EIA REPORT:

Specialist ecological study on the potential impacts of the proposed African Rainbow Energy (Pty) Ltd Upington photovoltaic (PV) Solar Energy Facility, near Upington, Northern Cape

Prepared by

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on behalf of
African Rainbow Energy (Pty) Ltd

11 October 2011

FINAL EIA REPORT:

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 385 Section 33 - Specialist reports and reports on specialized processes under the Act. Relevant clauses of the above regulation are quoted below and reflect the required information in the "Control sheet for specialist report" given above.

Regulation 33. (1): An applicant or the EAP managing an application may appoint a person who is independent to carry out a specialist study or specialized process.

Regulation 33. (2): A specialist report or a report on a specialized 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) declaration that the person is independent in a form as may be specified by the competent authority;

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

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

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

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

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

(j) any other information requested by 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 a proposed photovoltaic solar energy facility near Upington 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 300 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 and referee for 2 international journals.

Independence

David Hoare Consulting cc and its Directors have no connection with African Rainbow Energy (Pty) Ltd.David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. David Hoare is an independent consultant to 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. The percentage work received directly or indirectly from the proponent in the last twelve months is zero.

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.

TABLE OF CONTENTS

INTRODUCTION

Terms of reference and approach

Savannah Environmental (Pty) Ltd. was appointed by African Rainbow Energy (Pty) Ltd to undertake an application for environmental authorisation through an Environmental Impact Assessment (EIA) for the proposed “Upington 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, underground cabling between pv panels, inverters, short length of power line to link into an existing Eskom power line, small administration and workshop building for maintenance and storage, and internal access roads. The purpose of the EIA is to identify environmental impacts associated with the project.

On 28 February 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 positive 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 and fieldwork undertaken on site.

Study area

At a regional level the study area falls within the Northern Cape Province to the north-east of the town of Upington. 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 rder 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. 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.

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
	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). • Confirmed habitat for large densities of protected trees. • 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).

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
		• Habitat with scattered individuals of protected trees.
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 7 km north-east of the town of Upington within the Northern Cape (Figure 1). The site falls within the quarter degree grid 2821AD. It is situated along the northern banks of the Orange River. The proposed facility would occur on the following farm portions: Portion 0 of the Farm UAP 418.

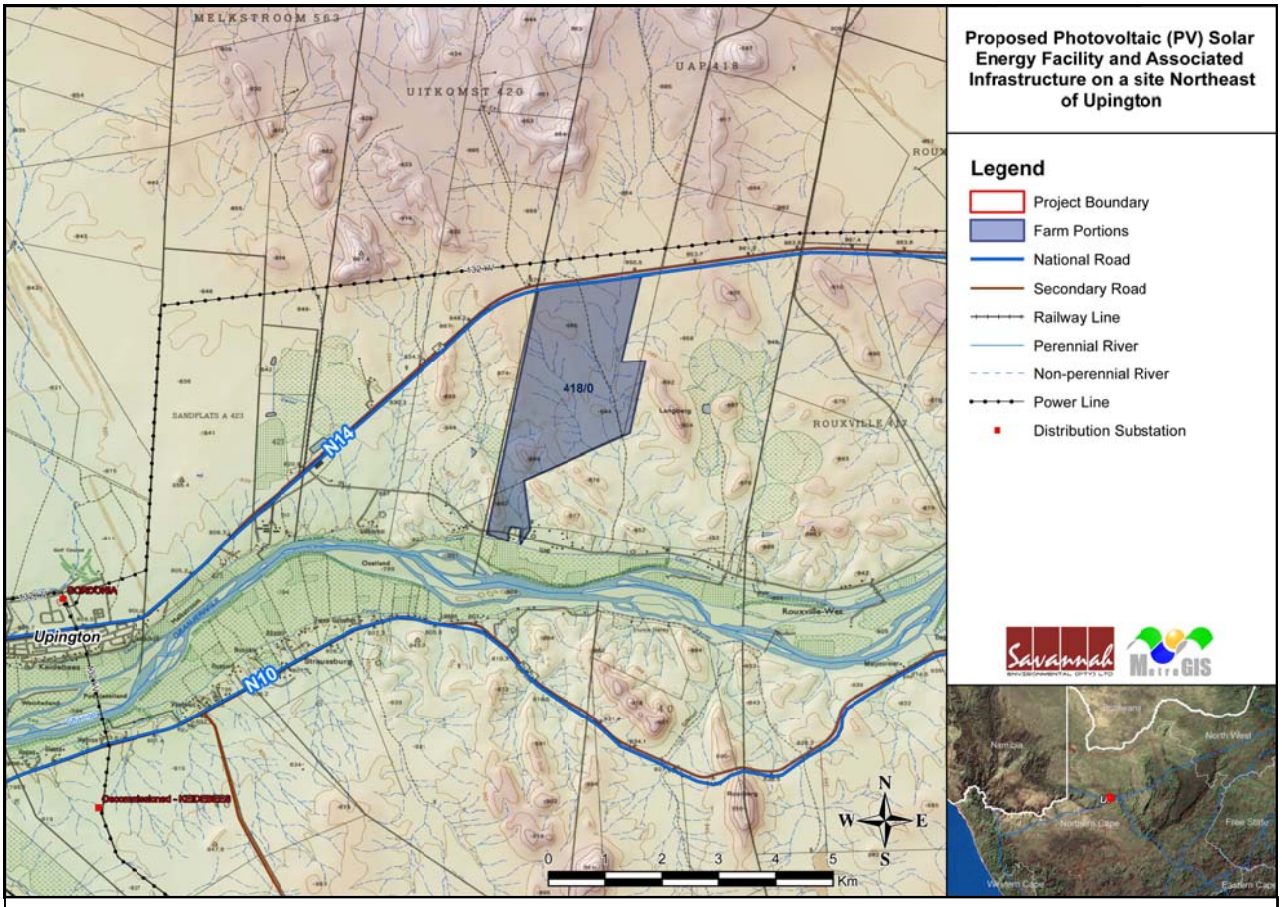
No alternative site is currently being considered for the proposed facility, but the current site is sufficiently large to allow placement of the facility in alternative positions within the site. The site was chosen because of its proximity to Upington and access to the electricity grid.

The study area is relatively accessible from Upington via the N14 which runs from Upington to Groblershoop (through the northern parts of the site). There is an existing access road to the central part of the site directly from the N14.

Topography

The study site is situated to the north of the Orange River. The topography of this area is relatively gentle and slopes in a southerly direction towards the Orange River. The elevation on site varies from 802 to 857 m above sea level.

There are various drainage lines draining the study area, all non-perennial. These primarily



drain in a southerly direction towards the Orange River.

