IMPACT ASSESSMENT REPORT:

Specialist ecological study on the potential impacts of the proposed INCA De Aar photovoltaic (PV) Solar Energy Facility, near De Aar, Northern Cape

Prepared by

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15 November 2011

DRAFT REPORT: 2nd Draft

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

REGULATIONS GOVERNING THIS REPORT

This report has been prepared in terms the EIA Regulations promulgated under the *National Environmental Management Act* No. 107 of 1998 (NEMA) and is compliant with Regulation 543 Section 32 - Specialist reports and reports on specialised processes under the Act. Relevant clauses of the above regulation are quoted below.

Regulation 32. (1): An applicant or the EAP managing an application may appoint a person who is independent to carry out a specialist study or specialised process.

Regulation 32. (2): The person referred to in subregulation (1) must comply with the requirements of regulation 17.

Regulation 32. (3): A specialist report or a report on a specialised process prepared in terms of these Regulations must contain:

(a) details of (i) the person who prepared the report, and
(ii) the expertise of that person to carry out the specialist study or specialized process;

(b) a declaration that the person is independent in a form as may be specified by the competent authority;

(c) an indication of the scope of, and the purpose for which, the report was prepared;

(d) a description of the methodology adopted in preparing the report or carrying out the specialized process;

(e) a description of any assumptions made and any uncertainties or gaps in knowledge;

(f) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;

(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority;

(h) a description of any consultation process that was undertaken during the course of carrying out the study;

(i) a summary and copies of any comments that were received during any consultation process;

(j) any other information requested by the competent authority.

Section 17 relates to General requirements for EAPs or a person compiling a specialist report or undertaking a specialized process, as follows:

An EAP appointed in terms of regulation 16(1) must-

(a) Be independent;
(b) Have expertise in conducting environmental impact assessments, including knowledge of the Act, these regulations and any guidelines that have relevance to the proposed activity;
(c) Perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
(d) Comply with the Act, the Regulations and all other applicable legislation;
(e) Take into account, to the extent possible, the matters referred to in regulation 8 when preparing the application and any report relating to the application; and
(f) Disclose to the applicant and the competent authority all material information in the possession of the EAP that reasonably has or may have the potential of influencing-
    i. Any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or
    ii. The objectivity of any report, plan or document to be prepared by the EAP in terms of these Regulations for submission to the competent authority.

Appointment of specialist

David Hoare of David Hoare Consulting cc was commissioned by Savannah Environmental (Pty) Ltd to provide specialist consulting services for the Environmental Impact Assessment for the proposed INCA De Aar photovoltaic solar energy facility near De Aar in the Northern Cape Province. The consulting services comprise an assessment of potential impacts on the flora, fauna, vegetation and ecology in the study area by the proposed project.

Details of specialist

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Summary of expertise

Dr David Hoare:

- 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.
- Conducted, or co-conducted, over 320 specialist ecological surveys as an ecological consultant.
- 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.
- Referee for 3 international journals.

Independence

David Hoare Consulting cc and its Directors have no connection with INCA De Aar Solar (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 Savannah Environmental (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.

Scope and purpose of report

The scope and purpose of the report are reflected in the “Terms of reference” section of this report.

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 ongoing 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.

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INTRODUCTION

Terms of reference and approach

Savannah Environmental (Pty) Ltd. was appointed by INCA De Aar Solar (Pty) Ltd to undertake an application for environmental authorisation through an Environmental Impact Assessment (EIA) for the proposed “INCA De Aar PV Solar Energy Facility". The project involves the establishment of a renewable energy facility for power generation and its associated infrastructure, including an array of pv panels, foundations for the pv panels, underground cabling between pv panels, inverters, internal access roads, an overhead power line approximately 100 m long to link into the existing Eskom Hydra substation, and an administration building, and or workshop area for maintenance and storage . The purpose of the EIA is to identify environmental impacts associated with the project.

On 21 March 2011 David Hoare Consulting cc was appointed by Savannah Environmental (Pty) Ltd to undertake an ecological assessment of the study area. The specific terms of reference for the ecological EIA study are as follows:

- An indication of the methodology used in determining the significance of potential environmental impacts;
- A description of the environmental issues that were identified during the environmental impact assessment process;
- An assessment of the significance of direct, indirect and cumulative impacts in terms of standard criteria;
- A description and comparative assessment of all alternatives identified during the environmental impact assessment process;
- Recommendations regarding practical mitigation measures for potentially significant impacts, for inclusion in the Environmental Management Plan;
- An indication of the extent to which the issue could be addressed by the adoption of achievable mitigation measures;
- A description of any assumptions, uncertainties and gaps in knowledge;
- An environmental impact statement which contains
- A summary of the key findings of the environmental impact assessment,
- An assessment of the positive and negative implications of the proposed activity,
- A comparative assessment of the positive and negative implications of the distribution line alternatives,
- A comparative assessment of the postivie and negative implications of the access road alternatives.

This report provides details of the results of the EIA phase. The findings of the study are based on a combination of a desktop assessment of the study area, detailed interpretation of aerial photography, fieldwork undertaken on site and expert knowledge of the area gained from general fieldwork conducted in the area for a number of similar projects.

Study area

At a regional level the study area falls within the Northern Cape Province to the south-east of the town of De Aar. A more detailed description of the study area is provided in a section below.

METHODOLOGY

The assessment is to be undertaken in two phases, a Scoping phase and an Environmental Impact Assessment phase. The objective of the EIA phase study was to assess the significance of potential impacts on flora, fauna and ecology within the study area. This report contains all the descriptive information on flora and fauna that were presented in the Scoping report as well as a comprehensive assessment of potential impacts. The results of the EIA phase study are provided in this report

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
3. threatened animal species

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 and animal species of concern

The purpose of listing Red List plant and animal species is to provide information on the potential occurrence of species of special concern 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 of conservation concern previously recorded in the area and any other species with potential conservation value. Historical occurrences of threatened plant species were obtained from the South African National Biodiversity Institute for the quarter degree squares within which the study area is situated.

Regulations published for the National Forests Act 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.

Provincial and 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)*.

Lists of threatened animal species that have a geographical range that includes the study area were obtained from literature sources (for example, Alexander & Marais 2007, Branch 1988, 2001, du Preez & Carruthers 2009, Friedmann & Daly 2004, Mills & Hes 1997). The likelihood of any of them occurring was evaluated on the basis of habitat preference and habitats available at each of the proposed sites. The three parameters used to assess the probability of occurrence for each species were as follows:

- *Habitat requirements*: most Red Data animals have very specific habitat requirements and the presence of these habitat characteristics within the study area were assessed;
- *Habitat status*: in the event that available habitat is considered suitable for these species, the status or ecological condition was 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
- *Habitat linkage*: 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.

For all threatened or protected organisms (flora and fauna) 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. fynbos), but detailed microhabitat requirements (e.g. mountain fynbos on shallow soils overlying Table Mountain 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 fynbos on shallow soils overlying Table Mountain 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), Eastern Cape Biodiversity Conservation Plan (ECBCP). 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)	• 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.

	And may also be positive for the following: • High intrinsic biodiversity value (high species richness and/or turnover, unique ecosystems) • 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)	• 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.	• 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 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.
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.
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.

Assessment of impacts

Direct, indirect, and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase were assessed in terms of the following criteria:

» The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
» The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high):
» The **duration**, wherein it was indicated whether:
  * the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  * the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  * medium-term (5–15 years) – assigned a score of 3;
  * long term (> 15 years) - assigned a score of 4; or
  * permanent - assigned a score of 5;
» The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

» The **probability** *of occurrence*, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
» the **significance**, was determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
» the **status**, which was described as either positive, negative or neutral.
» the degree to which the impact can be reversed.
» the degree to which the impact may cause irreplaceable loss of resources.
» the degree to which the impact can be mitigated.

