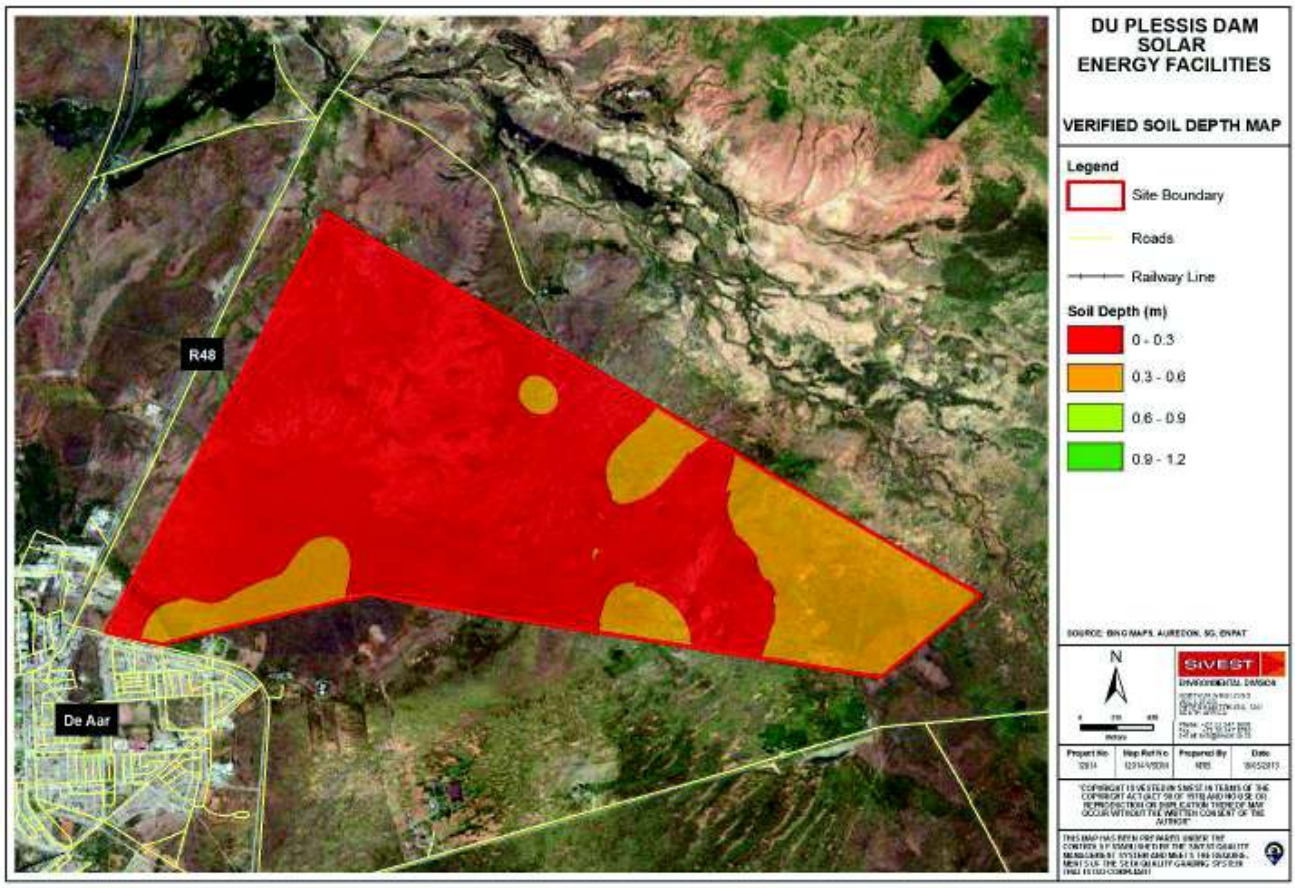

Figure 21: Verified Soil Depth Map

5. AGRICULTURAL POTENTIAL ASSESSMENT

In terms of this study, agricultural potential is described as an area's suitability and capacity to sustainably accommodate an agricultural land use with this potential being benchmarked against crop production.

5.1 Current Situation

The Du Plessis Dam Site is zoned as agricultural land, and is currently used as extensive grazing land for cattle production (**Figure 20**). Stocking rates are estimated at around 1 SSM (small stock unit) per 4.5 hectares and 1 LSU (large stock unit) per 18 hectares. The site does not currently accommodate any centre pivots, irrigation schemes or active agricultural fields. Urban expansion and the increasing rate of stock theft are increasing pressure on the productivity and sustainability of this farm unit. The evidence for this is that many of the farms in close proximity to De Aar have abandoned small stock farming in favour of game and in this case beef production.

5.2 Verified Agricultural Potential

Overall agricultural potential of the site is based on assessing a number of inter-related factors including climate, topography, soil type, soil limitations and current land use. The overriding climate is the major limiting factor for the site. The combination of low rainfall and an extreme moisture deficit

means that sustainable arable agriculture generally cannot take place without some form of irrigation. The site does not contain and is not bounded by a reliable surface water irrigation resource, and the use of borehole water for this purpose does not seem agriculturally and economically feasible. This is due to the current human pressure on borehole water, the expense of using borehole water as a source of irrigation and the brackish nature of the local groundwater resources.

The project area is characterised by flat undulating topography with an average gradient of less than 5%. The soils identified on the PDA are predominantly shallow and rocky with a low agricultural potential. Rocky soils (Mispah and Glenrosa Forms) cover 71% of the surveyed area while shallow duplex soils (Swartland) cover 24%. Most soils contained a layer that was limiting to plant growth and these layers included rock, saprolite, hard pan carbonate and strongly structured cutanic horizons.

A map indicating the agricultural potential in terms of **crop production** for the Du Plessis Dam Farm is provided in **Figure 22**. The majority of the site has been classified as having low potential for crop production due to an arid climate and highly restrictive soil characteristics. The site is not classified as high potential, nor is it a unique dry land agricultural resource. The physical and chemical limitations associated with the dominant forms restrict these soils to extensive and low density grazing land. The site is considered to have a moderate to moderately low value when utilised as grazing land, which is its current use.