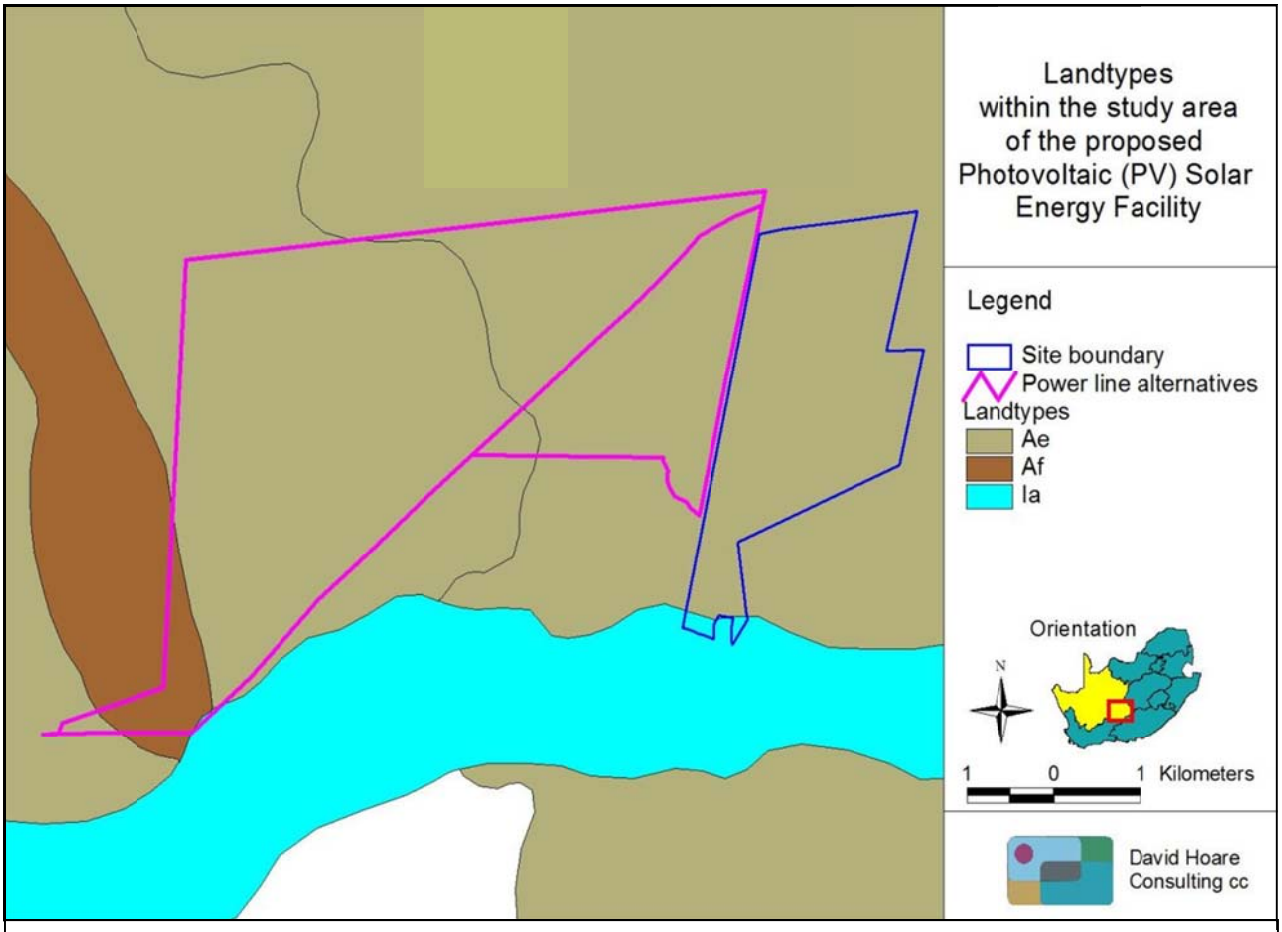
Land types and soils

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 are a variety of land types in the study area (Figure 2). The most common land type in the study area is Ae with a very small area of Ia in the Orange River floodplain (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). This is the most widespread landtype in the study area.

The Af landtype consists of red, high base status, > 300 mm soils with dunes (MacVicar et al. 1974). These are only found close to the Eskom Gordonia substation.

The Ia unit refers to land types with a soil pattern difficult to accommodate elsewhere, at least 60% of which comprises pedologically youthful, deep (more than 1 000 mm to underlying rock) unconsolidated deposits. In the study area, the areas along the Orange River fall within this category.



Climate

The climate is arid to semi-arid. Rainfall occurs from November to April, but peaks in mid- to late summer (February / March). Mean annual rainfall is 140 mm to 170 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 to very 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, except for a small area of cultivation in the southern part of the site close to the Orange River. In the northern part of the site, where the infrastructure is proposed to be located, the vegetation is largely in a natural state. There is a small kraal and a vehicle track running through the site, otherwise no alteration in the natural state of the vegetation has occurred. Livestock farming has affected the vegetation to some degree. This area of the country consists primarily of farms used as rangeland for commercial livestock production. Commercial farming systems are characterised by land stocked at economically sustainable levels. These regions have been commercially farmed as stock ranches for close to 100 years. Degradation of vegetation has been blamed on high stocking rates of domestic livestock in commercial farming areas. The study area is no exception and degradation due to overgrazing has occurred in places, although this has only happened to a small degree on site.

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 two vegetation types occurring within the study site, namely Kalahari Karroid Shrubland and Lower Gariep Alluvial Vegetationd (Figure 3). The power line crosses and additional vegetation type, Gordonia Duneveld. These vegetation types are described in more detail below.

Kalahari Karroid Shrubland

This is a low karroidshrubland occurring on flat gravel plains. Dominant species include the small trees, *Acacia mellifera*, *Parkinsoniaafricana* and *Bosciafoetida*, the tall shrub, *Rhigozumtrichotomum*, the low shrubs, *Hermanniaspinosa* and *Phaeoptilumspinosum*, the herbs, *Dicomacapensis*, *Chamaesyceinaequilatera* and *Limeumaethiopicum*, and the grasses, *Aristidaadscensionis*, *Enneapogondesvauxii*, *E. scaber*, *Stipagrostisobtusa* and *Aristidacongesta*.

There are no known endemics in this vegetation type, but the grass *Dinebriaretroflexa* has its south-western distribution limit in this vegetation type in this area (Mucina *et al*. 2006). At a national scale this vegetation type has been transformed only a small amount, but it contains the preferred routes of many roads and about a quarter of the vegetation type is invaded by *Prosopis* sp. Although only a small amount is conserved in Augrabies Falls National Park, it is not considered to be a threatened vegetation type (Mucina*et al*. 2006). This vegetation type is considered to be Least threatened (Table 2). A small percentage is conserved and 12% is transformed (Driver *et al*. 2005,Mucina *et al*. 2006).