The **significance** was calculated by combining the criteria in the following formula:

$S=(E+D+M)P$

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

» < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

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.

DESCRIPTION OF STUDY AREA

Location

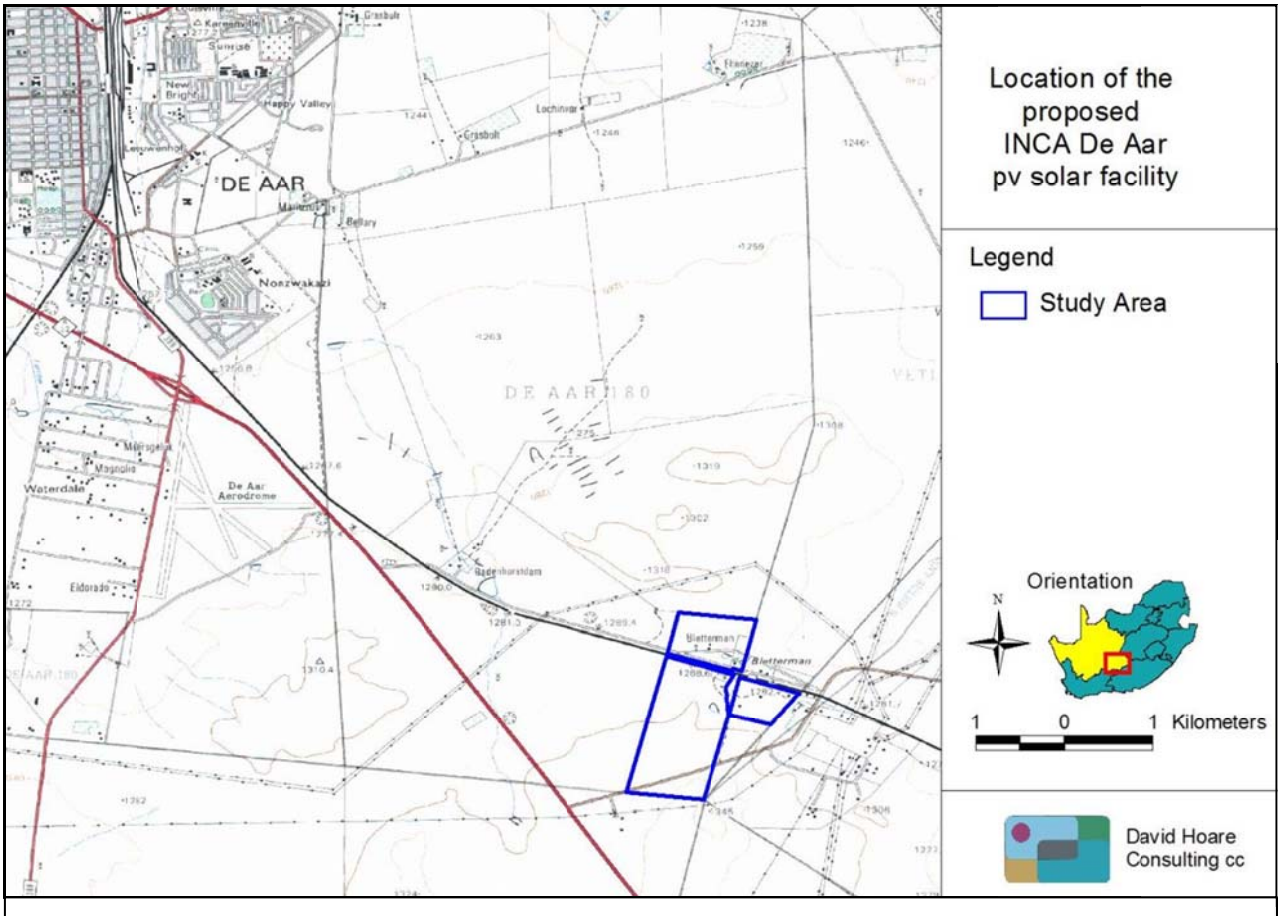
The study site is situated approximately 8 km south-east of De Aar within the Northern Cape (Figure 1). The site falls within the quarter degree grid 3024CA. The proposed facility would occur on Portion 3 of the Farm 4 (Vetlaagte) and the Remainder of Portion 2 (Portion of Portion 1) of the Farm De Aar 180.

No alternative site is currently being considered for the proposed facility, but the current site is sufficiently large to allow placement of the facility in alternative positions within the site in order to avoid any identified environmental sensitivities. The site was chosen because of the local topography, solar irradiation and access to the electricity grid via the existing Eskom Hydra substation. The Hydra substation is less than 200 m from the site.

The study area is accessible from De Aar via a secondary road from the N10 which runs through De Aar to Hanover, where it crosses the N1. There is a gravel road running through the southern part of the site and then near to the eastern boundary of the site. A railway line runs through the northern part of the site, partially along the northern boundary.

Topography

The topography of the study site is relatively gentle and slopes gently towards the north. The elevation on site varies from 1287 to 1344 m above sea level. There is a low hill in the



extreme south-eastern corner of the site, otherwise the topography is relatively flat. There is a single drainage line on the site that starts in the southern side and runs northwards and dissipates in the northern part of the site.

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, the Ae land type (Land Type Survey Staff, 1987).

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 275 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.

Landuse and landcover of the study area

A landcover map of the study area (Fairbanks *et al*. 2000) indicates that the entire site consists of natural vegetation. This is confirmed with some small exceptions from 1:50 000 topo-cadastral maps, although various areas of infrastructure are located adjacent to the site, which suggests that disturbance may have affected the vegetation on site, at least to some degree. The exceptions are two small cultivated lands in the northern part of the site and some farm buildings and roads associated with these.

Google imagery of the study area shows that a significant part of the eastern part of the site has been excavated and that remaining parts of the site are potentially in poor condition.

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 the study site, namely Northern Upper Karoo. No other vegetation type occurs anywhere within almost one kilometre of 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 1, as determined by best available scientific approaches (Driver *et al*. 2005).

Table 1: 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 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 type occurring in the study area (Table 2) is classified as Least Threatened (Driver *et al*. 2005; Mucina *et al*., 2006).

Table 2: Conservation status of different 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.

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. 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 on this list, *Protea subvestita*, which is listed as Vulnerable (see Table 3 for explanation of categories). 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 considered to be incorrect and this species does not occur anywhere near to the site. There are, therefore, no plant species of conservation concern that are considered likely to occur on site.

Table 3: Explanation of IUCN Ver. 3.1 categories (IUCN, 2001), and Orange List categories (Victor & Keith, 2004).

IUCN / Orange List category	Definition	Class
EX	Extinct	Extinct
CR	Critically Endangered	Red List
EN	Endangered	Red List
VU	Vulnerable	Red List
NT	Near Threatened	Orange List
Declining	Declining taxa	Orange List
Rare	Rare	Orange List
Critically Rare	Rare: only one subpopulation	Orange List
Rare-Sparse	Rare: widely distributed but rare	Orange List
DDD	Data Deficient: well known but not enough information for assessment	Orange List
DDT	Data Deficient: taxonomic problems	Data Deficient
DDX	Data Deficient: unknown species	Data Deficient

Red List animal species of the study area

All Red List vertebrates (mammals, birds, reptiles, amphibians) that could occur in the study area are listed in Appendix 2. Those vertebrate species with a geographical distribution that includes the study area, and habitat preference that includes habitats available in the study area are discussed further.