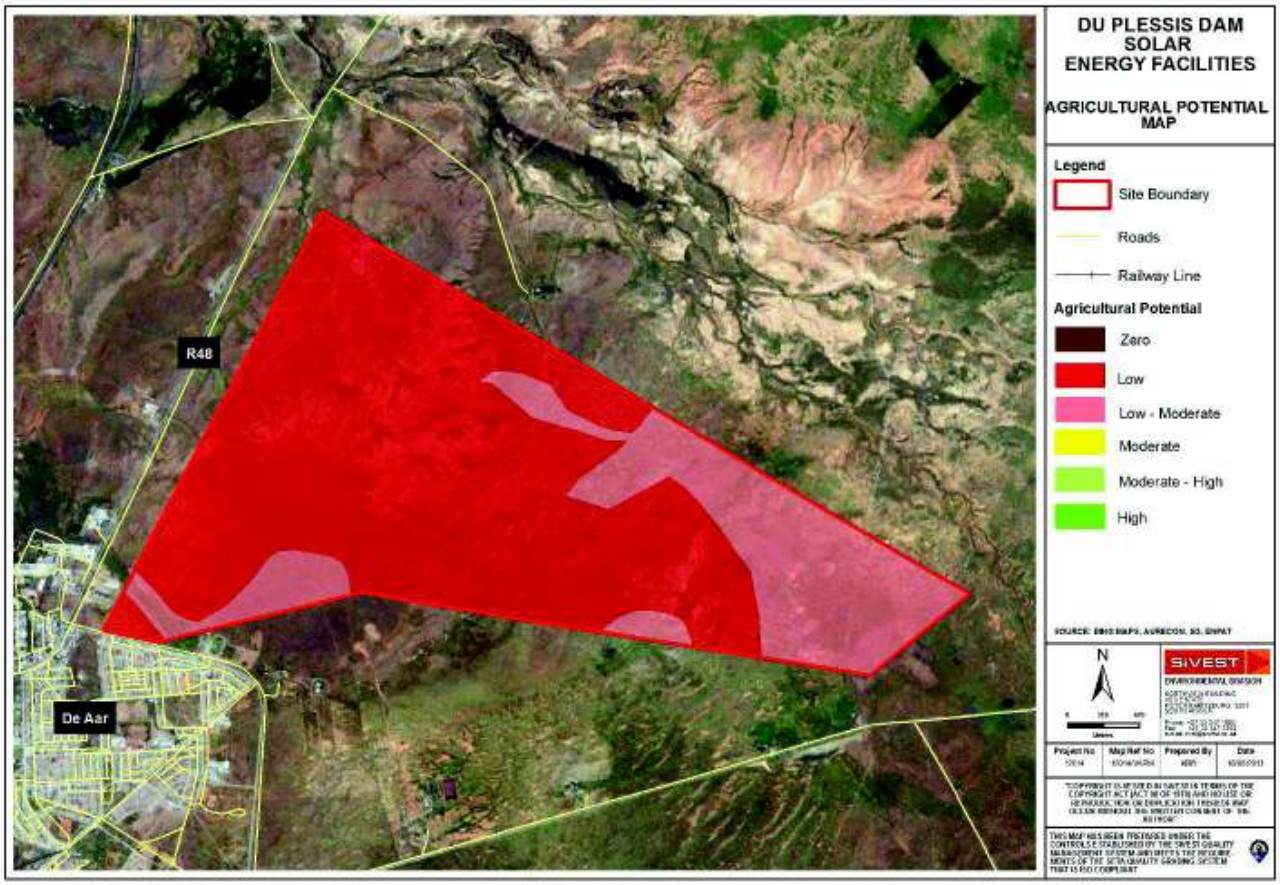

Figure 22: Agricultural Potential Map

6. AGRICULTURAL IMPACT ASSESSMENT

From an agricultural perspective the loss of high value farm land and / or food security production, as a result of the proposed activities, is the primary concern of this assessment. In South Africa there is a scarcity of high potential agricultural land, with less than 14% of the total area being suitable for dry land crop production (**Smith, 2006**). Consequently areas which can sustainably accommodate dry land production need to be protected from non-agricultural land uses. The desktop assessment, field verification and agricultural potential assessment (**Sections 3, 4 and 5**) has already shown that the study area is unsuitable for crop production and is dominated by unimproved grazing land[1].

The results of agricultural assessment indicate that the Du Plessis Dam Farm has low agricultural value and is replaceable when assessed within the context of the proposed development. Consequently, the overall impact of the Solar Energy Facility on the study area's agricultural potential and production will be low, due to the site's low inherent agricultural potential and value. There are no centre pivots, irrigation schemes or active agricultural fields which will be influenced by the proposed development. As such, when considering the agricultural assessment as a standalone specialist study, there are no problematic or fatal flaw areas for the proposed solar energy facilities.

[1] Unimproved grazing land can be defined as areas of veld which are in a relatively natural condition and which have not been previously cultivated or physically/chemically improved for agricultural purposes.

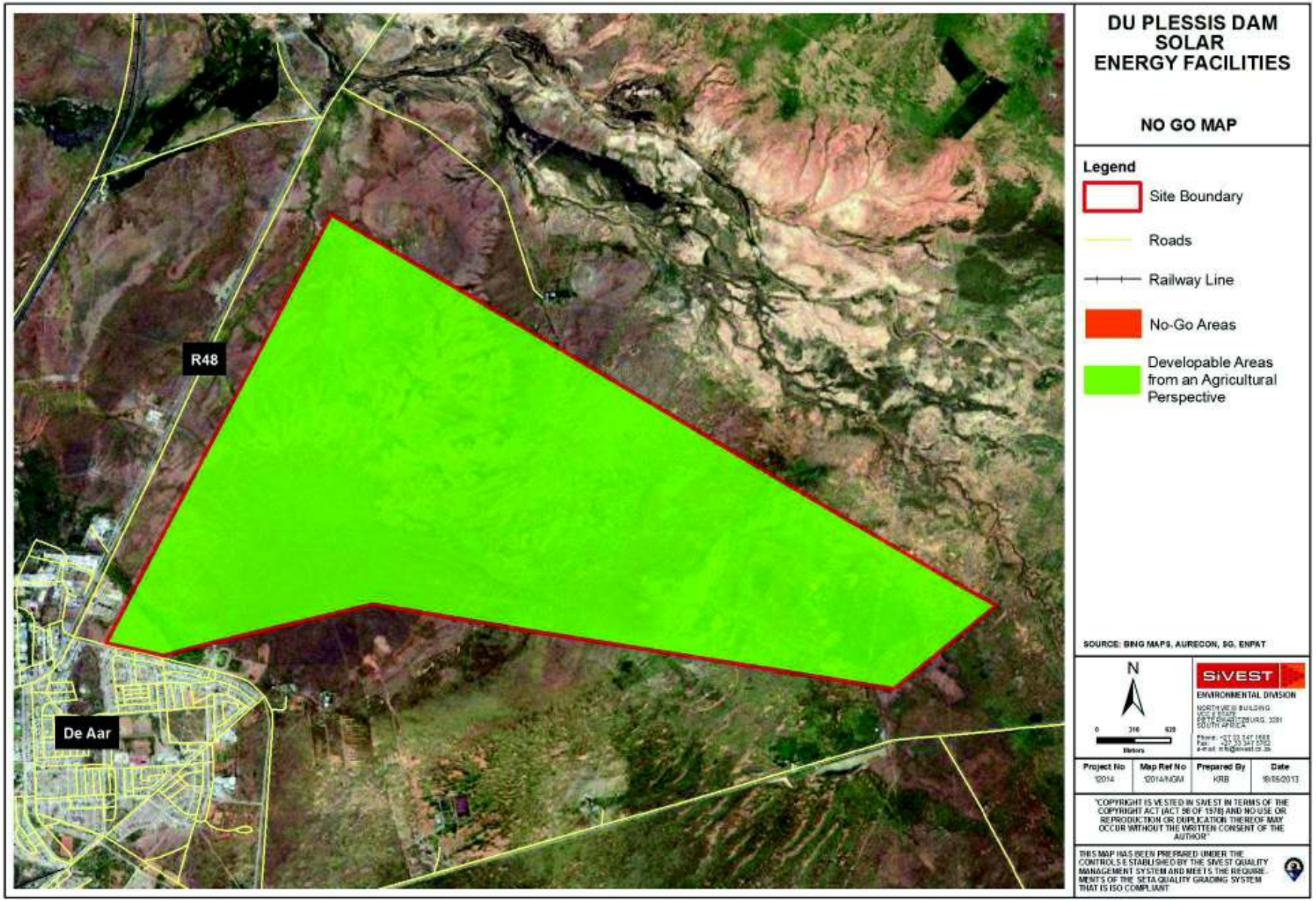

Figure 23: No Go Map (Agriculture)

6.1 Impact of the proposed PV solar facilities

6.1.1 Construction Phase

The proposed development's primary impact on agricultural activities includes the construction of the solar fields and associated infrastructure, which entails the clearing of vegetation and levelling of the site. This will effectively eliminate the impacted land's agricultural potential in terms of crop production (or in this case grazing) during the construction phase, which is estimated to last between 12 and 24 months per PV facility. The construction of the solar fields will influence a portion of each of the farms total area. The remaining land will continue to function as it did, prior to the development. Furthermore, facilities on the farm will be phased and constructed consecutively, depending on whether the projects are approved by the DoE and DEA (**Aurecon, 2013**). Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing the remaining un-impacted areas. The footprint of each proposed PV facility is summarised below and illustrated in **Figure 4**.

Table 3: Summary of the 3 PV Facilities and Alternatives on Du Plessis Dam Farm (**Aurecon, 2013**)

Layout Alternatives	Facility	Individual Footprint (ha)	Cumulative Footprint (ha) and Remaining land (ha)	Capacity (MW)	Mid-Point Co-Ordinates
1	PV 2	273	859 (377)	75	30°38'11.38"S; 24° 4'22.75"E
1	PV 3	212		75	30°37'53.03"S; 24° 3'28.26"E
1	PV 4	374		75	30°37'27.44"S; 24° 2'31.14"E
2	Extended PV 1	1000	1000 (236)	400	30°37'51.78"S; 24°3'14.27"E

6.1.2 Operational Phase

After construction the land will need to be rehabilitated, including the re-vegetation of the solar fields. It is recommended that more palatable grass species are planted to enable faster stocking initiation. Pertinent plant species should be obtained from a vegetation specialist when the site specific EMP is compiled. It is unlikely that typical vegetation species (Karoo shrubs) will return to the PV fields. The shading of the panels could also influence the vegetation pattern within the PV fields.

In order to further mitigate the potential impacts it is highly recommended that periodic grazing within the PV fields is allowed. This mitigation minimizes the loss of grazing land and reduces the overall impact on agricultural production. Interestingly, the farmers around De Aar have changed from sheep to beef production due to the high prevalence of stock theft. Unfortunately, cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation, it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps. The problem of small stock theft should be mitigated by the additional security and fencing associated with the PV facilities.