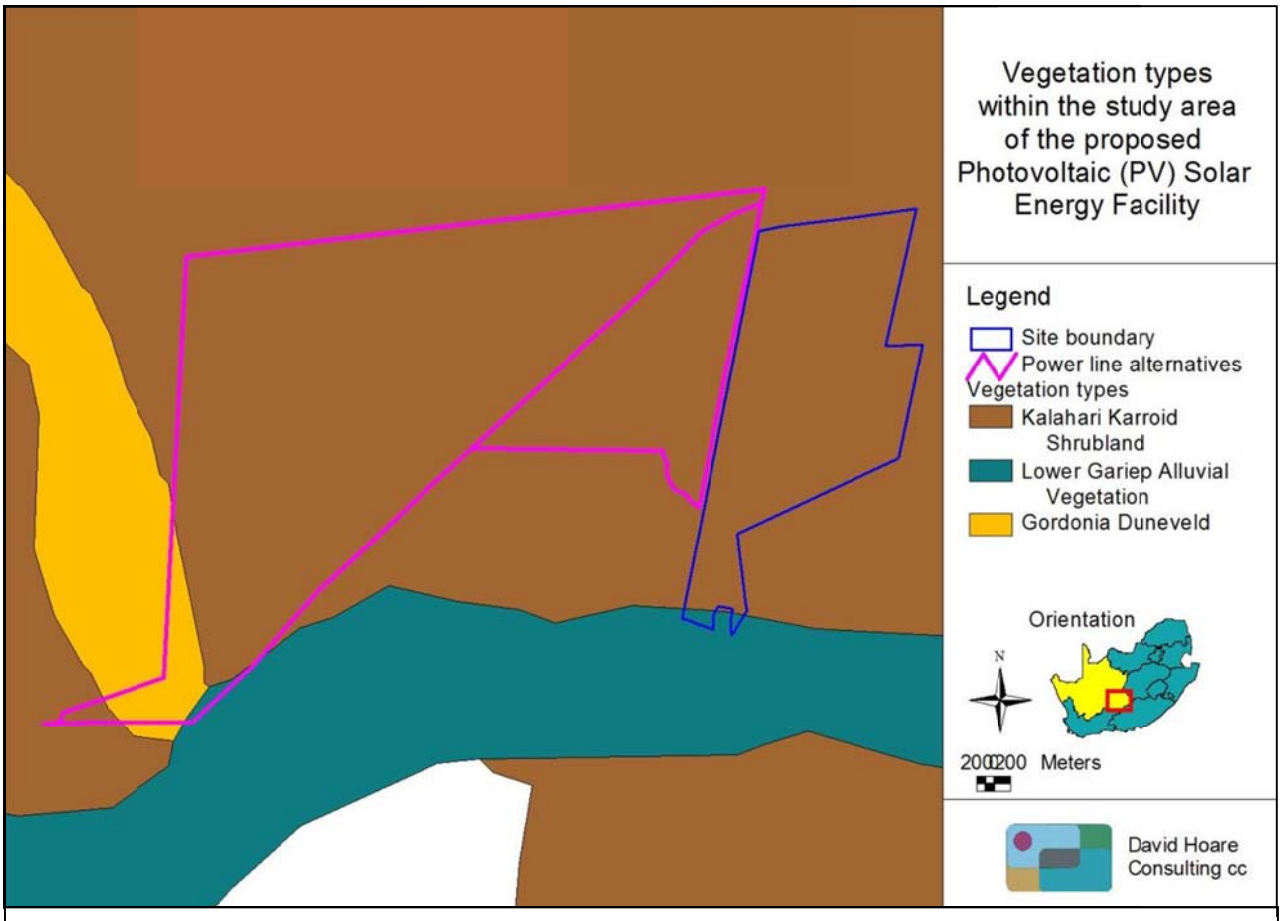
Lower Gariep Alluvial Vegetation

Lower Gariep Alluvial Vegetation occurs between Groblershoop and the mouth of the Orange River at the Atlantic Ocean (Mucina et al. 2006). The Orange River in this region consists of a wide floodplain. This usually has well-developed levees on both sides and, at low-levels, extensive sand-banks occur in the channel. Where the river cuts steep valleys through dolerite dykes or other hard rock, these sand banks are absent and the river becomes faster-flowing and rocky. The levees may be up to 250 m wide and contain alluvial woodland, forest or scrub, also described as Riparian Thicket. The numerous small to extensive sand-banks in the river-bed may contain a number of temporary to semi-permanent plant communities. These habitats are characterised by regular seasonal flooding, silting and alternating dry and wet conditions. The substrate is dynamic and may shift to new positions on occasion. Submerged wetland plant communities are virtually absent from the Orange River due to the periodic sudden, large floods as well as the normally high silt-loads of the water (Werger 1980). Where dolerite dykes cross the river, these may be exposed at low-level periods of flow. These rocky outcrops may contain sparse stands of the low shrub, *Gomphostigmavirgata* (Werger 1980).

This vegetation type is considered to be Endangered with more than 50% transformed by agriculture and only 6% conserved (in AugrabiesFallsNational Park) of a target of 31%.

Gordonia Duneveld

This vegetation is found on the parallel dunes, which are approximately 3-8 m above the surrounding plains. The vegetation is an open shrubland with ridges of grassland on the dune crests and *Acacia haematoxylon* on the dune slopes. Dominant species include the small tree, *Acacia mellifera*, the tall shrubs, *Grewia flava* and *Rhigozum trichotomum*, and the grasses, *Schmidtia kalahariensis* and *Stipagrostis amabilis*.



This vegetation type is considered to be Least threatened (Table 2). Approximately 14% is conserved of a target of 16% and less than 1% is transformed (Driver *et al*. 2005, 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).

The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver et al. 2005).

One of the vegetation types occurring in the study area (Table 2) is classified as Least Threatened and one is classified as Endangered (Driver *et al*. 2005; Mucina*et al*., 2006).

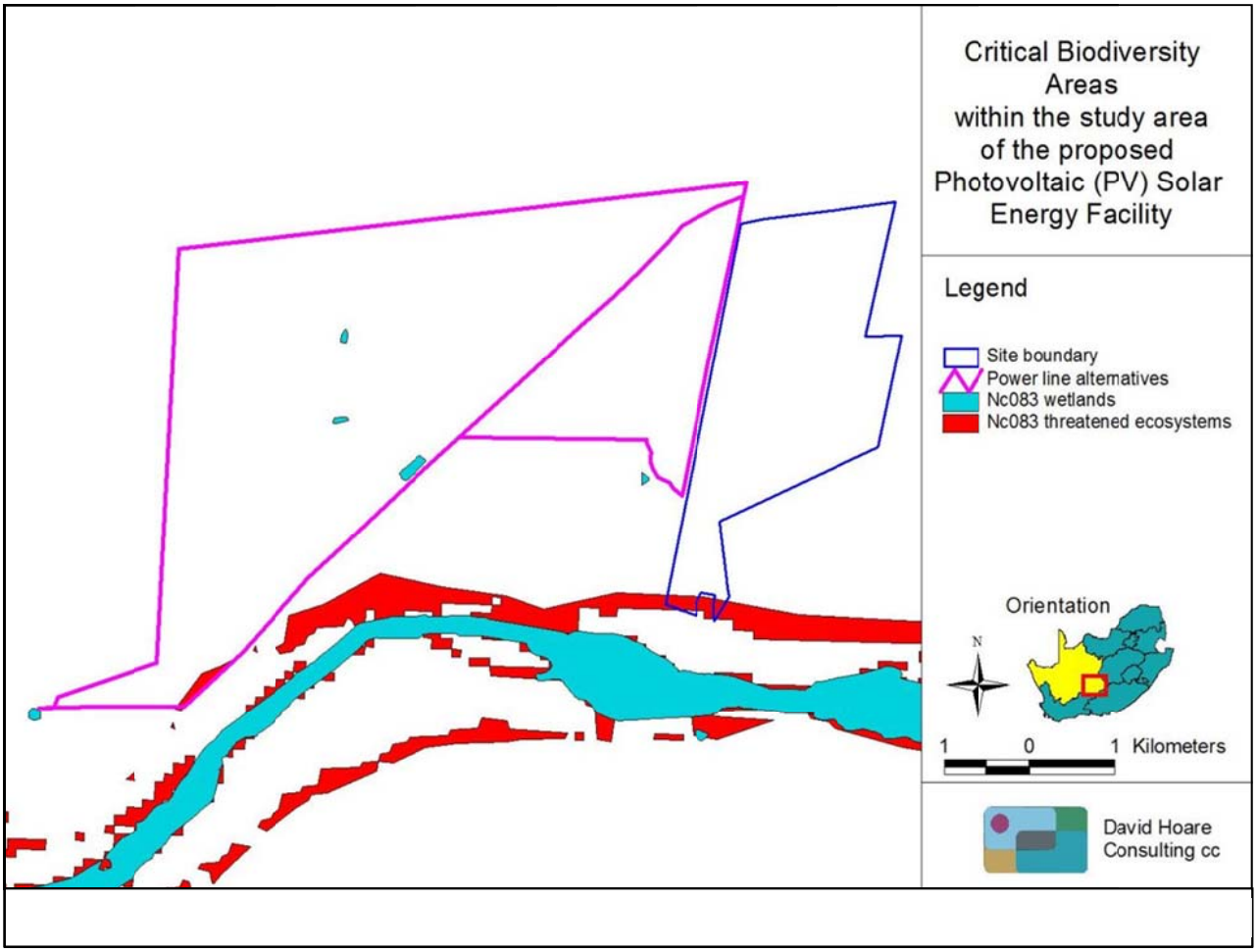


Table 2: Conservation status of different vegetation types occurring in the study area, according to Driver *et al*. 2005 and Mucina *et al*. 2005.