There is one mammal species of low conservation concern that could occur in available habitats in the study area. This is a species classified nationally as near threatened (NT), but globally as Least Concern, namely Geoffroy's Horseshoe Bat. This is a cave-dwelling species and, based on aerial imagery, it is unlikely that there are caves on site or nearby.

There are three threatened bird species (all VU) and three Near Threatened bird species that have a medium to high probability of utilising available habitats in the study area, either for foraging or breeding. The only species likely to use parts of the site for breeding is Ludwig's Bustard. The other species, the Martial Eagle, Lesser Kestrel, Blue Korhaan, Secretarybird and Lanner Falcon, may use the site or parts of the site for foraging.

The Giant Bullfrog is the only amphibian species with a distribution that includes the study area and which could occur on site. This species is classified as Least Concern globally and Near threatened in South Africa. It is, however, protected under the National Environmental

Management: Biodiversity Act and any impacts on a specimen of this species or that may negatively affect the survival of the species would require a permit.

There are no reptile species of conservation concern that have a distribution that includes the study area.

The threatened species of potential concern for the site are therefore as follows:

- Ludwig's Bustard (VU),

Protected trees

Tree species protected under the National Forest Act are listed in Appendix 3. 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 could occur in any part of the study area, depending on local conditions.

Sensitivity assessment

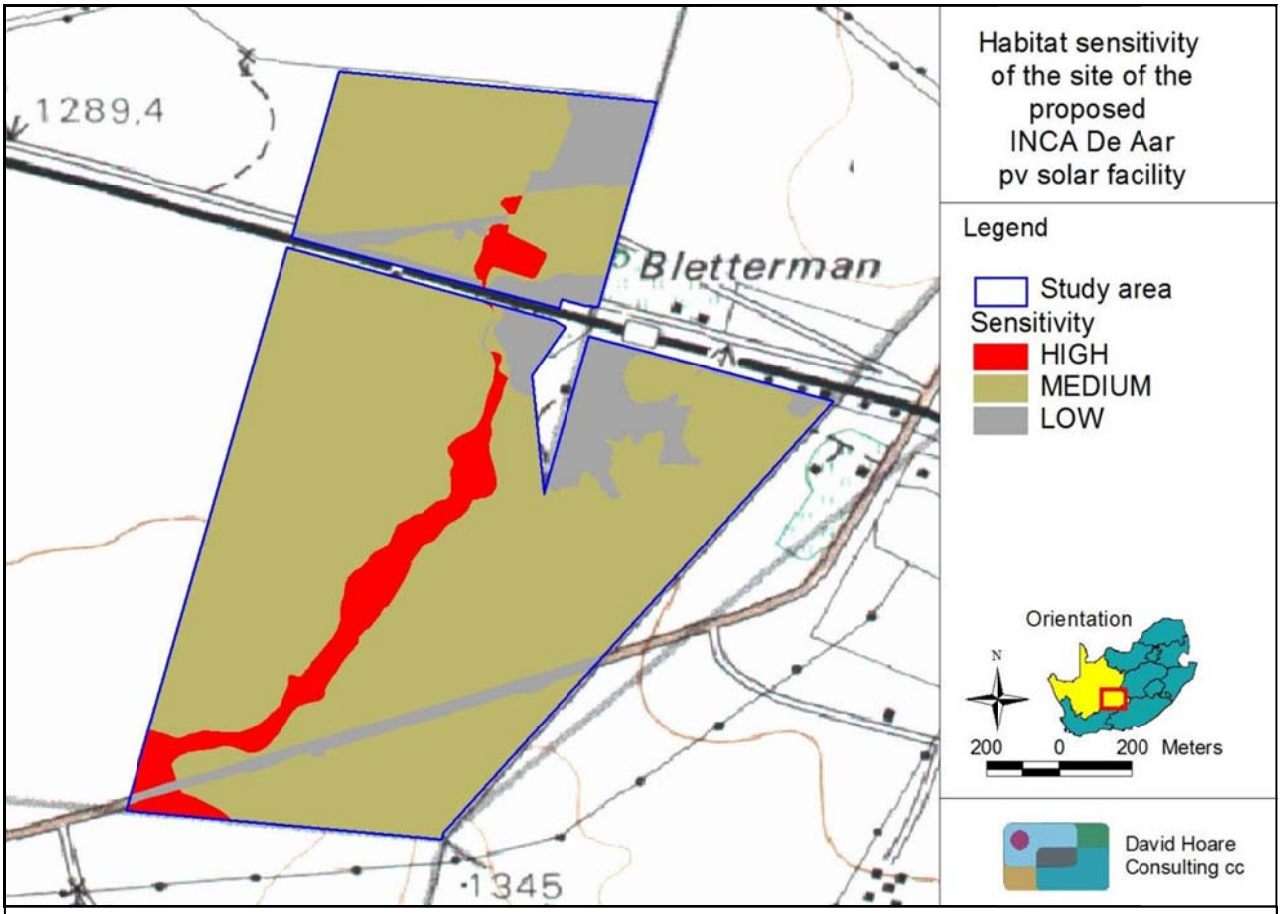
The sensitivity assessment identifies those parts of the study area that could possibly have high conservation value or that may be sensitive to disturbance. Areas containing untransformed natural vegetation of conservation concern, high diversity or habitat complexity, Red List organisms or systems 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.

The information provided in the preceding sections was used to compile a preliminary map of remaining natural habitats and areas important for maintaining ecological processes in the study area. Areas of potential sensitivity are shown in Figure 2 in brown. The location and identity of these will be confirmed in the EIA field study. Broad scale mapping was used to provide information on the location of sensitive features. There are a number of features that need to be taken into account in order to evaluate sensitivity in the study area. These include the following:

1. Potential occurrence of populations of birds of conservation concern that have been evaluated as having a chance of occurring within natural habitats within the study area;
2. Non-perennial watercourses: this represents a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal.

These factors have been taken into account in evaluating sensitivity within the study area (Figure 2). The sensitivity classification for the site is as follows:

1. HIGH: Drainage areas on site are classified as having HIGH sensitivity and conservation value (see Figure 2).
2. MEDIUM: All of the remaining natural areas on site are classified as having medium sensitivity (see Figure 2).
3. LOW: Areas where no natural vegetation occurs is classified as having low sensitivity (see Figure 2).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Habitat sensitivity of the site of the proposed INCA De Aar pv solar facility
Legend
Study area
Sensitivity
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MEDIUM
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RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS

Relevant legislation is provided in this section to provide a description of the key legal considerations of 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;
- 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. 1477 of 2009: Draft National List of Threatened Ecosystems

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).

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.