A simplified and generic phased construction approach and related mitigations are illustrated in **Figure 24**, where

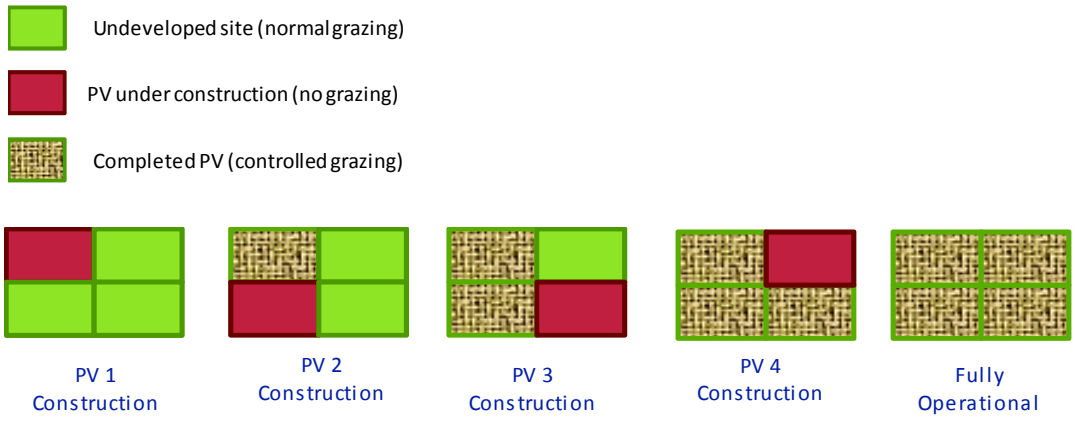

Figure 24: The proposed phased construction approach and grazing schedule (This simplified example is based on the construction of 4 PV facilities but can be adapted to any number of proposed PV facilities)

6.1.3 Cumulative Impacts

A number of solar and renewable energy projects have been proposed in the De Aar area, and thus, the cumulative impact of these developments on surrounding farms could become detrimental to local agricultural resources if the loss of usable grazing land is not taken into account when determining optimum herd size. A phased approach in combination with erosion control and land rehabilitation, within each farm, will reduce this impact. The inherently low agricultural potential of the region also reduces the overall cumulative impact.

6.2 Impact of the Transmission Line and Associated Infrastructure

Three new 132 kV transmission line will be constructed in order to connect the new solar PV facilities to the Eskom grid. Two routing alternatives have been proposed. According to spatial Land Use data and in-field verification, these routes are dominated by vacant land and peri-urban land uses. Owing to this, the crossing of this land by these power lines will have a very limited impact on agricultural production. Where the lines do cross farm land normal grazing can still take place under the power lines. The only loss of agricultural land will be directly below the tower's footprint. In terms of line routing, there is no significant variance between agricultural characteristics within the assessment corridor and as such, from an agricultural perspective, the lines may be routed anywhere within this corridor.

Due to spatial extent and impacts associated with the remaining supporting infrastructure, *inter alia* road and water pipe line construction, it is envisioned that this supporting will a negligible impact on agricultural resources and production.

6.3 Determination of Impact Significance: Methodology

Significance is determined through a synthesis of impact characteristics which include the context and the 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 or baseline conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence). 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. The rating system used in this assessment is based on **Aurecon's Methodology** and is summarised below:

For each impact, the EXTENT (spatial scale), MAGNITUDE and DURATION (time scale) would be described. These criteria would be used to ascertain the SIGNIFICANCE of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place.

The tables below indicate the scale used to assess these variables, and defines each of the rating categories.

Table 4: Assessment criteria for the evaluation of impacts

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	**Regional**	Beyond a 10 km radius of the candidate site.
	Local	Within a 10 km radius of the candidate site.
	Site specific	On site or within 100 m of the candidate site.
Magnitude of impact (at the indicated spatial scale)	**High**	Natural and/ or social functions and/ or processes are *severely* altered
	Medium	Natural and/ or social functions and/ or processes are *notably* altered
	Low	Natural and/ or social functions and/ or processes are *slightly* altered
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered
	Zero	Natural and/ or social functions and/ or processes remain *unaltered*

CRITERIA	CATEGORY	DESCRIPTION
Duration of impact	**Construction period**	Up to 4 years if PV facilities is constructed consecutively
	Short Term	Up to 5 years after construction
	Medium Term	5-15 years after construction
	Long Term	More than 15 years after construction

The SIGNIFICANCE of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained in **Table 5**.

Table 5: Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED
High	• High magnitude with a regional extent and long term duration • High magnitude with either a regional extent and medium term duration or a local extent and long term duration • Medium magnitude with a regional extent and long term duration
Medium	• High magnitude with a local extent and medium term duration • High magnitude with a regional extent and construction period or a site specific extent and long term duration • High magnitude with either a local extent and construction period duration or a site specific extent and medium term duration • Medium magnitude with any combination of extent and duration except site specific and construction period or regional and long term • Low magnitude with a regional extent and long term duration
Low	• High magnitude with a site specific extent and construction period duration • Medium magnitude with a site specific extent and construction period duration • Low magnitude with any combination of extent and duration except site specific and construction period or regional and long term • Very low magnitude with a regional extent and long term duration
Very low	• Low magnitude with a site specific extent and construction period duration • Very low magnitude with any combination of extent and duration except regional and long term
Neutral	• Zero magnitude with any combination of extent and duration

Once the significance of an impact has been determined, the PROBABILITY of this impact occurring as well as the CONFIDENCE in the assessment of the impact, would be determined using the rating systems outlined in **Table 6** and **Table 7** respectively. It is important to note that the significance of an impact should always be considered in concert with the probability of that impact occurring. Lastly, the REVERSIBILITY of the impact is estimated using the rating system outlined in **Table 8**.

Table 6: Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95 % chance of the impact occurring.
Probable	Estimated 5 to 95 % chance of the impact occurring.
Unlikely	Estimated less than 5 % chance of the impact occurring.

Table 7: Definition of confidence ratings

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.

Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 8: Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is in all practical terms permanent.
Reversible	The impact is reversible within 2 years after the cause or stress is removed.

6.4 Impact Summaries: Solar Energy Facilities

This impact summary investigates the construction, operational and decommissioning phases of the two Layout Alternatives tabled for Du Plessis Dam Farm.

Table 9: Impact rating table for the loss of agricultural land and degradation of soil resources during the construction phase (**Solar Energy Facility: Layout Alternative 1: PV 2, 3 and 4**)

Layout Alternative 1: Construction Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Med**	**Low**
Duration	**Construction**	**Construction**
Significance rating	**Low**	**Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing the remaining land portions. ▪ Initiate land rehabilitation and re-vegetation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed development, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should	

	be employed. ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion. ➢ If additional earthworks are required, any steep or large embankments that are expected to be exposed during the 'rainy' months should be armoured with fascine like structures. A fascine structure usually consists of a natural wood material and is used for the strengthening of earthen structures or embankments. ➢ If earth works are required then storm water control and wind screening should be undertaken to prevent soil erosion.

Table 10: Impact rating table for the loss of agricultural land and degradation of soil resources during the construction phase (**Solar Energy Facility: Layout Alternative 2: PV 1)**

Layout Alternative 2: Construction Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Med**	**Med**
Duration	**Construction**	**Construction**
Significance rating	**Low**	**Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing the remaining land portions. ▪ Initiate land rehabilitation and re-vegetation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed development, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should be employed. ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion. ➢ If additional earthworks are required, any steep or large embankments that are expected to be exposed during the 'rainy' months should be armoured with fascine like structures.	

	A fascine structure usually consists of a natural wood material and is used for the strengthening of earthen structures or embankments. ➢ If earth works are required then storm water control and wind screening should be undertaken to prevent soil erosion.

Table 11: Impact rating table for the loss of agricultural land and degradation of soil resources during the operational phase (**Solar Energy Facility: Layout Alternative 1: PV 2, 3 and 4**)

Layout Alternative 1: Operational Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Medium**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ Initiate land rehabilitation and re-vegetation as soon as possible and continue to monitor land degradation. ▪ It is recommended that more palatable species form part of the re-vegetation plan to enable faster stocking initiation. Pertinent plant species should be obtained from a vegetation specialist when the site specific EMP is compiled. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Allow periodic grazing within the PV fields (sheep and wildlife). This mitigation will minimise the loss of grazing land and reduce the impact on agricultural production. ▪ Unfortunately cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps.	

Table 12: Impact rating table for the loss of agricultural land / production and degradation of soil resources during the operational phase **(Solar Energy Facility: Layout Alternative 2: PV 1)**

Layout Alternative 2: Operational Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Medium**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ Initiate land rehabilitation and re-vegetation as soon as possible and continue to visually monitor land for early detection of degradation. ▪ It is recommended that more palatable species form part of the re-vegetation plan to enable faster stocking initiation. Pertinent plant species should be obtained from a vegetation specialist when the site specific EMP is compiled. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Allow periodic grazing within the PV fields (sheep and wildlife). This mitigation will minimise the loss of grazing land and reduce the impact on agricultural production. ▪ Unfortunately cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps.	

Table 13: Impact rating table for soil disturbance and temporary disturbance to grazing regime during the decommissioning phase (**Solar Energy Facility: Layout Alternative 1: PV 2, 3 and 4)**

Layout Alternative 1: Decommissioning Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Very Low**	**Very Low**
Duration	**Construction**	**Construction**

Significance rating	**Very Low**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Reversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Initiate land rehabilitation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed activities, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should be employed. ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion.	