Vegetation Type	Target (%)	Conserved (%)	Transformed (%)	Conservation status	
				Driver *et al*. 2005; Mucina*et al*., 2006	Draft Ecosystem List (NEMBA)
Kalahari Karroid Shrubland	21	0	1	Least Threatened	Not listed
Lower Gariep Alluvial Vegetation	31	6	51	Endangered	Endangered
Gordonia Duneveld	16	14	1	Least Threatened	Not listed

The Siyanda Environmental Management Framework (Environomics 2010) identifies Kalahari Karroid Shrubland as being a high conservation priority in the Siyanda area, despite it being transformed only 1% (Table 2), listed as Least Threatened in scientific literature (Mucina et al. 2006), not listed according to NEMBA and being allocated a low sensitivity index score in the EMF (Environomics 2010). The intention of identifying this vegetation as being a high conservation priority is due to it being largely restricted to the Siyanda study area and there being little of it conserved, despite little being transformed. It is therefore a long-term consideration to place some of this area of vegetation within a conservation area. No conservation areas for this vegetation type are proposed anywhere near to Upington. The site is therefore not within a proposed conservation area (Environomics 2010).

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 wetlands and threatened vegetation types as the only areas of concern in the study area (Figure 4). This is consistent with patterns identified from other sources within the current EIA document.

Red List plant species of the study area

Lists of plant species 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 are six species on this list.

The species on this list were evaluated to determine the likelihood of any of them occurring on site on the basis of habitat suitability. Of the species that are considered to occur within the geographical area under consideration, there is one species recorded in the quarter degree grid that is listed on the Red List that could occur in habitats that are available in the study area, *Aloe dichotoma* subsp. *dichotoma*. According to IUCN Ver. 3.1 (IUCN, 2001) this species is listed as Vulnerable. No individuals of this species were found in that part of the site where infrastructure is proposed to be located.

There are also three species listed as Declining that could occur on site (see Table 3 for explanation of categories). Species listed as Declining are a low conservation priority and not considered to be threatened. The one Vulnerable species was evaluated as having a high probability of occurring on site due to the site having suitable habitat for this species. The study area is therefore potential habitat for all except one species on the list in Appendix 1.

Only the species listed as Vulnerable is considered to be threatened, the other species are listed in a low conservation status category.

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

One protected plant species, *Harpagophytum procumbens*, could potentially occur on site. A single seed was found in the watercourse just adjacent to the N14 national road, but no plants.

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 are three mammal species of low conservation concern that could occur in available habitats in the study area. This includes three species classified nationally as near threatened (NT), i.e. the Honey Badger, Littledale's Whistling Rat and the Dassie Rat, all three of which are classified as Least Concern globally.

There are three threatened bird species (all VU) and five 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 two species most likely to use parts of the site for breeding are the Kori Bustard and Ludwig's Bustard. The Martial Eagle, Secretarybird, Lanner Falcon, Black Stork, Marabou Stork and Sclater's Lark may also use the site or parts of the site for foraging. None of these species were seen on site or in the surrounding areas, although the habitat is potentially suitable for them to occur there.

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. The part of the site where infrastructure is proposed to be located did not contain habitat suitable for this species.

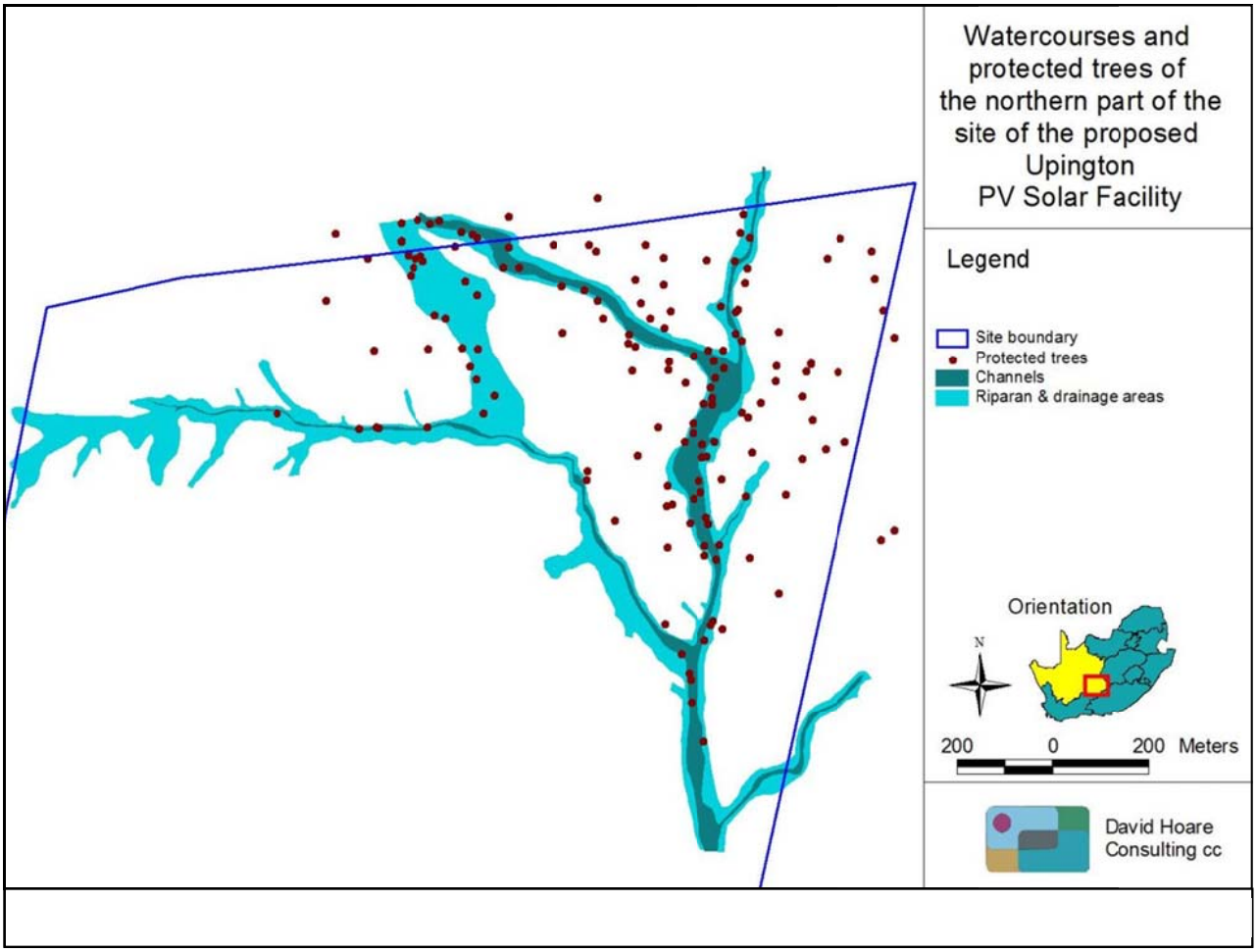
There are no reptile species of conservation concern that have a distribution that includes the study area.