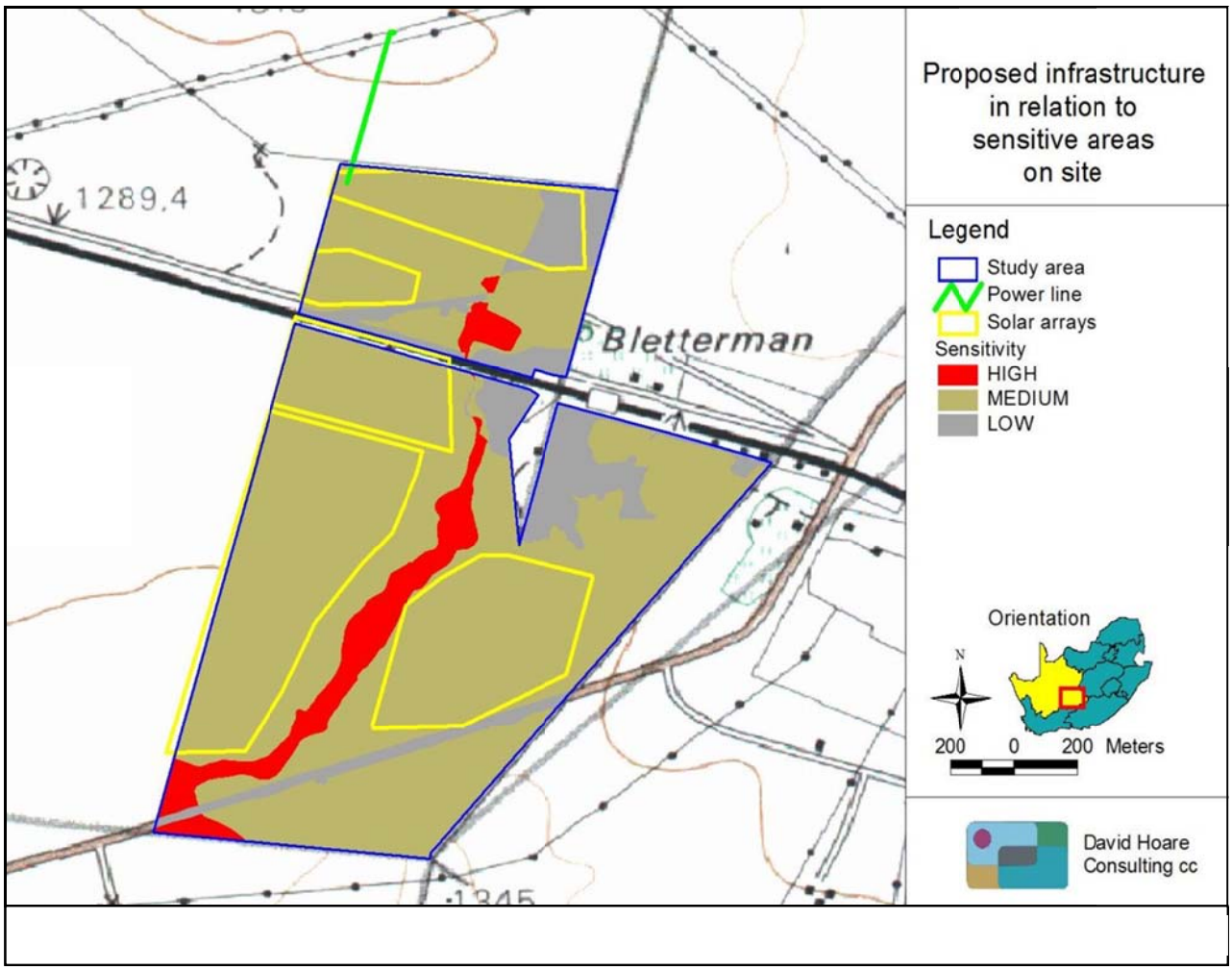
Other Acts

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)

DESCRIPTION OF INFRASTRUCTURE

The position of the proposed infrastructure within the study area is indicated in Figure 3. This shows solar panels arranged in five groups across the site. An on-site substation will be constructed, which will be within the area designated for the northernmost solar panels. A short power line is proposed that will connect directly to the existing power lines approximately half a kilometer north of the site.



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 and fauna), 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 (if applicable).
- 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.

There are also risks associated with **operation** of the proposed facility, as follows:

- Maintenance of surrounding vegetation as part of management of the facility.

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.

Impact 1: Impacts on 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). The general condition of the vegetation on site can only be assessed during the field survey to be undertaken during the EIA phase. 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 on site is Northern Upper Karoo, which is classified as Least Threatened. The vegetation on site is also degraded across significant parts of the site and appears to be in relatively poor condition across the remainder of the site.

Impact 2: Impacts on 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 plant species likely to occur on site. This potential impact is therefore not applicable to the current proposal.

Impact 3: Impacts on 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 was not found on site. This potential impact is therefore not applicable to the current proposal.

Impact 4: Impacts on threatened animals

Nature: Threatened animal species are indirectly affected primarily by the overall loss of habitat, since direct construction impacts can often be avoided due to movement of individuals from the path of construction. Animals are generally mobile and, in most cases, can move away from a potential threat.

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 animal species, loss of a population or individuals could lead to a direct change in the conservation status of the species. This may arise if the proposed infrastructure is located where it will impact on such individuals or populations or the habitat that they depend on. 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 chances of the species overall survival chances.

It has been evaluated that there is one threatened reptile and six threatened or near threatened bird species that could occur in available habitats in the proposed study area. This is Ludwig's Bustard, Martial Eagle, Lesser Kestrel, Blue Korhaan, Secretarybird and Lanner Falcon, and the Karoo Padloper.

Impact 5: Bird collisions with powerlines

Nature: Threatened bird species may be directly affected by collisions with overhead powerlines. Cranes, bustards, flamingos, waterfowl, shorebirds, gamebirds and falcons are among the most frequently affected (Jenkins et al. 2010). Ludwig's Bustard is especially affected by collisions.

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 animal species, loss of a population or individuals could lead to a direct change in the conservation status of the species. This may arise if the proposed infrastructure is located where it will impact on such individuals or populations or the habitat that they depend on. 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 chances of the species overall survival chances.

There are three threatened bird species (all VU) and three Near Threatened bird species that have a medium to high probability of utilising available habitats in the study area, either for foraging or breeding. The only species likely to use parts of the site for breeding is Ludwig's Bustard. The other species, the Martial Eagle, Lesser Kestrel, Blue Korhaan, Secretarybird and Lanner Falcon, may use the site or parts of the site for foraging.

Impact 6: Impacts on wetlands and drainage areas

Nature: The site is in a very arid area. There are unlikely to be any wetlands on site, but there are clearly a number of dry stream beds and drainage areas. According to the National Water Act, these are classified as wetlands or water resources. Construction may lead to some direct or indirect loss of or damage to some of these areas or changes to the catchment of these areas. This may affect the hydrology of the landscape or lead to loss of habitat for species that depend on this habitat type. None of the infrastructure is proposed to be located within drainage areas on site, but is close to it in places.

Impact 7: 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 activites) 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*. The shrub, *Prosopis glandulosa*, is potentially the most problematic and is widely distributed in the Northern Upper Karoo vegetation type. 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.

ASSESSMENT OF IMPACTS

Impacts are assessed for each infrastructure component and each power line alignment alternative, as shown in all figures in this report.

Solar arrays and substation

Impact 1: Loss or fragmentation of indigenous natural vegetation (terrestrial)
There is likely to be total loss of vegetation under the solar arrays.

Duration: The impact will be permanent due to the fact that clearing of vegetation for construction purposes cannot be reversed, and no vegetation will be permitted to re-establish under the panels.

Extent: The impact will occur at the site of the proposed solar array and is scored as local (limited to the immediate area or site of development).

Magnitude: At the scale of the study area, the magnitude may be considered to be moderate (will result in processes continuing but in a modified way) to low (will cause a slight impact on processes). Two factors must be considered in judging the potential magnitude of this impact: (1) Only a small area of vegetation will be affected relative to the overall extent of the vegetation types concerned. (2) There are various parts of the site that are disturbed and therefore in poor condition.

Probability: It is definite that there will be impacts on natural vegetation.

Potential significance: The impact could potentially be of medium significance.

Mitigation measures: Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint of the array.