Table 14: Impact rating table for soil disturbance and temporary disturbance to grazing regime during the decommissioning phase (**Solar Energy Facility: Layout Alternative 2: PV 1)**

Layout Alternative 2: Decommissioning Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Medium**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Initiate land rehabilitation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed activities, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should be employed. ➢ Clearing activities should be kept to a minimum. ▪ In the unlikely event that heavy rains are expected, activities should	

	be put on hold to reduce the risk of erosion.

Table 15: Impact rating table for the predicted cumulative loss of agricultural land and degradation of soil resources

Cumulative Impacts		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Regional**	**Regional**
Magnitude	**Low**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Low**
Probability	**Probable**	**Probable**
Confidence	**Unsure**	**Unsure**
Reversibility	**Reversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Initiate land rehabilitation and re-vegetation as soon as possible and continue to monitor land for early signs of degradation and erosion.	

6.5 Impact Assessment: 132kV Transmission Lines

a) Planning Phase

Loss of agricultural land and / or production is not envisioned during this phase of the project.

b) Construction and Operational Phases: 132 kV Transmission Lines

Due to the nature of the development, the construction and operational phases have been combined for this particular activity. Desktop and field data indicates that both Alignment Alternatives (1 and 2) share virtually identical agricultural potential and value, and are both suitable to accommodate the proposed transmission lines. As result the impact assessment for both Alternatives have been rated in a single table (**Table 13**)

Table 16: Combined Impact rating table for construction and operation of a 132 kV Transmission Lines (Alternatives 1 and 2)

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Local**	**Local**
Magnitude	**Very Low**	**Very Low**

Duration	**Long Term**	**Long Term**
Significance rating	**Very Low**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Certain**	**Certain**
Reversibility	**Reversible**	**Reversible**
Mitigation measures	▪ Due to the overarching route characteristics, and the nature of the proposed development, viable mitigation measures are limited and will most likely revolve around erosion control: ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion. ➢ If additional earthworks are required, any steep or large embankments that are expected to be exposed during the 'rainy' months should be armoured with fascine like structures. A fascine structure usually consists of a natural wood material and is used for the strengthening of earthen structures or embankments. ▪ If earth works are required then storm water control and wind screening should be undertaken to prevent soil erosion. ▪ Interact with landowners during the routing process.	

6.7 Preferred Alternatives

It is evident that if the proposed mitigation measures are implemented, then the proposed activities will have a low impact on current agricultural production and soil resources.

From an agricultural perspective, **Layout Alternative 1** is preferable due to the phased approach and the smaller developmental footprint. Pre and post-mitigation scores in the construction phase are also lower for Alternative Layout 1.

Desktop and field data indicates that both Alignment Alternatives (1 and 2) share virtually identical agricultural potential and value, and are both suitable to accommodate the proposed transmission lines. However, **Alternative 2** is recommended as it represents the shortest proposed power line route.

7. EROSION MANAGEMENT PLAN

Soil is a natural resource, is non-renewable in the short term and is expensive either to reclaim or improve following degradation (**van Lynden & Oldeman, 1997**). Even though the areas directly affected by the proposed developments have low agricultural value and capability, the activities still have the potential to negatively impact the immediate and surrounding soil and land resources. The

International Soil Reference and Information Centre **(ISRIC)**, the producers of the World Map of Human-Induced Soil Degradation, recognises two categories of human-induced soil degradation processes.

The **first category** deals with soil degradation by displacement of soil material mainly through water and wind erosion. Soil erosion causes land degradation through a reduction in agricultural potential in many parts of South Africa. The major issues surrounding soil erosion are the loss of the top soil layer required for plant growth, reduction of soil nutrients, siltation of aquatic systems as well as the general land and ecosystem degradation.

The **second category** of soil degradation deals with in-situ soil physical ,chemical and biological deterioration. In-situ soil degradation due to anthropogenic activities can be divided into various classes and subclasses:

- **Physical Degradation** (waterlogging, compaction, crusting, pore modification, etc.)
- **Chemical Degradation** (eutrophication, acidification, salinisation, heavy metal pollution, etc.)
- **Biological Degradation** (pathogen introduction, modification of microbial activity etc.)

A single or combination of the aforementioned degradations leads to a decrease in soil quality/health, which in turn influences land capability ratings (**ISRIC, 1990**). Due to the proposed activities this management plan focuses primarily on soil erosion however generic soil contamination mitigations are provided in **Section 7.3**.

7.1 Soil Erosion Monitoring

Due to the size of the site and without rigorous scientific methods and equipment, soil erosion will need to be monitored visually by the appointed Environmental Control Officer (ECO)[2]. Soil erosion is a natural process, whose rate and intensity can be anthropogenically increased. Excessive erosion can lead to land degradation and the reduction of the area's carrying capacity. It is recommended that areas around roads, stockpiles and PV panels are visually monitored during audits. A photographic record of the on-site conditions will also aid in the identification of erosion problems. A quarterly (3 month) photographic frequency is recommended. However, photographs should be taken immediately after significant rainfall events, as these events are associated with the highest rate of erosion. Signs of rill and gully erosion should be remediated as soon as possible. Typical remediation techniques are provided in **Section 7.2**, below.

7.2 Proposed Soil Erosion Mitigatory Measures

Clearing activities should be kept to a minimum and must only be undertaken during agreed working times, as well as permitted weather conditions. If heavy rains are expected clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts. The further unnecessary removal of groundcover vegetation from slopes must be prevented. Following the clearing of an area, the surfaces of all exposed slopes must be roughened to retain water and

[2] The person appointed will provide direction to the Contractor concerning the activities within the Construction Zone, and who will be responsible for conducting the Environmental Audit of the project during the construction and operational phases of the project.

increase infiltration (especially important during the wet season). Any steep or large embankments that are expected to be exposed during the 'rainy' months should either be armoured with fascine like structures or vegetated. If a cleared area is not going to be built on immediately, the top layer (nominally 150 mm) of soil should be removed and stockpiled in a designated area approved by the ECO. Vegetation shall be stripped in a sequential manner as the work proceeds so as to reduce the time that stripped areas are exposed to the elements. Top-soiling and re-vegetation shall start immediately after the completion of an activity and at an agreed distance behind any particular work front. It is highly recommended that existing farm roads are used as much as possible, while the additional creation of access roads should be kept to a minimum.

Storm water control and wind screening should be undertaken to prevent soil loss from the site. All embankments shall be protected by a cut off drain to prevent water from running down the face of the embankment, resulting in soil erosion. Typical erosion control measures such as the installation of silt fences, hay bales, EcoLogs™ and Bio Jute™ are recommended if erosion problems are noted during construction and operation phases (**Figure 25**).

Figure 25: Typical soil erosion mitigatory measure: BioJute Installtion (**top left**); a silt fence protecting a stockpile (**top right**) and pegged hay bale wall used to reduce runoff velocities (**bottom**)

7.3 Proposed Groundwater and Soil Contamination Mitigatory Measures

Every precaution must be taken to ensure that chemicals and hazardous substances do not contaminate the soil or groundwater on site.
For this purpose the Contractor must:

- Ensure that the mixing /decanting of all chemicals and hazardous materials should take place on a tray or impermeable surface.
- Dispose of any generated waste at a registered landfill site.

- Ensure all storage tanks are designed and managed in order to prevent pollution of drains, groundwater and soils.
- Construct separate storm water collection areas and interceptors at storage tanks, and other associated potential pollution activities.
- Ensure the control of fuels and chemicals in order to prevent spillage potential ground leaching. Adequate spillage containment measures shall be implemented, such as cut off drains, etc. Fuel and chemical storage containers shall be set on a concrete plinth. The containment capacity shall be equal to the full amount of material stored, plus 10%.
- Appoint appropriate contractors to remove any residue from spillages from site. Handling, storage and disposal of excess or containers of potentially hazardous materials shall be in accordance with the requirements of the above-mentioned Regulations and Acts.
- Ensure that used oils/lubricants are not disposed of on/near the site, and that contractors purchasing these materials understand the liability under which they must operate. The ECO will be responsible for reporting the storage/use of any other potentially harmful materials to the relevant authority.
- Ensure that potentially harmful materials are properly stored in a dry, secure environment, with concrete or sealed flooring. The ECO will ensure that materials storage facilities are cleaned/maintained on a regular basis, and that leaking containers are disposed of in a manner that allows no spillage onto the bare soil or surface water. The management of such storage facilities and means of securing them shall be agreed upon.
- Site staff shall not be permitted to use any stream, river, other open water body or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing or for any other construction or related activities. Municipal water or another source approved by the ECO should rather be used for all activities such as washing of equipment, dust suppression, concrete mixing and compacting.