Protected trees

Tree species protected under the National Forest Act are listed in Appendix 3. Those that have a geographical distribution that includes the study area are *Acacia erioloba* (Camel Thorn, Kameeldoring), *Acacia haematoxylon* (Grey Camel Thorn, Vaalkameeldoring), *Boscia albitrunca* (Shepard's Tree / Witgatboom / !Xhi) and *Euclea pseudebenus* (Ebony Tree, Ebbeboom).

The tree *Acacia erioloba* occurs in dry woodland along watercourses in arid areas where underground water is present as well as on deep Kalahari sands (mostly Bushmanland Arid Grassland). *Acacia haematoxylon* occurs on deep Kalahari sand between dunes or along dry watercourses (Bushmanland Arid Grassland). *Boscia albitrunca* occurs in semi-desert areas and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils (mostly Bushmanland Arid Grassland). *Euclea pseudobenus* occurs in semi-desert and desert areas, usually along watercourses and in depressions. It could occur in the hills or on the flats. *Acacia erioloba* and *Boscia albitrunca* are relatively common in the study area, whereas *Acacia haematoxylon* occurs more sparsely and *Euclea pseudobenus* is only likely to occur in rockier areas closer to the Richtersveld.

Both *Acacia erioloba* and *Boscia albitrunca* occur on site. Most of the trees on site are *Boscia albitrunca*. They occur primarily associated with drainage areas and watercourses, although scattered individuals may also occur in terrestrial habitats (Figure 5). A total of 150 protected trees were found in the northern part of the site where infrastructure is proposed to be located, of which 7 are *Acacia erioloba* and the remainder are *Boscia albitrunca*.



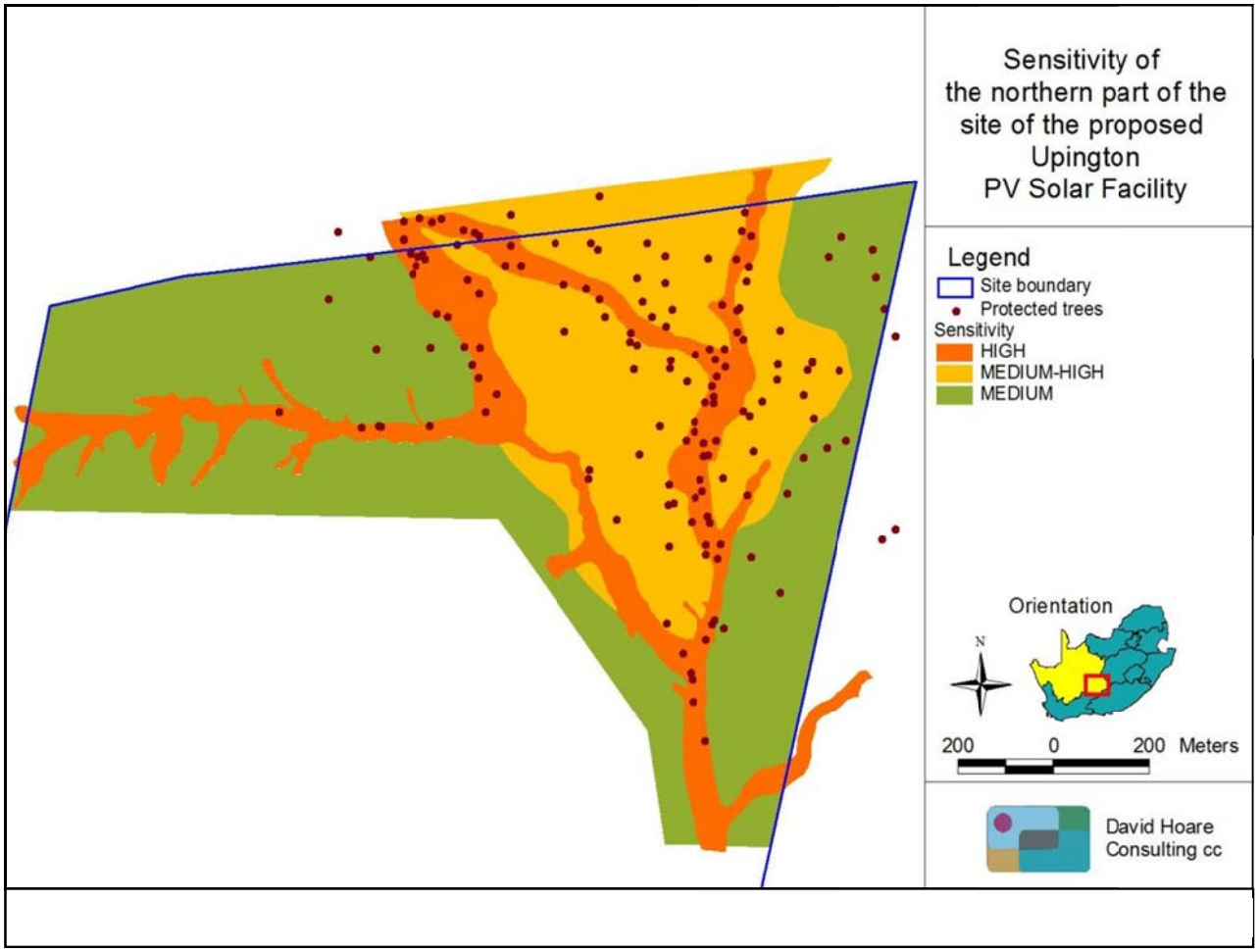
Sensitivity assessment

The sensitivity assessment identifies those parts of the study area that have high conservation value or that may be sensitive to disturbance. 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. Occurrence of parts of the study area (Kalahari Karroid Shrubland) within an area classified in the Siyanda EMF as having high conservation priority.
2. Perennial and non-perennial rivers and watercourses: this represents a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal;
3. Occurrence of populations of flora and fauna of conservation concern and protected trees.

These factors have been taken into account in evaluating sensitivity within the northern part of the site, where infrastructure is proposed to be located (Figure 6). The sensitivity classification for the site is as follows:

1. HIGH: (i) All drainage areas on site, including associated channels and riparian vegetation. They are considered to be areas that provide high value ecosystem goods and services and also contain high numbers of protected trees.
2. MEDIUM-HIGH: Habitats on site that contain moderate densities of protected trees.



3. MEDIUM: All other remaining natural areas on site.
4. LOW: Areas where no natural vegetation occurs is classified as having low sensitivity. This includes cultivated lands, areas of buildings, roads and bare ground. There were no extensive areas within the northern part of the site where no natural vegetation occurs.

This sensitivity assessment is based on a desktop study, detailed field evaluation of the site and detailed analysis of aerial photography.

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."

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.

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.

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 specially protected and protected species for the Province. According to the Act, no person may hunt, import, export, transport, keep, possess, breed or trade in a specimen of a specially protected or protected animal species. According to the Act, no person may pick, import, export, transport, possess, cultivate or trade in a specimen of a specially protected or protected plant species.

The Act makes no mention of control of impacts due to development or destruction *in situ* of any listed species due to construction activities or any permit requirements for these types of activities.

National Water Act, No. 36 of 1998

Provides for the protection of water resources in South Africa, including protecting aquatic and associated ecosystems and their biological diversity, reducing, and preventing pollution and degradation of water resources. According to the Act, 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;
- Awetland, 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.