Nature: Loss or fragmentation of indigenous natural vegetation		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate to low (5)	low (4)
Probability	Definite (5)	Definite (5)
Significance	**Medium (55)**	**Medium (50)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	No, but can be limited in extent	
Mitigation: Avoid unnecessary impacts on natural vegetation surrounding infrastructure. Impacts should be contained, as much as possible, within the footprint of the array.		
Cumulative impacts: Alien invasions may lead to additional loss of habitat that could exacerbate this impact.		
Residual Impacts: Some loss of this vegetation type will occur, but this is insignificant relative to the total extent of the vegetation type.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 4: Loss of habitat for threatened animals

There is a low likelihood of any threatened or near threatened animal species being affected by the proposed project. Birds and other animals that could potentially occur on site are relatively mobile and will move away during construction. The footprint of the solar array is small relative to the overall availability of habitat in the general area. The potential impact on them due to a loss of a small area of habitat is therefore not considered to be serious. In addition, the site is close to the Hydra sub-station and a relatively busy farm road. Sensitive bird species are therefore not highly likely to occur on site or nearby.

Duration: In localised areas, the impact will be permanent due to the fact that clearing of habitat for construction purposes cannot be reversed.

Extent: The impact will occur at the site of the proposed solar arrays. In all cases, the area of concern is likely to be limited in extent and is scored as local.

Magnitude: At a local scale, the potential magnitude of this impact will probably be small (will have no effect on population processes).

Probability: The probability of the impact occurring is rated as improbable. If any species occur on site, they will not be critically dependant on the small area of habitat that will be lost.

Mitigation measures: None required.

Nature: Loss of habitat for threatened animals – corridor 1, 2 and 4		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	small (1)	small (1)
Probability	Improbable (2)	Improbable (2)
Significance	**Low (14)**	**Low (14)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible to some degree	Reversible to some degree
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Not required	
Mitigation: None required		
Cumulative impacts: None		
Residual Impacts: None likely		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 6: Damage to wetlands/watercourses

There are a number of dry stream beds and drainage areas on site. According to the National Water Act, these are classified as wetlands or water resources. The infrastructure layout plan for the solar arrays impacts on the edge of one drainage area. Construction may lead to some

direct or indirect loss of or damage to these affected areas or changes to the catchment of these areas.

Extent: The impact will occur at the site of the proposed solar array, but could have downstream impacts. The extent of the potential impact is therefore on the site and surroundings.

Duration: The impact will occur during construction, but will probably result in impacts that have a long-term to permanent effect.

Magnitude: In the long-term, impacts could result in processes continuing but in a modified way, which is scored as moderate.

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

Mitigation measures:

1. Ground surfaces within the solar array must be properly maintained to avoid erosion impacts.
2. A comprehensive storm-water management plan must be compiled for the solar array. This must indicate how water velocities will be reduced before storm water is allowed to enter natural channels and how natural processes for water infiltration of the affected landscape will be accommodated. Current project design already foresees the use of gutter-like rainwater collection channels below the panels, in order to drive runoff water from panels to underground water tanks.
3. There is a legal obligation to apply for a Water Use Licence for any wetlands that may be affected, since they are classified in the National Water Act as a water resource.

Nature: Damage to wetland areas resulting in hydrological impacts

	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate to low (5)	Low to small (3)
Probability	probable (3)	probable (3)
Significance	**medium (33)**	**low (27)**
Status (positive or negative)	Negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	

Mitigation:

(1) Ground surfaces within the solar array must be properly maintained to avoid erosion impacts.

(2) A comprehensive storm-water management plan must be compiled for the solar array. This must indicate how water velocities will be reduced before storm water is allowed to enter natural channels and how natural processes for water infiltration of the affected landscape will be accommodated. Current project design already foresees the use of gutter-like rainwater collection channels below the panels, in order to drive runoff water from panels to underground water tanks

(3) There is a legal obligation to apply for a Water Use Licence for any wetlands that may be affected, since they are classified in the National Water Act as a water resource. This measure is not considered necessary unless drainage areas are directly affected.

Cumulative impacts:
Soil erosion, alien invasions, may all lead to additional impacts on watercourse habitats that will exacerbate this impact.
Residual Impacts:
None.

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 7: Establishment and spread of declared weeds and alien invader plants

There are very few concentrations of alien plants on site. The shrub, *Prosopis glandulosa* (honey mesquite), is found adjacent to existing disturbances on site. Construction of the solar arrays will require the total clearing of vegetation within the footprint and this will probably be maintained as clear areas for the lifetime of the project. It is possible that there will be some invasion by aliens along the margins of disturbed areas. This could to lead to general invasion of surrounding vegetation, especially along watercourses.

Extent: The impact will occur at the site of the solar array and surrounding areas.

Duration: The impact will be long-term unless alien plants are controlled.

Magnitude: The potential magnitude of this impact is moderate for local ecosystems (will result in ecological processes continuing but in a modified way).

Probability: There is a moderate to high likelihood that alien species will spread on site in the absence of control measures. The probability is therefore scored as highly probable.

Potential significance: The impact could potentially be of medium significance. Standard control measures, if put in place, would adequately control this impact and reduce the significance to low.

Mitigation measures: Disturbance of indigenous vegetation must be kept to a minimum. Where disturbance is unavoidable, disturbed areas should be rehabilitated as quickly as possible once construction is completed. Soil stockpiles should not be translocated from areas with alien plants into the site and within the site alien plants on stockpiles must be controlled so as to avoid the development of a soil seed bank of alien plants within the stock-piled soil. Any alien plants must be immediately controlled. 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.

Nature: Establishment and spread of declared weeds and alien invader plants		
	Without mitigation	**With mitigation**
Extent	Site & surroundings (2)	Site & surroundings (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	medium (6)	minor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	**Medium (48)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation:		

(1) Keep disturbance of indigenous vegetation surrounding array to a minimum (2) Rehabilitate disturbed areas as quickly as possible following completion of construction activities in an area (3) Do not translocate soil stockpiles from areas with alien plants (4) Control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove (5) Establish an on-going monitoring programme to detect and quantify any aliens that may become established
Cumulative impacts: Other disturbance to parts of the site could lead to similar impacts.
Residual Impacts: Will probably be very low if control measures are effectively applied

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Overhead power line

Impact 1: Loss or fragmentation of indigenous natural vegetation (terrestrial)
The powerline will be a maximum of 500 m long. A maximum of 3 – 4 tower structures is likely to be required. The footprint of 4 tower structures is very small compared to the overall extent of vegetation on site and the overall extent of the vegetation type that will be affected.

Duration: The impact will be medium-term. Affected vegetation will recover over time due to the fact that the footprint of the towers is small and vegetation re-growth should repair any other damage associated with construction. There will be some localised long-term damage to vegetation where there are no existing access roads.

Extent: The impact will occur at the site of the proposed power line servitude, which is scored as local.

Magnitude: The impact will be minor (will not result in an impact on processes).

Probability: It is highly probable that there will be impacts on natural vegetation.

Potential significance: The potential significance of this impact could be of medium significance.

Mitigation measures: Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the servitude of the power line. Existing access routes must be used and should be located along the boundaries of existing disturbed areas, if possible.

Nature: Loss of habitat within indigenous natural vegetation types – Array 1 & 4		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Minor (2)	Minor (2)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Low (24)**	**Low (20)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Yes	Yes

Can impacts be mitigated?	Yes, to a large extent
Mitigation: Avoid unnecessary impacts on natural vegetation surrounding infrastructure. Impacts should be contained, as much as possible, within the servitude of the power line. Existing access routes must be used and should be located along the boundaries of existing disturbed areas, if possible.	
Cumulative impacts: Alien invasions may lead to additional loss of habitat that could exacerbate this impact.	
Residual Impacts: Some loss of this vegetation type will occur, but this is insignificant relative to the total extent of the vegetation type.	