7.4 Stockpile Management

General requirements for stockpiles include that they should be situated in an area that should not obstruct the natural water pathways on site. Topsoil stockpiles will be kept separate from other stockpiles, shall not be compacted, and shall not exceed 2m in height. If exposed to windy conditions or heavy rain, stockpiles should be protected by re-vegetation using an indigenous grass seed mix or cloth, depending on the duration of the project. The construction of a berm consisting of sand bags, or a low brick wall, can be placed around the base of the stockpile for retention purposes. Stockpiles should be weeded regularly; to ensure they are kept free of alien vegetation and shall be kept free of any contaminants whatsoever, including paints, building rubble, cement, chemicals, oil, etc.

Subsoil and topsoil stockpiles will be moved to areas of final utilisation as soon as possible to avoid unnecessary erosion. Stockpiles not utilized within three months of the initial stripping process (or prior to the onset of seasonal rains) will be seeded with appropriate grass seed mixes, including indigenous grasses to further avoid possible erosion.

7.5 Land Rehabilitation

All rubble is to be removed from the site to an approved landfill site as per the construction phase requirements. No remaining rubble is to be buried on site. The site is to be free of litter, and surfaces

are to be checked and cleared of waste products resulting from activities such as concreting or asphalting.

After construction the land will need to be rehabilitated, which includes a re-vegetation plan. It is recommended that more palatable species are planted to enable the faster stocking initiation.

8. SUMMARY AND RECOMMENDATIONS

Aurecon on behalf of Mulilo Renewable Energy requested a baseline assessment of the soil, land use and agricultural characteristics for the areas affected by the proposed construction of three separate solar energy facilities, on Du Plessis Dam Farm (Remainder of Farm 179), near De Aar in the Northern Cape.

A detailed soil and agricultural report was undertaken for Du Plessis Dam Farm in January 2012, as part of a larger environmental assessment. Environmental Authorisation for a 19.9 MW Photovoltaic (PV) solar energy facility, known as Du Plessis PV1, and associated infrastructure was granted for this project in late September 2012. Mulilo now plans to construct three additional PV facilities on the Du Plessis Dam Farm. The area previously approved for PV1 (approximately 64 ha) will be included in the proposed layouts for the additional PV facilities as an attempt to maximise the generation capacity of the farm (**Aurecon, 2013**).

The farm is situated in the Emthanjeni Local Municipality, and is zoned as agricultural land. The farm borders the north eastern corner of De Aar and consists of flat grassy plains which are used as unimproved grazing land for cattle production. Water is the major limiting factor to local agricultural enterprise, and the farm neither contains nor directly borders a perennial river / freshwater impoundment which could be used as a source of irrigation water.

The study area has a semi-arid to arid continental climate with a summer rainfall regime i.e. most of the rainfall is confined to summer and early autumn. MAP is approximately 300 mm per year. The low rainfall and moisture availability is reflected in the lack of dry land crop production within the study area. The climate for the study area is severely restrictive to arable agriculture, primarily due to the lack of rainfall and severe moisture availability restrictions. The majority of the study area is characterised by flat plains and gently sloping topography with an average gradient of less than 5%. These plains are ideal areas for intensive agriculture, with a high potential for large scale mechanisation. From a developmental perspective, the flat topography will also allow for minimal earthworks and site preparation.

The soils identified on the PDA are predominantly shallow and rocky with a low agricultural potential. Rocky soils (Mispah and Glenrosa Forms) cover 71% of the surveyed area while shallow duplex soils (Swartland) cover 24%. Most soils contained a layer that was limiting to plant growth, including rock, saprolite, hard pan carbonate and strongly structured cutanic horizons. Virtually all the soil encountered in the study area contained a layer, close to the soil surface, that was limiting to plant growth and these layers included rock, hard pan carbonate and dorbank. Soils with an effective depth of greater than 50 cm were rarely observed during the soil survey. The physical and chemical limitations associated with the dominate forms, will in most instances, restrict these soils to extensive grazing.

The majority of the site has been classified as having low potential for crop production due to an arid climate and highly restrictive soil characteristics. The site is not classified as high potential nor is it a unique dry land agricultural resource. The site is considered to have a moderate to moderately low value when utilised as grazing land, its current use.

There are no centre pivots, irrigation schemes or active agricultural fields which will be influenced by the proposed development, and as such there are no problematic or fatal flaw on-site areas for the proposed solar energy facilities, based on the agricultural assessment as a standalone specialist study.

The proposed development's primary impact on agricultural activities will involve the construction of the solar fields and associated infrastructure. This will entail the clearing of vegetation and levelling of the site. This will effectively eliminate the impacted land's agricultural potential in terms of crop production, or in this case grazing, during the construction phase, which is estimated to last between 12 and 24 months. The construction of the solar fields will influence a portion of the farms total area. The remaining land will continue to function as it did prior to the development. Furthermore, facilities on the farm will be phased and constructed consecutively depending on whether the projects are approved by the DoE and DEA. Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing on the remaining land portions.

After construction the land will need to be rehabilitated, including the re-vegetation of the solar fields. It is recommended that more palatable species are planted to enable the faster stocking initiation.

In order to further mitigate the potential impacts it is highly recommended that periodic grazing within the PV fields is allowed. This mitigation will minimise the loss of grazing land and reduce the overall impact on agricultural production. Interestingly the farmers around the De Aar have changed from sheep to beef production due to the high prevalence of stock theft. Unfortunately cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps. The problem of small stock theft should be mitigated by the additional security and fencing associated with the PV facilities.

A number of solar and renewable energy projects have been proposed in the De Aar area and thus, the cumulative impact of these developments on surrounding farms could become detrimental to local agricultural resources, if the loss of usable grazing land is not taken into account when determining optimum herd size. A phased approach for each farm in combination with erosion control and land rehabilitation within each farm will reduce this impact. The inherently low agricultural potential of the region also reduces the overall cumulative impact.

From an agricultural perspective **Layout Alternative 1** is preferred due to the phased approach and the smaller developmental footprint. Pre and post-mitigation scores in the construction phase are also lower for Alternative Layout 1 (low negative).

Desktop and field data indicates that both Alignment Alternatives (1 and 2) share virtually identical agricultural potential and value and are both suitable to accommodate for the proposed transmission

lines. However, **Alternative 2** is recommended as it represents the shortest of the proposed power line routes.

If the suggested mitigation measures and erosion management plan are correctly implemented there is no reason why the proposed solar energy facilities and supporting infrastructure cannot be accommodated on the Du Plessis Dam Site.

9. REFERENCES

AGIS Database. (2013). Source: *http://www.agis.agric.za/agisweb/agis.html*

Aurecon South Africa. (2013). Draft Scoping Reports for the Proposed Photovoltaic (solar) Energy Facilities on Du Plessis Dam Farm near De Aar, Northern Cape.

Brady, N.C., and Weil, R.R. (2004). Elements of The Nature and Properties of Soils, 2nd edn. Upper Saddle, NJ: Prentice-Hall.

Department of Environmental Affairs and Tourism. (2001). *Environmental Potential Atlas for South Africa.* Source: www.environment.gov.za/enviro-info/enpat.htm.

FAO. (2007) Mapping biophysical factors that influence agricultural production and rural vulnerability. Source: www.fao.org/docrep/010/a1075e/a1075e00.HTM.

Fey, M. (2010). Soils of South Africa. Cambridge University Press.

Mucina, L. and Rutherford, M.C.(eds). 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

SAWS. (2010). Climate Information for De Aar. Source: *http://www.weathersa.co.za/Climat/Climstats/DeAarStats.jsp*

Smith, B. (2006). The Farming Handbook. University of KwaZulu-Natal Press.

SiVEST (2012). Proposed Solar Energy Facilities Near De Aar: Final Soil and Agricultural Assessment Report.

Soil Classification Working Group. (1991). Soil Classification: a taxonomic system for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.

Van Lyden, **G.W.J.** and **Oldeman**, **L.R.(1997)** The Assessment of the Status of Human-Induced Soil Degradation in South and Southeast Asia. International Soil Reference and Information Centre.