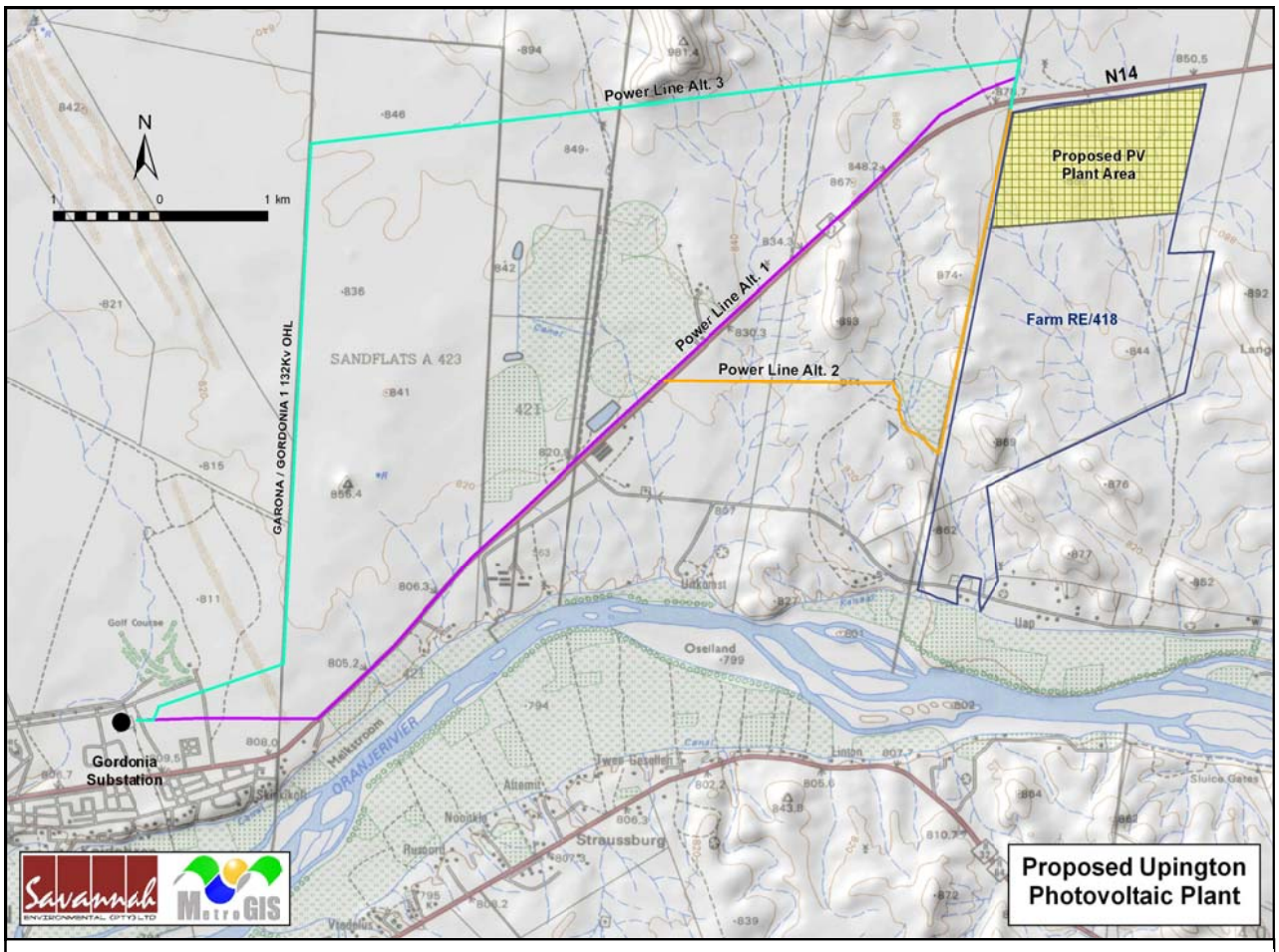
DESCRIPTION OF INFRASTRUCTURE

The position of the proposed infrastructure within the study area is indicated in Figure 6. This shows the array positions and two alternative overhead power line options.

There are two alternative powerline alignments from the site, both to the Gordonia substation at Upington. Alternative 1 follows the N14 road from the site to the Gordonia substation. Alternative 2 runs south exits the property on its north west corner and joins the path of the existing Garona – Gordonia 132 KV line. These are shown in Figure 6 (Alternative 1 in pink, alternative 2 in orange).

The evaluation of impacts will therefore be undertaken for the following infrastructure components:

1. Solar array;
2. Overhead 132 kV power line (two options).



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

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

The most widespread vegetation type on site and the only vegetation type that will be affected by the proposed project is Kalahari KarroidShrubland, which is classified as Least Threatened. The proposed facility will have an impact on a relatively small area of indigenous natural vegetation.

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 very few threatened species listed for the area surrounding the site. This is unfortunately due to the fact that this is an extremely undercollected area floristically speaking and the local flora is not well documented. There may, therefore, be a number of species that

occur within this area for which there are no records. There are six known Red List or Orange List plant species that have a geographic distribution that includes the site of which four could occur in available habitats in the study area. This includes one species classified as Vulnerable, and three as Declining. None of these species were found on site. This potential impact is therefore not assessed further and is scored as zero for all project infrastructure components.

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".

Both *Acacia erioloba* and *Boscia albitrunca* occur on site. Most of the trees on site are *Boscia albitrunca*. They occur primarily associated with drainage areas and watercourses, which will be avoided by the development, although scattered individuals may also occur in terrestrial habitats (see Figure 5).

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.

There are three mammal species and eight bird species of conservation concern that could occur in available habitats in the proposed study area. This includes three species classified as Vulnerable, Kori Bustard, Ludwig's Bustard and Martial Eagle, and eight species classified as near threatened (NT), Secretarybird, Lanner Falcon, Sclater's Lark, Marabou Stork, Black Stork, Honey Badger, Littledale's Whistling Rat and the Dassie Rat. Only three of these were assessed during the Scoping phase as having a high probability of occurring on site, Littledale's Whistling Rat (NT), the Dassie Rat (NT) and the Honey Badger (NT). It must be noted that, although the national status for these three species is NT, the global status is considered to be Least Concern (www.iucnredlist.org). The part of the site that is proposed to be developed is adjacent to the N14 national road and there is a regular stream of heavy traffic passing the site. This makes it unlikely that any species that are sensitive to human

disturbance, e.g. Kori Bustard and Ludwig's Bustard would be found on site. None of these species were found on site during the field investigation. The site is therefore not considered to be important for threatened animal species. All the potentially affected species have the ability to move away from the path of construction.

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 eight bird species of conservation concern that could occur in available habitats in the proposed study area and that may be vulnerable to colliding with overhead powerlines. This includes three species classified as Vulnerable, Kori Bustard, Ludwig's Bustard and Martial Eagle, and eight species classified as near threatened (NT), Secretarybird, Lanner Falcon, Sclater's Lark, Marabou Stork and Black Stork. The part of the site that is proposed to be developed is adjacent to the N14 national road and there is a regular stream of heavy traffic passing the site. This makes it unlikely that any species that are sensitive to human disturbance, e.g. Kori Bustard and Ludwig's Bustard would be found on site, although in more remote areas along the proposed power line alternative routes, it is possible that they may occur.

Impact 6: Impacts on watercourses 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. Riparian vegetation, including woodland associated with the banks of watercourses, are also included in defined areas, according to the National Water Act. 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. Dry river beds and drainage lines are an important habitat for a number of species in the study area, including those with a restricted distribution or species with an elevated conservation status.