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 4: Loss of habitat for threatened animals

The powerline will be a maximum of 500 m long. A maximum of 3 – 4 tower structures is likely to be required. The footprint of 4 tower structures is very small compared to the overall extent of vegetation on site and the overall extent of habitat that will be affected. The only threatened animals that will be affected are all bird species. The site constitutes a small area of potential foraging for any of the species. The power line tower structures will affect and even smaller component of this. Birds that could potentially occur on site are relatively mobile and will move away during construction. The potential impact on them due to a loss of a small area of habitat is therefore not considered to be serious.

Duration: In localised areas, the impact will be long-term.

Extent: The impact will occur at the site of the proposed power line.

Magnitude: At a local scale, the potential magnitude of this impact will be small (will have no effect on population processes).

Probability: The probability of the impact occurring is rated as highly improbable.

Mitigation measures: None required.

Nature: Loss of habitat for threatened animals		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	small (1)	small (1)
Probability	highly improbable (1)	highly improbable (1)
Significance	**Low (6)**	**Low (6)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible to some degree	Reversible to some degree
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Not required	
Mitigation: None required		
Cumulative impacts: None		
Residual Impacts: None likely		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 5: Bird collisions with powerlines

There is a low to moderate likelihood of threatened or near threatened bird species occurring along the proposed overhead power line routes. The potential impact on them due to collisions is therefore not considered to be likely to be of high frequency. There are a number of existing power lines in the immediate area surrounding the site. The addition of a small length of additional power line may only add very slightly to this impact.

Duration: The impact will be long-term.

Extent: The impact will occur at the site of the proposed power line.

Magnitude: Relative to the existing impact of existing power lines, the potential magnitude of this impact will probably be small (will have no effect on population processes).

Probability: The probability of the impact occurring is rated as improbable.

Mitigation measures: Devices to make power lines more visible to birds should be put in place. The exact configuration of such visibility devices should be established through consultation with avian specialists with knowledge of the relationship between power lines and the bird species in the study area that may be affected.

Nature: Loss of habitat for threatened animals		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	small (1)	small (0)
Probability	improbable (2)	Highly improbable (1)
Significance	**Low (12)**	**Low (5)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible to some degree	Reversible to some degree
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some degree	
Mitigation: Devices to make lines more visible must be attached to overhead power lines.		
Cumulative impacts: None		
Residual Impacts: None likely		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 6: Damage to wetlands/watercourses

There are no watercourses or drainage areas that are within the servitude of the power line. This potential impact is therefore not applicable to the current infrastructure component and is scored as having zero significance.

Impact 7: Establishment and spread of declared weeds and alien invader plants

There are very few concentrations of alien plants on site. The shrub, *Prosopis glandulosa* (honey mesquite), is found adjacent to existing disturbances in this general area. Construction of the power line will require the clearing of vegetation within the footprint of tower structures and along access roads. It is possible that there will be some invasion by aliens along the margins of disturbed areas. This could to lead to some invasion of surrounding vegetation.

Extent: The impact will occur at the site of the servitude of the power line and surrounding areas, which is scored as local.

Duration: The impact will be long-term unless alien plants are controlled.

Magnitude: The potential magnitude of this impact is low for local ecosystems.

Probability: There is a moderate likelihood that alien species will spread in the absence of control measures. The probability is therefore scored as probable.

Potential significance: The impact could potentially be of low significance. Standard control measures, if put in place, would adequately control this impact and reduce the significance further.

Mitigation measures: Disturbance of indigenous vegetation must be kept to a minimum. Where disturbance is unavoidable, disturbed areas should be rehabilitated as quickly as possible. Soil stockpiles should not be translocated from areas with alien plants into the site and within the site alien plants on stockpiles must be controlled so as to avoid the development of a soil seed bank of alien plants within the stock-piled soil. Any alien plants must be immediately controlled. 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.

Nature: Establishment and spread of declared weeds and alien invader plants		
	Without mitigation	**With mitigation**
Extent	local (1)	Site & surroundings (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	low (4)	small (2)
Probability	probable (3)	Highly improbable (1)
Significance	**Low (27)**	**Low (8)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: (1) Keep disturbance of indigenous vegetation to a minimum (2) Rehabilitate disturbed areas as quickly as possible following completion of construction activities in an area (3) Do not translocate soil stockpiles from areas with alien plants (4) Control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove (5) Establish an on-going monitoring programme to detect and quantify any aliens that may become established		
Cumulative impacts: Other disturbance to parts of the site could lead to similar impacts.		
Residual Impacts:		

Will probably be very low if control measures are effectively applied

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

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 across most of the site is therefore not considered to have high conservation status.

Local factors that may lead to parts of the study area having elevated ecological sensitivity are the potential presence of some birds of conservation concern and drainage areas.

There are a number of bird species of conservation concern that may occur in habitats within the broad study area. This includes three threatened bird species, Ludwig's Bustard, Martial Eagle and Lesser Kestrel (all classified as VU) of which one species may use the site for breeding purposes (Ludwig's Bustard) and three near threatened bird species that may be found on site (Secretarybird, Lanner Falcon and Blue Korhaan). Habitat requirements for these species are provided in the appendices to this report.

There is one protected tree species that occurs in the area, *Boscia albitrunca* (shepherd's tree). It does not occur on site within the footprint of proposed infrastructure.

There are no plant species of conservation concern that have a high likelihood of occurring in available habitats in the study area.

The study area is mostly in a natural condition, but there is degradation of habitat in parts of the site. Degraded areas on site are classified as having low sensitivity and conservation value.

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

1. Impacts on indigenous natural vegetation
2. Impacts on protected tree species
3. Impacts on threatened animals
4. Impacts on wetlands and drainage areas
5. 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 before and after mitigation is given in Table 4 below. This shows that the potential impact on natural vegetation by the solar arrays is the only impact with a significance of "medium" after mitigation. This significance score is due to the fact that the impact will be permanent and will definitely occur. No mitigation measures will reduce the significance of this impact further. All other potential impacts are either "low" or can be reduced to "low" with mitigation.

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. Taking this assessment into consideration, this project is supported from an ecological point of view.

Table 4: Summary of the significance of impacts for different infrastructure components before and after mitigation.

Impact	Solar arrays		Overhead power lines	
	Without mitigation	With mitigation	Without mitigation	With mitigation
1. Vegetation	medium (55)	medium (50)	low (24)	low (20)
2. Threatened animals	low (14)	low (14)	low (6)	low (6)
3. Birds	zero (0)	zero (0)	low (12)	low (5)
4. Watercourses	medium (33)	low (27)	zero (0)	zero (0)
5. Alien plants	medium (48)	low (16)	low (27)	low (8)

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

MANAGEMENT PLAN

Control measures are only proposed for those impacts where mitigation measures are proposed to reduce the significance of impacts, i.e. some impacts are of low significance and thus no mitigation measures are proposed or no mitigation measures are possible or required.

Impacts on threatened animals

OBJECTIVE: Limit impacts on threatened animals	
Project component/s	Any infrastructure or activity that will result in disturbance to habitat suitable for threatened animal species or to populations of threatened animal species
Potential Impact	Loss of habitat suitable for populations of threatened animal species or direct loss of individuals of threatened animals
Activity/risk source	Construction, operation, environmental management
Mitigation: Target/Objective	Target: no significant impacts on identified suitable habitat or populations of threatened animal species within project control area Time period: construction, operation

Mitigation: Action/control	Responsibility	Timeframe
(1) Ensure that construction impacts are contained within the footprint of the proposed infrastructure and do not spread into surrounding natural areas. (2) Place devices on overhead power lines to make them more visible to birds.	Construction team, management (environmental officer),	construction, operation

Performance Indicator	No significant loss of individuals of threatened animal species
Monitoring	• Collision mortality of birds with overhead power lines.