10. APPENDIX A: SOIL PROPERTIES

PV Site	Auger Number	Soil Form	Soil Family	Effective Depth (m)	Limiting Layer	X	Y
PV 4	79	Ms	1200	0.1	Rock	24.051640	-30.621820
PV 4	80	Sw	1122	0.4	Saprolite	24.058060	-30.622250
PV 4	81	Gs	1112	0.2	Rock	24.062960	-30.624080
PV 4	82	Sw	1122	0.5	Saprolite	24.066400	-30.627790
PV 4	83	Ms	1200	0.1	Rock	24.069040	-30.630210
PV 4	84	Sw	1122	0.4	Saprolite	24.074180	-30.631220
PV 4	85	Sw	1122	1.2	Saprolite	24.077780	-30.633890
PV 4	86	Sw	1122	0.5	Saprolite	24.080610	-30.635680
PV 4	87	Sw	1122	0.6	Saprolite	24.083010	-30.636920
PV 4	88	Sw	1122	0.5	Saprolite	24.082340	-30.640960
PV 4	89	Sw	1122	0.4	Saprolite	24.081870	-30.643920
PV 4	90	Sw	1122	1	Saprolite	24.078050	-30.643420
PV 4	91	Ms	1200	0.2	Rock	24.072930	-30.642450
PV 4	92	Sw	1122	0.5	Saprolite	24.066470	-30.641460
PV 4	93	Ms	1200	0.2	Rock	24.059150	-30.640310
PV 4	94	Ms	1200	0.1	Rock	24.051540	-30.638930
PV 4	95	Ms	1200	0.1	Rock	24.046580	-30.638240
PV 4	96	Sw	1122	0.4	Saprolite	24.041090	-30.636360
PV 4	97	Ms	1200	0.1	Rock	24.035700	-30.634160
PV 4	98	Cg	2000	0.2	HPC	24.037630	-30.628980
PV 4	99	Ms	1200	0.2	Rock	24.041500	-30.624470
PV 4	100	Gs	1112	0.2	Rock	24.043670	-30.620270
PV 4	101	Ms	1200	0.2	Rock	24.048270	-30.622250
PV 4	102	Ms	1200	0.1	Rock	24.052260	-30.625610
PV 4	103	Ms	1200	0.1	Rock	24.057710	-30.627720
PV 4	104	Sw	1122	0.3	Saprolite	24.063700	-30.629820
PV 4	105	Ms	1200	0.2	Rock	24.069160	-30.633240
PV 4	106	Ms	1200	0.1	Rock	24.071090	-30.636170
PV 4	107	Ms	1200	0.2	Rock	24.072710	-30.638130
PV 4	108	Ms	1200	0.1	Rock	24.060010	-30.620360
PV 4	109	Gs	1112	0.2	Rock	24.027000	-30.64100

SiVEST Civil Engineering

VCC Estate, North View Building,
170 Peter Brown Drive, Montrose, Pietermaritzburg, 3201
PO Box 707, Msunduzi, 3231
South Africa
Tel + 27 33 347 1600
Fax +27 33 347 5762
Email info@sivest.co.za
www.sivest.co.za
Contact Person: Kurt Barichievy
Cell No.: 084 5549442
Email: Kurtb@sivest.co.za

FRESHWATER ASSESSMENT FOR THE PROPOSED PHOTOVOLTAIC (SOLAR) ENERGY FACILITIES ON DU PLESSIS DAM FARM NEAR DE AAR, NORTHERN CAPE

May 2013

Prepared for:

Mulilo Renewable Energy (Pty) Ltd

P.O. Box 50

Cape Town International Airport

CAPE TOWN

7525

Prepared By:

Toni Belcher

Cell: 082 883 8055

Email: toni.b@iburst.co.za

Executive Summary

Mulilo proposes to construct three PV facilities, each with a generation capacity of 75MW AC on Du Plessis Dam Farm (Remainder of farm 179), near De Aar. A previous EIA was undertaken at the same location and information is available and environmental sensitive areas were taken into consideration in the preliminary designs. It is therefore proposed to further develop a site which is already well studied, found suitable for the proposed development, is located close to existing and proposed Eskom infrastructure, and where no fatal flaws have been identified.

The freshwater features on the farm Du Plessis Dam consist of ephemeral tributaries of the Brak River. These tributaries are considered to be in a largely natural ecological state, with a low ecological importance and sensitivity. The expected impacts of the proposed activities are likely to be as follows:

- *Solar energy facility (brown polygons):* The preferred proposed layout will result in some modification of a few minor freshwater features/drainage lines on the site.
- *Overhead transmission lines/corridors (white polygons with yellow lines):* The preferred transmission lines/corridors will cross two minor freshwater features/drainage lines.
- *Substations (black rectangles).* The Central substation as well as PV1 and possibly PV2 substations are located within the wide depressions that are indicated as freshwater features/drainage lines. These areas tend to be much wetter than the surrounding areas and it is advised that the substations be located at least 30m outside of these wide drainage areas.
- *Access routes (red lines) and water pipeline (blue line):* The proposed access route and water pipeline will cross the two drainage channels crossed by the transmission lines.
- *Layout camp:* The proposed laydown camp is located outside of any identified freshwater features therefore the potential impact on freshwater features is very low for this component.

While the likely significance of the proposed preferred and alternative layouts are similar (moderate significance), the preferred layout (Alternative 1) is seen as the better option in terms of its potential impact on the freshwater features. In particular, by relocating the proposed substations mentioned above to outside of the demarcated drainage line, the potential impact of the proposed layout for the preferred alternative, would be significantly reduced.

Should the following recommended mitigation measures be implemented, the significance of the impact is expected very low:

- A buffer of 30m should be maintained adjacent to the identified streams for the proposed PV footprint area as well as the substations.
- Construction activities for the proposed infrastructure that will need to take place within the river channels and riparian zone (i.e. linear development components – roads, transmission lines and water pipeline) should transect the streams at right angles and be limited as far as possible to ensure minimum disturbance of this area. Disturbed areas within the riparian zones and stream

beds should be rehabilitated as soon as possible after construction has been completed and revegetated with suitable indigenous vegetation. Where possible previously disturbed areas such as existing roads or transmission line routes should be utilised. Disturbed areas should be visually monitored every 3 months and kept free of invasive alien plant growth.

- Construction should preferably take place during the low flow months (May to October) to minimize the risk of erosion and contaminated runoff from construction sites into adjacent freshwater features.
- All rubble, sand and waste material resulting from the construction activities should be removed from any stream and drainage channels to ensure that flow in these channels are not impeded.
- Invasive alien plants should be removed from the disturbed areas within the drainage channels.
- Contaminated runoff from the construction sites should be prevented from entering the streams.
- All materials on the construction sites should be properly stored and contained.
- Disposal of waste from the sites should also be properly managed.
- Construction workers should be given ablution facilities at the construction sites that are located at least 100m away from the river systems/freshwater features and regularly serviced.
- The laydown area(s) should be cleaned and rehabilitated after construction is complete according to the approved rehabilitation plan.
- There should be an approved storm water management plan in place for the operation phase of the project. Storm water runoff from the constructed areas should also be visually monitored after large rainfall events to ensure that eroded areas do not develop, particularly within the drainage channels.
- A decommission plan should be drawn up and approved for the site that addresses the removal of the PV facilities and infrastructure post operation phase. The decommission plan should address aspects such as monitoring and management of invasive alien plants and erosion of the site after the activities on the site are complete.

A water use authorization application may need to be submitted to the Department of Water Affairs Northern Cape Regional Office for approval of the water use aspects of the proposed activities, in particular a water use authorisation will be required for any development activities relating to the stream crossings.

TABLE OF CONTENTS

1. BACKGROUND

Mulilo Renewable Energy (Pty) Ltd (Mulilo) proposes to construct three separate solar energy facilities, on Du Plessis Dam Farm (Remainder of Farm 179), near De Aar in the Northern Cape. Each of the three proposed facilities would have a maximum generation capacity of 75MW Alternating Current (AC) through photovoltaic (PV) technology.

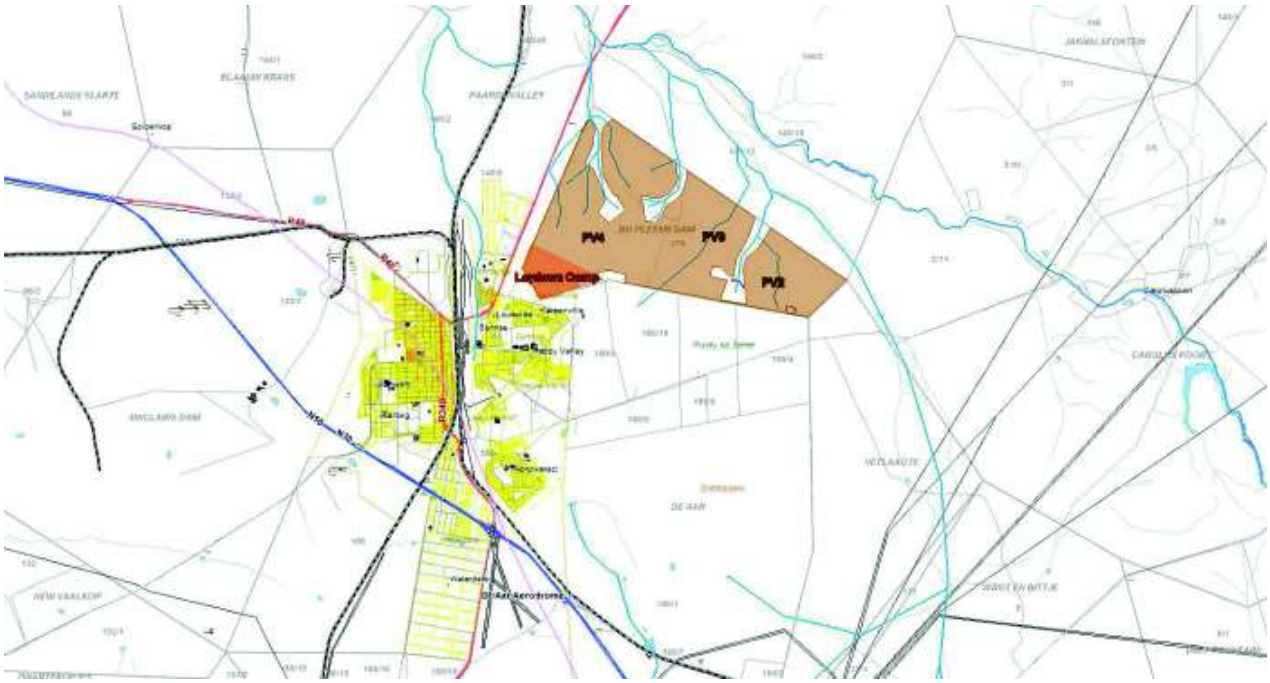

Figure 1. Locality map of the proposed photovoltaic energy facilities

The nature of the activity includes:

- Technology: A photovoltaic component comprising of numerous arrays of PV panels to generate up to 75MW per facility, through the photovoltaic effect.
- Transmission lines (132kV) and substations.
- Boundary fencing: Each 75MW facility will be fenced for health, safety and security reasons.
- Roads: one access road and internal access roads for servicing and maintenance.
- Water supply infrastructure.
- Storm water infrastructure: Including drainage channels, berms, detention areas and kinetic energy dissipaters.
- Buildings: Buildings would likely include onsite substations, a connection building, control building, guard cabin, an electrical substation and solar resource measuring substation.

2. TERMS OF REFERENCE

The proposed Terms of Reference for the aquatic specialist studies are as follows:

- Summary of available information pertaining to surface water (streams, dams and wetlands) in close vicinity to the sites;
- Undertake water quality and biotic assessments sampling for stream, wetland and dam condition assessments;
- Describe and determine importance, functionality and trophic state of the water resources;
- Assess the potential impact of the change in site hydrology (quantity) and water chemistry (quality) on any streams, dams and wetlands during the construction and operational phases;
- Assessment of cumulative impacts;
- Evaluate (a) magnitude, frequency of occurrence, duration and probability of impacts, (b) the local, regional, and national significance of predicted impacts, (c) the level of confidence in findings relating to potential impacts, (d) the degree to which the impact can be reversed, and (e) cumulative impacts that may occur as a result of the activities;
- Recommend mitigation measures aimed at minimising the potential negative impacts and enhancing potential positive impacts while retaining reasonable operational efficiencies;
- List additional or required permitting and/or licensing requirements; and
- Take cognisance of the Wetland Delineation Guideline Document of the Department of Water, and if applicable the DEA&DP draft guideline: "Guideline for involving biodiversity specialists in EIA processes.

3. APPROACH TO THE STUDY AND STUDY LIMITATIONS AND ASSUMPTIONS

Input into this report was informed by a combination of desktop assessments of existing freshwater ecosystem information for the study area and catchment, as well as by a more detailed assessment of the freshwater features at the various proposed sites. Aquatic Ecosystem Health assessments were carried out to provide information on the ecological condition and ecological importance and sensitivity of the river and wetland systems to be impacted. The assessments were carried out using the Department of Water Affairs developed methodologies.

The site was visited in January 2012 (Belcher, 2012) during the first EIA process and again in May 2013 for this assessment. During the May 2013 field visit, the characterisation, mapping and integrity assessments of the freshwater features were undertaken. This information/data was used to inform the potential impact of the proposed activities as well as the recommended mitigation measures.

Limitations and uncertainties often exist within the various techniques adopted to assess the condition of ecosystems. Analysis of the freshwater ecosystems was undertaken according to nationally developed

methodologies and was undertaken at a rapid level which was considered a suitable level of evaluation for this freshwater impact assessment.

4. USE OF THIS REPORT

This report reflects the professional judgment of its author. The full and unedited content of this should be presented to the client. Any summary of these findings should only be produced in consultation with the author.

5. OVERVIEW OF THE PROPOSAL

5.1. Overview of the Study Area

The study area is situated in the Northern Cape Province, within the boundaries of the Emthanjeni Local Municipality as well as the greater Pixley ka Seme District Municipality near De Aar. The broader landscape consists of predominantly flat lowlands along with few flat-topped hills.

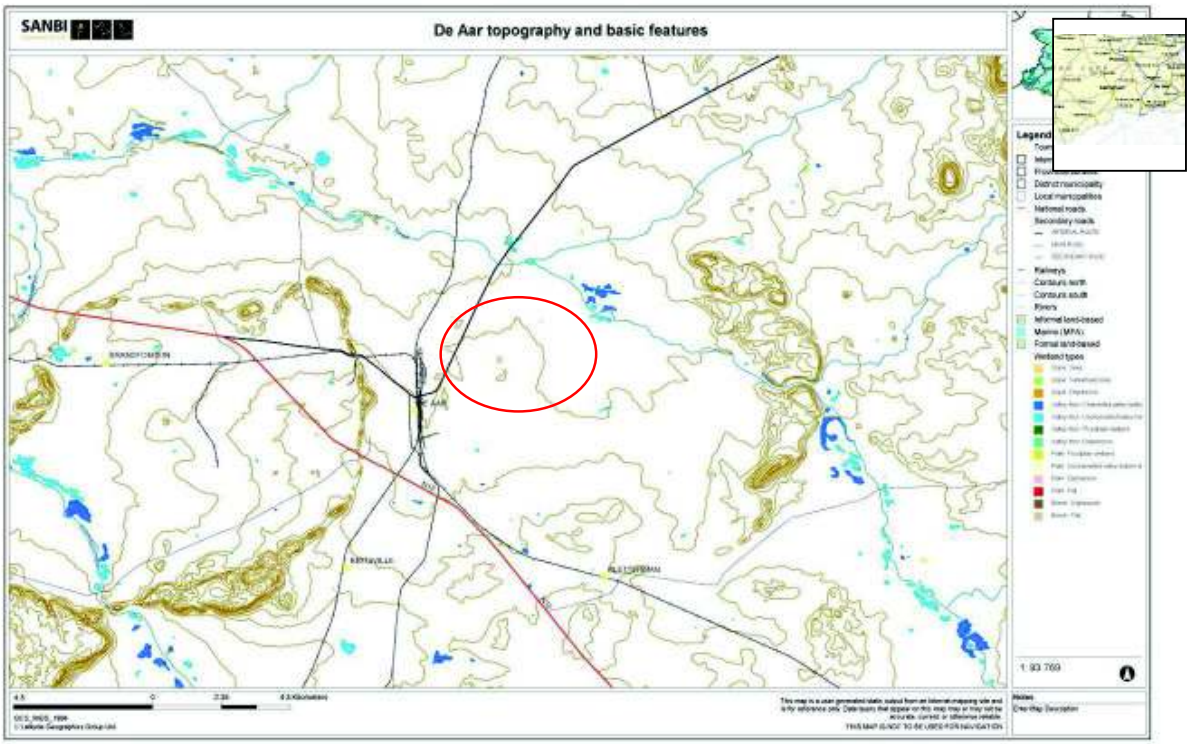

Figure 2. Locality map for the study area

The main water feature in the area is the Brak River, a tributary within the Orange River System. Most of the land surrounding De Aar is undeveloped and only utilised for grazing of sheep, cattle, goats, ostriches or game such as springbok.

5.2. Activity Description and Alternatives

Mulilo proposes to construct three PV facilities, each with a generation capacity of 75MW AC on Du Plessis Dam farm (Remainder of farm 179), near De Aar (see Figure 14). The total extent of the three proposed facilities would be approximately 755ha as set out in Figure 3.

A previous EIA was undertaken at the same location (Aurecon, 2013) and information is available and environmental sensitive areas were taken into consideration in the preliminary designs. It is therefore proposed to further develop a site which is already well studied, found suitable for the proposed development, is located close to existing and proposed Eskom infrastructure, and where no fatal flaws have been identified.