There are watercourses that are likely to be affected by the proposed infrastructure (solar arrays and overhead power lines). The client has attempted to avoid watercourses, but, according to the layout provided, there are still riparian areas that are affected.

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.

It is not known to what extent the site contains alien plants. 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. This species invades riverbeds, riverbanks and drainage lines in semi-arid and arid regions and has been recorded near to the site. There is therefore the potential for alien plants to spread or invade following disturbance on site. Honey mesquite, *Prosopis glandulosa*, occurs on site in areas that have been previously disturbed, although not at high densities.

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

Impact 1: Loss or fragmentation of indigenous natural vegetation (terrestrial)
There will 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) The proposed disturbance will be adjacent to an existing road. There will therefore be little fragmentation of natural vegetation.

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 (6)	Moderate to low (5)
Probability	Definite (5)	Definite (5)
Significance	**Medium (60)**	**Medium (55)**
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 3: Loss of individuals of protected tree species

There are two protected tree species that occur on site, *Acacia erioloba* and *Boscia albitrunca*. Of the 143 trees of *Boscia albitrunca* recorded within the area to be developed, 68 will be directly destroyed by the development and a further 10 may be affected (are within 10 m of proposed infrastructure. A significant proportion of these are large, mature individuals, probably of advanced age. Of the 7 trees of *Acacia erioloba* recorded within the area to be developed, 4 will be directly destroyed by the development. These are relatively small individuals.

Duration: The impact will be permanent because clearing of trees for construction purposes will lead to the complete loss of those individuals.

Extent: The impact will occur at the site of solar array, which is scored as local.

Magnitude: The potential magnitude of this impact will be low (will cause a slight impact on processes). This is justified as follows: Having undertaken a number of similar studies in the area around Upington, it is estimated that the density of *Boscia albitrunca* and *Acacia erioloba* on site is typical of the general area. The study area may, therefore, contain as many as 700 individuals of *Boscia albitrunca* and 30-40 individuals of *Acacia erioloba*. The loss of individuals of protected trees within the footprint of the solar array therefore represents approximately 10% of the population within the greater study area.

Probability: It is definite that protected trees will be affected.

Significance: The impact will be of medium significance.

Mitigation measures: Although not considered a mitigation measure, a permit would need to be obtained for any protected trees that are affected. All efforts must be made to not damage trees that are outside the development footprint.

Nature: Loss of individuals of protected trees		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	low (4)	low (4)
Probability	Definite (5)	Definite (5)
Significance	**Medium (50)**	**Medium (50)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Not necessary	
Mitigation: Obtain a permit for any protected trees that have to be destroyed in order to construct the solar array.		
Cumulative impacts: None		
Residual Impacts: None likely		

*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.

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 minor (will have no effect on population processes).

Probability: The probability of the impact occurring is rated as improbable. It is not known whether the species occur on site or not. If they do, 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	minor (2)	minor (2)
Probability	Improbable (2)	Improbable (2)
Significance	**Low (16)**	**Low (16)**
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 includes a buffer area of 30 m around most major watercourses, but still impacts on various drainage areas and riparian vegetation. 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. There is the potential for impacts to result in processes being altered to the extent that they temporarily cease, which is scored as high.

Probability: According to the provided layout, it is highly 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 high (7)	Low (4)
Probability	Highly probable (4)	Highly probable (4)
Significance	**medium (52)**	**medium (40)**
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.		

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 moderateto 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)

A large proportion of alignment Alternative 1 is adjacent to existing disturbance, mostly the N14. A very small area of vegetation is therefore likely to be affected by this alignment, even if the entire servitude is cleared. Alignment alternative 2 exits the site from its north corner and rejoins the current path of the Garona – Gordonia 132 KV line. A small area of vegetation is therefore likely to be affected by this route as well. Alignment alternative 3 is primarily through natural vegetation, but mainly adjacent to an existing power line (Garona/Gordonia 1 132 kV OHL). There is therefore an existing service road and the only expected impact will be due to erection of tower structures. A small area of vegetation is therefore likely to be affected by this route.

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. This will primarily affect Alternative 2.

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 for Alternative 1 (will not result in an impact on processes), low to moderate for Alternative 2 (will result in a slight 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	Alt 1: Medium-term (3)	Alt 1: Medium-term (3)

	Alt 2: Long-term (4) Alt 3: Medium-term (3)	Alt 2: Long-term (4) Alt 3: Medium-term (3)
Magnitude	Alt 1: Minor (2) Alt 2: Low (4) Alt 3: Minor (2)	Alt 1: Minor (1) Alt 2: Low (3) Alt 3: Minor (2)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Alt 1: Low (24)** **Alt 2: Medium (36)** **Alt 3: Low (24)**	**Alt 1: Low (20)** **Alt 2: Medium (32)** **Alt 3: 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 3: Loss of individuals of protected tree species

There are two protected tree species that occur on site, *Acacia erioloba* and *Boscia albitrunca*. There are individual trees along the alignment that are likely to be affected by construction of the power line, although the exact position of towers is unknown at this stage. It is estimated that approximately 20 trees may be under the power lines along the Alternative 1 route, approximately 50 along the Alternative 2 route and approximately 150 along the Alternative 3 route. It is likely that only some of these will be directly affected by power line tower structures, but any trees taller than 4 m within the servitude will be trimmed or removed.

Duration: The impact will be permanent because clearing of trees for construction purposes will lead to the complete loss of those individuals.

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

Magnitude: The potential magnitude of this impact will be minor (will not result in an impact on processes), due to the small number of trees that are likely to be affected.

Probability: It is highly probable that protected trees will be affected along Alternative 2 and 3 and probable that trees will be affected along Alternative 1.

Significance: The impact will be of medium significance.

Mitigation measures: Undertake a walkthrough survey of the selected route, once tower and access road positions are known, in order to determine the exact number of individuals of each species that will be affected. Although not considered a mitigation measure, a permit

would need to be obtained for any protected trees that are affected, so a legal obligation remains to determine the presence of protected trees irrespective of the significance of the impact.

Nature: Loss of individuals of protected trees – Array 2 only		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	minor (2)	minor (2)
Probability	Alt 1: Probable (3) Alt 2: Highly probable (4) Alt 3: Highly probable (4)	Alt 1: Improbable (2) Alt 2: Probable (3) Alt 3: Probable (3)
Significance	**Alt 1: Low (24)** **Alt 2: Medium (32)** **Alt 3: Medium (32)**	**Alt 1: Low (16)** **Alt 2: Low (24)** **Alt 2: Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Not necessary	
Mitigation: Undertake a walkthrough survey of the selected route, once tower and access road positions are known, in order to determine the exact number of individuals of each species that will be affected. Obtain a permit for any protected trees that have to be destroyed or trimmed in order to construct or maintain the power line. Use existing access roads as far as possible.		
Cumulative impacts: None		
Residual Impacts: None likely		

*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 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 medium-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 probably be low (may have a slight effect on population processes).

Probability: The probability of the impact occurring is rated as highly improbable for Alternative 1 and 3 and improbable for Alternative 2. It is not known whether the species occur on site or not. If they do, they will not be critically dependant on the small area of habitat that will be lost, but may be affected by collisions with power lines. The position of Alternative 1 adjacent to the N14 reduces the potential for collsions to some degree.