Impacts due to alien invasive plants

OBJECTIVE: Control alien invasive plants

Project component/s	Any infrastructure or activity that will result in disturbance to natural areas
Potential Impact	Invasion of natural vegetation surrounding the site by declared weeds or invasive alien species
Activity/risk source	Construction, environmental management
Mitigation: Target/Objective	Target: no alien plants within project control area Time period: construction, operation

Mitigation: Action/control	Responsibility	Timeframe
(1) avoid creating conditions in which alien plants may become established: a. keep disturbance of indigenous vegetation to a minimum b. rehabilitate disturbed areas as quickly as possible c. do not import soil from areas with alien plants (2) establish an on-going monitoring programme to detect and quantify any alien species that may become established and identify the problem species (as per Conservation of Agricultural Resources Act) (3) immediately control any alien plants that become established using registered control methods	Construction team, management (environmental officer),	construction, operation

Performance Indicator	For each alien species: number of plants and aerial cover of plants within project area and immediate surroundings
Monitoring	• On-going monitoring of area by environmental control officer during construction • On-going monitoring of area by environmental manager during operation • Annual audit of project area and immediate surroundings by qualified botanist. If no species are detected, then this can be stated. If any alien invasive species are detected then the distribution of these should be mapped (GPS co-ordinates of plants or concentrations of plants), number of individuals (whole site or per unit area), age and/or size classes of plants and aerial cover of plants. The results should be interpreted in terms of the risk posed to sensitive habitats within and surrounding the project area. The environmental manager should be responsible for driving this process. Reporting frequency depends on legal compliance framework.

Impacts on indigenous natural vegetation

OBJECTIVE: Control loss of indigenous natural vegetation

Project component/s	Any infrastructure or activity that will result in disturbance to natural areas
Potential Impact	Loss of indigenous natural vegetation due to construction activities
Activity/risk source	Construction
Mitigation: Target/Objective	Target: minimal loss of natural vegetation Time period: construction

Mitigation: Action/control	Responsibility	Timeframe
(1) The construction impacts must be contained to the footprint of the infrastructure. (2) Rehabilitate any disturbed areas immediately to stabilize landscapes.	Construction team, management (environmental officer),	construction

Performance Indicator	No loss of natural vegetation outside planned footprint of infrastructure.
Monitoring	• None

Impacts on watercourses

OBJECTIVE: Limit damage to watercourses

Project component/s	Any infrastructure or activity that will result in disturbance to wetlands
Potential Impact	Damage to watercourses areas by any means that will result in hydrological changes (includes erosion, siltation, dust, direct removal of soil of vegetation, dumping of material within wetlands). The focus should be on the functioning of the watercourse as a natural system
Activity/risk source	Construction, operation
Mitigation: Target/Objective	Target: no damage to watercourses within project area Time period: construction, operation

Mitigation: Action/control	Responsibility	Timeframe
(1) Ground surfaces within the solar array must be properly maintained to avoid erosion impacts. (2) A comprehensive storm-water management plan must be compiled for the solar array. This must indicate how water velocities will be reduced before storm water is allowed to enter natural channels and how natural processes for water infiltration of the affected landscape will be accommodated. Current project design already foresees the use of gutter-like rainwater collection channels below the panels, in order to drive runoff water from panels to underground water tanks	Construction team, management, environmental control officer	Planning, construction

Performance Indicator	No permanent infrastructure within watercourses
Monitoring	• None

REFERENCES:

ACOCKS, J.P.H. 1988. Veld types of South Africa (3rd edn.). *Mem. Bot. Surv. S. Afr.* No 28. Government printer, Pretoria.

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.

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. (eds) 2003. Plants of southern Africa: an annotated checklist. *Strelitzia* 14. National Botanical Institute, Pretoria.

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.

GROOMBRIDGE, B. (ed.) 1994. *1994 IUCN Red List of Threatened Animals*. IUCN, Gland, Switzerland.

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.

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

LOW, A.B. & REBELO, A.G. (1998) Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria.

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.

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.

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.

PALMER, A.R. 1991. A syntaxonomic and synecological account of the vegetation of the eastern Cape midlands. *S.Afr.J.Bot.* 57: 76-94.

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.

SCHULZE, B.R. 1984. Climate of South Africa, Part 8, General Survey, WB 28. *South African Weather Bureau* 60. Government Printer, Pretoria.

VAN WYK, A.E. & SMITH, G.F. 2001. Regions of floristic endemism in southern Africa. Umdaus press, Hatfield.

WEATHER BUREAU 1996. *Climate data for stations from the Eastern Cape*.

WHITE, F. 1983. The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNISO vegetation map of Africa. Natural Resources Research 20. Unesco, Paris.

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: Threatened vertebrate species with a geographical distribution that includes the current study area.

MAMMALS

Common name	Taxon	Habitat[1]	National status	Global status[2]	Likelihood of occurrence
Black rhinoceros	*Diceros bicornis bicornis*	Wide variety of habitats, but currently only occurs in game reserves.	CR	CR	**NONE**, only occurs in game reserves
Geoffroy's horseshoe bat	*Rhinolophus clivosus*	Caves and subterranean habitats; fynbos, shrubland, grassland, succulent and Nama-karoo; insectivore	NT	LC	**MEDIUM**, overall geographical distribution includes this area, general habitat is suitable - presence of caves unknown, but improbable.

[1]Distribution and national status according to Friedmann & Daly 2004.
[2]Global status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 14 April 2011.

AMPHIBIANS

Common name	Species	Habitat	Status	Likelihood of occurrence
Giant Bullfrog	*Pyxicephalus adspersus*	Widely distributed in southern Africa, mainly at higher elevations. Inhabits a variety of vegetation types where it breeds in seasonal, shallow, grassy pans in flat, open areas; also utilises non-permanent vleis and shallow water on margins of waterholes and dams. Prefer sandy substrates although they sometimes inhabit clay soils.	NT[1] LC[2] Protected (NEMBA)	**LOW**, within known distribution range , but no suitable habitat occurs on site.

[1]Status according to Minter et al. 2004.
[2]Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 11 September 2010.

REPTILES

Common name	Species	Habitat	Status[3]	Likelihood of occurrence
None				

[3]Distribution according to Alexander & Marais 2007.
[4]Status according to Alexander & Marais 2007.