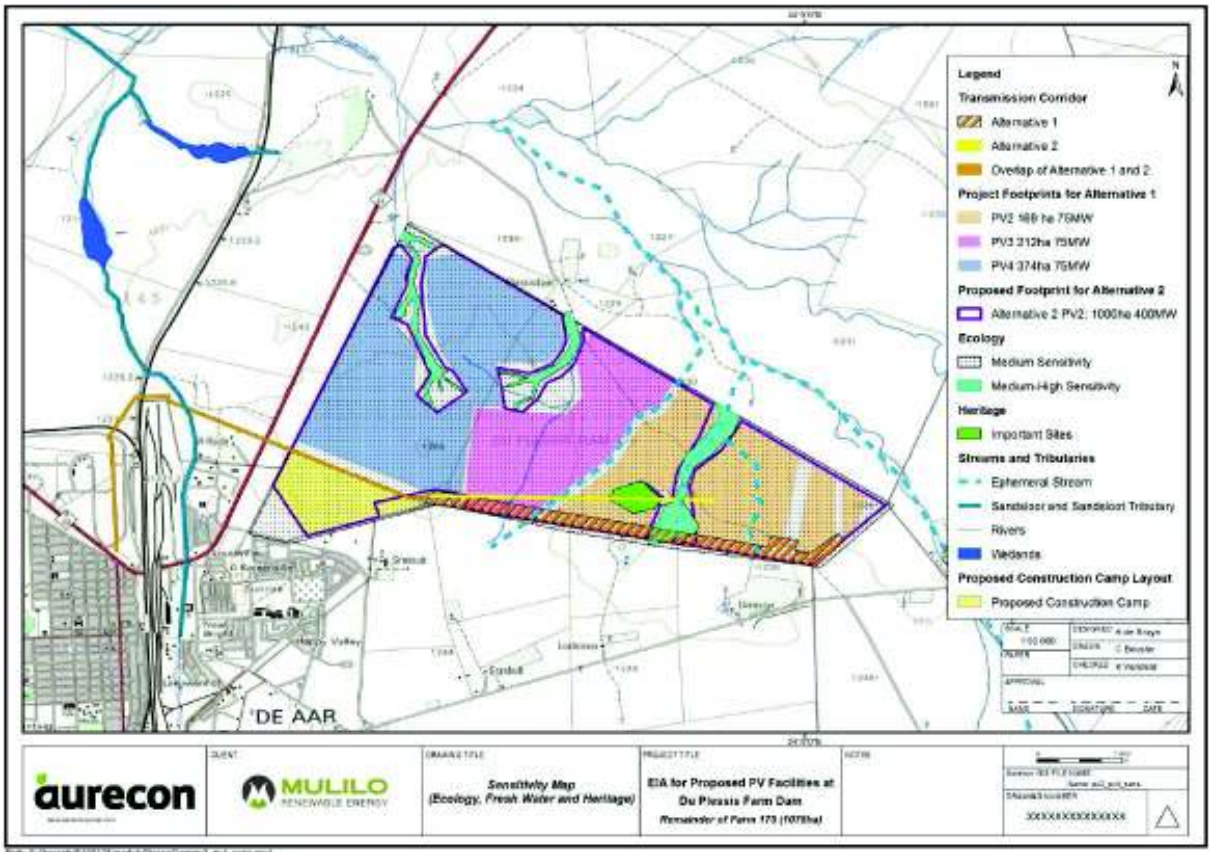

Figure 3. Diagram of the proposed localities of the Photovoltaic power generation facilities

Each of the proposed PV facilities would consist of the following:

- **Solar energy facility:** A photovoltaic component comprising of numerous arrays of PV panels and associated support infrastructure to generate up to 75MW per facility, through the photovoltaic effect.
- **Transmission lines:** 132kV overhead transmission lines to connect each facility to the central onsite substation or an existing Eskom substation.
- **Facility substations:** An onsite 132kV, 3 bay central substation.

- **Boundary fence:** Each 75MW facility will be fenced for health, safety and security reasons.

It is proposed that the following infrastructure be shared between the three facilities to lessen the impact on the surrounding environment:

- **Central substation:** One central 132kV substation and connection to Eskom grid. This central substation will connect the PV facilities with Eskom's De Aar substation via either an existing overhead 132kV Eskom line or the previously authorised 132kV overhead transmission line directly to De Aar substation.
- **Roads:** Access road and internal access roads for servicing and maintenance of the site.
- **Water supply infrastructure**: It is proposed that potable water will be obtained from the Emthanjeni Municipality. Water will be transferred to the site via the municipal pipeline from the nearest municipal supply point and will be contained onsite in a jo-jo tank. However, the Municipality would need to confirm availability of capacity to do so.
- **Storm water infrastructure**: Including drainage channels, berms, detention areas and kinetic energy dissipaters.
- **Buildings**: Buildings would likely include onsite substations, a connection building, control building, guard cabin, an electrical substation and solar resource measuring substation.

Proposed Alternatives

Two scale and magnitude alternatives are being considered, however the approved capacity limit (MW) of the facilities will determine the layout of the facilities.

Layout Alternative 1

This alternative consists of the three proposed 75MW PV facilities and associated infrastructure as indicated in Figure 3 (referred to as PV2, PV3 and PV4). These layouts take cognisance of the 75MW Department of Energy cap and the environmentally sensitive areas as identified by Aurecon (2012).

Layout Alternative 2

This alternative consists of one 400MW PV facility. The layout for this alternative was developed by extending and combining the proposed 75MW facilities. This alternative is thus not limited to the DOE's 75MW cap per project. By increasing the capacity it has the benefit of utilising industries at scale thereby reducing associated development and construction costs which reduces lending rates and essentially lower the tariff of electricity sold. As indicated in Figure 3 the layout of extended PV1 more or less overlaps with the Alternative 1 layouts.

5.3. Legal Requirements

The following Acts, regulations and ordinances are applicable to the development:

The National Environmental Management Act (Act No. 107 of 1998) (NEMA)

Chapter Seven of the NEMA states that:

"Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment".

The Act also clearly states that the landowner, or the person using or controlling the land, is responsible for taking measures to control and rectify any degradation. These may include measures to:

"(a) investigate, assess and evaluate the impact on the environment;

(b) inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment:

(c) cease, modify or control any act, activity or process causing the pollution or degradation:

(d) contain or prevent the movement of pollutants or degradation: or

(e) eliminate any source of pollution or degradation: or

(f) remedy the effects of the pollution or degradation."

- NEMA Basic Assessment Regulations, GN R543 of 2010

Activities listed in terms of Chapter 5 of NEMA in Government Notice No. R. 544, 5 and 6 trigger a mandatory Basic Assessment, or even a full scoping EIA process, prior to development.

The National Environmental Management Second Amendment Act (Act No.8 of 2004) provided for formal procedures for offenders in terms of Section 24G to apply for rectification of the unlawful commencement of listed activities.

National Water Act, 1998 (Act No. 36 of 1998)

The purpose of the National Water Act (Act 36 of 1998) (NWA) is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the NWA as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorisation

and register as users. The NWA also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

- Regulations Requiring that a Water User be Registered, GN R.1352 (1999)

Regulations requiring the registration of water users were promulgated by the Minister of the Department of Water Affairs (DWA) in terms of provision made in section 26(1)(c), read together with section 69 of the NWA. Section 26(1)(c) of the NWA allows for registration of all water uses including existing lawful water use in terms of section 34(2). Section 29(1)(b)(vi) also states that in the case of a general authorisation, the responsible authority may attach a condition requiring the registration of such water use. The Regulations (Art. 3) oblige any water user as defined under section 21 of the Act to register such use with the responsible authority and effectively to apply for a Registration Certificate as contemplated under Art.7(1) of the Regulations.

- General Authorisation in terms of s. 39 of the National Water Act, GN R 1199 of 2009

Government Notice R1199 was issued as a revision of the General Authorisations (No. 1191 of 1999) for Section 21 (c) and (i) water uses as defined under the NWA (Act 36 of 1998). The revision was published and came into effect on 2009/12/18. According to the preamble to Part 6 of the National Water Act, "*This Part establishes a procedure to enable a responsible authority, after public consultation, to permit the use of water by publishing general authorisations in the Gazette...*"

"The use of water under a general authorisation does not require a licence until the general authorisation is revoked, in which case licensing will be necessary…"

The authorisation of water use activities for Sections 21 (a) - abstraction, 21 (c) - change to the bed, banks and characteristics of a water course and 21 (i)- impeding and diverting the flow, will need to be applied for at the Northern Cape Regional Office of the Department of Water Affairs. As such, the regional office will need to be notified of the proposed activities and will need to give comments as to whether the activities require a licence process or not in a-non binding letter.

6. AQUATIC SYSTEMS IN THE STUDY AREA

6.1. Description of the Study Area

a. Physical Characteristics

The proposed project is located just northeast of the town of De Aar, in the Northern Cape Province. De Aar was established in 1903 and derives its name refers from the water-bearing arteries that occur underground. The surrounding area is characterised by wide open plains and low hills, with sparse settlements and predominately wide open spaces.

Figure 4. A view of the De Aar area

b. Climate

De Aar normally receives on average about 196mm of rain per year, mostly during autumn. The lowest rainfall (1mm) usually occurs in August and the highest (45mm) in March (Figure 5). The average midday temperatures for De Aar range from 16°C in June to 30.3°C in January. The region is the coldest during July when the mercury drops to 0.3°C on average during the night.

Figure 5. Average monthly rainfall for the area (SA Explorer, 2008)

c. Geology and Soil

The geology of the study area can be described as being underlain by flat-lying sedimentary rocks of the Karoo Supergroup, which have been intruded by innumerable sills and dykes of dolerite.

ERROR: ioerror
OFFENDING COMMAND: image

STACK:

-mark-
-savelevel-