BIRDS

Common name	Species	Habitat	Status	Importance of site for species
Ludwig's Bustard	*Neotis ludwigii*	This is a near-endemic to southern Africa, with its range centred on the Nama Karoo and Succulent Karoo biomes. It occurs in western grasslands of the Eastern Cape, but supposedly as a nonbreeding visitor. The most important threat to this species is collisions with overhead powerlines and telephone wires. It inhabits the open plains of the semi-arid Karoo and especially in areas where extensive sheep farming is prevalent. Common resident in study area.	VU[1] EN[2] Protected (NEMBA)	MEDIUM, breeding, HIGH, foraging
Martial Eagle	*Polemaetus bellicosus*	The Martial Eagle is widespread but uncommon throughout South Africa and neighbouring countries. It tolerates a wide range of vegetation types, being found in open grassland, scrub, Karoo and woodland. It relies on large trees (and electricity pylons) to provide nest sites. It is found typically in flat country and is rarer in mountains and forests. One of the main reason it is declining is because of persecution on private land. This species has been recorded from the study area and many surrounding areas. Common resident in study area.	VU[1] NT[2] Protected (NEMBA)	LOW, breeding, MEDIUM, foraging
Lesser Kestrel	*Falco naumannii*	Open grassveld, mainly on highveld, usually near towns or farms. Common non-breeding migrant in study area.	VU	LOW, breeding, MEDIUM, foraging
Blue Korhaan	*Eupodotis caerulescens*	Open grassveld, karoo scrub, cultivated lands. Endemic to South Africa. Common resident in study area.	NT	MEDIUM, breeding,

Common name	Species	Habitat	Status	Importance of site for species
				MEDIUM, foraging
Yellow-billed Stork	*Mycteria ibis*	Mainly inland waters; rivers, dams, pans, floodplains, marshes; less often estuaries. Uncommon non-breeding migrant in study area.	NT	LOW, breeding, LOW, foraging
Secretarybird	*Sagittarius serpentarius*	Widespread across South Africa, occurring in savanna and open grassland from coastal regions to high altitudes, but avoids thick bush and forest. Sensitive to disturbance and high human population numbers - higher numbers usually found in conservation areas. Uncommon resident in study area.	NT	MEDIUM, breeding, MEDIUM, foraging
Lanner Falcon	*Falco biarmicus*	Widespread species, occurring in Afrotropics, Middle East and western Palearctic. Occurs in mountains or open country from semidesert to woodland and agricultural land; also cities (Durban, Harare). Common resident in study area.	NT	LOW, breeding, MEDIUM, foraging
Peregrine Falcon	*Falco peregrinus*	Cliffs, mountains, steep gorges; may hunt over open grassland, farmland and forests; rarely enters cities to hunt pigeons. Uncommon resident or non-breeding migrant in study area.	NT	LOW, breeding, LOW, foraging

[1]Status according to Barnes 2000.
[2]Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 11 September 2010.

Appendix 3: 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 4: Checklist of plant species recorded during previous botanical surveys in the study area and surrounds.
(Species from quarter degree grid in which the site is located as well as surrounding grids in which similar vegetation is found)

Allophyllus decipiens
Aptosimum procumbens
Aptosimum spinescens
Arachnioides webbiana subsp. foliosa
Arctotis leiocarpa
Aristida adscensionis
Aristida congesta subsp. barbicollis
Aristida congesta subsp. congesta
Aristida vestita
Asparagus striatus
Asparagus suaveolens
Athanasia minuta subsp. minuta
Atriplex vestita var. appendiculata
Barleria rigida
Bassia salsoloides
Berkheya eriobasis
Brunsvigia radulosa
Bulbostylis humilis
Calobota spinescens
Campylopus robillardei
Cenchrus ciliaris
Chaenostoma halimifolium
Cheilanthes eckloniana
Chloris virgata
Chrysocoma ciliata
Clutia impedita
Colchicum asteroides
Commelina africana var. africana
Crassula corallina subsp. corallina
Cucumis africanus
Cucumis heptadactylus
Cucumis myriocarpus subsp. leptodermis
Cullen tomentosum
Cyanella lutea
Cynodon incompletus
Daubenya comata
Dianthus micropetalus
Dicoma capensis
Digitaria erianthe
Dimorphotheca cuneata
Dimorphotheca zeyheri
Dipcade viride
Disa pulchra
Empodium elongatum
Enneapogon desvauxii
Enneapogon scaber
Enneapogon scoparius
Eragrostis bergiana
Eragrostis bicolor
Eragrostis chloromelas
Eragrostis curvula
Eragrostis homomalla

Eragrostis lehmanniana var. lehmanniana
Eragrostis nindensis
Eragrostis obtusa
Eragrostis procumbens
*Eragrostis tef
Eragrostis truncata
Erucastrum strigosum
Eulophia foliosa
Euphorbia aequoris
Euphorbia arida
Euphorbia pugniformis
Felicia burkei
Felicia filifolia subsp. filifolia
Felicia muricata subsp. muricata
Fingerhuthia africana
Galenia pubescens
Gazania jurineifolia subsp. jurineifolia
Gazania krebsiana subsp. arctotoides
Geigeria filifolia
Geigeria ornativa subsp. ornativa
Gisekia pharnacioides var. pharnacioides
Gladiolus dalenii subsp. dalenii
Gladiolus ecklonii
Gladiolus permeabilis subsp. edulis
Gnidia polycephala
Grewia flava
Haworthia venosa subsp. tessellata
Helichrysum asperum var. asperum
Helichrysum dregeanum
Helichrysum micropoides
Helichrysum zeyheri
Heliophila minima
Heliotropium lineare
Hermannia burkei
Hermannia cuneifolia var. cuneifolia
Hermannia erodioides
Hermannia pulchella
Hertia pallens
Heteropogon contortus
Huernia humilis
Hymenophyllum tunbridgense
Hypericum lalandii
Hypertelis salsoloides var. salsoloides
Indigastrum argyraeum
Jamesbrittenia filicaulis
Kniphofia ensifolia subsp. ensifolia
Ledebouria apertiflora
Lessertia annularis
Lepidostephium denticulatum
Leysera tenella
Limeum sulcatum var. sulcatum
Limosella africana var. africana
Lobelia flaccida subsp. flaccida
Lotononis platycarpa
Lycium horridum
Lycium pumilum
Manulea fragrans

Melianthus dregeanus
Melica decumbens
Melolobium candicans
Microloma armatum var. armatum
Monopsis scabra
Moraea falcifolia
Nemesia fruticans
Oligomeris dipetala var. dipetala
Ornithogalum nannodes
Ornithoglossum vulgare
Oropetium capense
Oscularia deltoides
Osteospermum leptolobum
Osteospermum spinescens
Osyris lanceolata
Oxalis depressa
Othonna pavonia
Pachypodium succulentum
Panicum coloratum var. coloratum
Panicum impeditum
Peliostomum leucorrhizum
Peliostomum origanoides
Pelargonium aestivale
Pelargonium pseudofumarioides
Pelargonium tragacanthoides
*Pennisetum villosum
Pentaschistis airoides subsp. airoides
Pentaschistis setifolia
Pentzia calcarea
Pentzia elegans
Pentzia globosa
Pentzia incana
Pentzia lanata
Pentzia quinquefida
Pentzia spinescens
Phymaspermum aciculare
Phymaspermum parvifolium
Polygala ephedroides
Protea subvestita (3024CC)
Pseudocrossidium crinitum
Psilocaulon coriarium
Pteronia glauca
Pteronia glaucescens
Pteronia sordida
*Puccinellia distans
Radyera urens
Riccia albornata
Riccia nigrella
Rosenia humilis
Rosenia oppositifolia
Rumex lanceolatus
Salsola calluna
Salsola dealata
Salsola glabrescens
Salsola humifusa
Salvia verbenaca
Satyrium longicaude var. longicaude

Sebaea pentandra var. pentandra
Selago albida
Selago paniculata
Selago saxatilis
Senecio isatideus
Sesamum capense
Solanum retroflexum
*Sorghum halepense
Sporobolus discosporus
Sporobolus fimbriatus
Sporobolus iocladus
Stachys cuneata
Stachys linearis
Stapelia grandiflora var. grandiflora
Stipagrostis ciliata var. capensis
Stipagrostis namaquensis
Stipagrostis obtusa
Syringodia concolor
Tetragonia fruticosa
Themeda triandra
Thesium congestum
Tortula atrovirens
Tragus berteronianus
Tragus koelerioides
Tragus racemosus
Trichostomum brachydontium
Tripteris aghillana var. aghillana
Urochloa panicoides
Wahlenbergia nodosa
Zaluzianskya karrooica
Zygophyllum microcarpum