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	low (4)	low (4)
Probability	Alt 1: highly improbable (1) Alt 2: improbable (2) Alt 3: highly improbable (1)	Alt 1: highly improbable (1) Alt 2: improbable (2) Alt 3: highly improbable (1)
Significance	**Alt 1: Low (9)** **Alt 2: low (18)** **Alt 1: Low (9)**	**Alt 1: Low (9)** **Alt 2: low (18)** **Alt 1: Low (9)**
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, but could potentially have a serious impact on some species.

Duration: 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 for Alternative 1 will probably be low (may have a slight effect on population processes). The potential magnitude of an impact due to Alternative 3 would be moderate to high on its own, but the fact that it is situated adjacent to an existing line means that only the additional impact is considered, which is expected to be low.

Probability: The probability of the impact occurring is rated as highly improbable for Alternative 1, due to its position adjacent to the N14 national road, and probable for Alternatives 2 and 3.

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	low (4)	low (4)
Probability	Alt 1: highly improbable (1) Alt 2: probable (3) Alt 3: probable (3)	Alt 1: highly improbable (1) Alt 2: improbable (2) Alt 3: improbable (2)
Significance	**Alt 1: Low (9)** **Alt 2: low (27)** **Alt 3: Low (27)**	**Alt 1: Low (9)** **Alt 2: low (18)** **Alt 3: Low (18)**
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 a number of watercourses and drainage areas that are within the servitude of the powerline alternatives. According to the National Water Act, these are classified as wetlands or water resources. Construction within these areas may lead to some direct or indirect loss of or damage to these affected areas or changes to the catchment of these areas. Impacts are more likely to be associated with the power lien access road rather than the power line towers.

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

4. Place tower structures a minimum of 50 m from watercourses.
5. Service roads in the servitude must be properly maintained to avoid erosion impacts.
6. If not possible to avoid impacting these drainage lines, 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	Alt 1: Low (4) Alt 2: Moderate (6) Alt 3: Low (4)	Alt 1: Small (2) Alt 2: Low (4) Alt 1: Small (2)
Probability	Alt 1: Probable (3) Alt 2: Highly probable (4) Alt 3: Probable (3)	Alt 1: Improbable (2) Alt 2: Probable (3) Alt 3: Improbable (2)
Significance	**Alt 1: medium (30)** **Alt 2: medium (48)** **Alt 3: medium (30)**	**Alt 1: low (16)** **Alt 2: medium (30)** **Alt 3: low (16)**
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) Place tower structures a minimum of 50 m from watercourses. (2) Service roads in the servitude must be properly maintained to avoid erosion impacts. (3) Alternative 2 must be moved out of the one drainage line along which it runs. (4) If not, 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.		
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 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 general invasion of surrounding vegetation, especially along watercourses. Due to the fact that Alternatives 2 and 3 cross significant areas of natural vegetation, including watercourses, the probability of invasions emanating from construction of Alternative 2 and 3 are higher than for Alternative 1.

Extent: The impact will occur at the site of the servitude of the power line and surrounding areas.

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

Magnitude: The potential magnitude of this impact is medium for local ecosystems for Alternative 2 and 3 (may result in ecological processes continuing but in a modified way) and low for Alternative 1 (may cause a slight impact on ecological processes).

Probability: There is a moderate likelihood that alien species will spread along Alternative 1 in the absence of control measures. The probability is therefore scored as probable for

Alternative 1. There is a moderate to high likelihood that alien species will spread along Alternative 2 and 3 in the absence of control measures. The probability is therefore scored as highly probable for Alternative 2 and 3.

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 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	Site & surroundings (2)	Site & surroundings (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Alt 1: low (4) Alt 2: medium (6) Alt 3: medium (6)	minor (2)
Probability	Alt 1: probable (3) Alt 2: highly probable (4) Alt 3: highly probable (4)	Alt 1: Highly improbable (1) Alt 2: Improbable (2) Alt 3: Improbable (2)
Significance	**Alt 1: Medium (30)** **Alt 2: Medium (48)** **Alt 3: Medium (48)**	**Alt 1: Low (8)** **Alt 2: Low (16)** **Alt 3: 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 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.

Evaluation of infrastructure alternatives

Power line

Power line Alternative 1 is situated primarily along the N14 national road, whereas power line Alternative 2 passes through areas of natural vegetation and through a wide drainage line before joining the other alignment next to the N14. Alternative 2 therefore affects a greater area of natural vegetation and associated sensitive features. Alternative 3 passes through a large area of natural vegetation, but adjacent to an existing overhead power line and existing access road. The significance of impacts is therefore greater for Alternative 2 than for Alternative 1.

The significance of impacts on natural vegetation are rated as low for Alternative 1 and 3 and medium for Alternative 2.

None of the alignments affect threatened plant species.

The significance of impacts on protected trees is low for Alternative 1 and medium for Alternatives 2 and 3, although this can be reduced to low by positioning infrastructure (power line towers and access roads) in such a way as to avoid as many protected trees as possible, especially large (old) individuals.

The significance of impacts on threatened and near threatened animals is low for all alternatives, although slightly higher for Alternative 2.

The significance of impacts on watercourses is medium for all alternatives, but higher for Alternative 2. Mitigation measures can reduce the significance for all alternatives, but it will remain of medium significance for Alternative 2, whereas it will be of low significance for Alternatives 1 and 3.

Alien plants are more likely to be problematic along Alternatives 2 and 3 than Alternative 1 due to the greater area of natural vegetation and a watercourse crossed by Alternatives 2 and 3. The significance of impacts is rated as being of medium significance for all alternatives, but slightly higher for Alternatives 2 and 3.

The three power line options are similar in the potential impacts that they may cause, although the significance of impacts is higher for Alternative 3 than Alternative 1 and highest for Alternative 2. Alternative 1 affects a lesser amount of natural habitat and approximately half the number of protected trees. It also avoids some more sensitive habitats, such as a watercourse, that will be required to be crossed by Alternatives 2 and 3. From an ecological perspective, the much preferred power line is therefore Alternative 1 followed by Alternative 3, although any option can be considered, if necessary, on condition mitigation measures are applied.

DISCUSSION AND CONCLUSIONS

There are two major vegetation types that occur in the study area, namely Kalahari Karroid Shrubland and Lower Gariep Alluvial Vegetation. One of these vegetation types, Kalahari Karroid Shrubland, is classified as Least Threatened and also has a wide distribution and extent. Lower Gariep Alluvial Vegetation is classified as Endangered. This vegetation is the alluvial vegetation associated with the Orange River. The natural vegetation across most of the site, with the exception of the Orange River, is therefore not considered to have high conservation status. Proposed infrastructure is planned to be located in the northern part of the site, away from the Orange River, so this vegetation will not be affected.

Local factors that may lead to parts of the study area having high ecological sensitivity are the presence of drainage lines on site and the potential presence of various plant and animal species of conservation concern.

Drainage lines / watercourses represent particularly vital natural corridors as they function both as wildlife habitat, providing resources needed for survival, reproduction and movement, and as biological corridors, providing for movement between habitat patches. In arid areas, water movement below the surface may be vital for sustaining biodiversity elements. The functioning of these areas is therefore important to maintain. Wetlands (including drainage lines / watercourses) are protected under national legislation (National Water Act). Any impacts on these areas would require a permit from the National Department of Water Affairs.

There are two protected tree species that occur in the area. Approximately 140 individuals of *Boscia albitrunca* and seven individuals of *Acacia erioloba* occur within the northern part of the site where the solar array is proposed to be located. Half of these are likely to be directly lost to construction of the infrastructure.

There are four plant species of conservation concern that have a high likelihood of occurring in available habitats in the study area. This includes one species classified as Vulnerable and three as Declining. Only the Vulnerable species is of concern for this study since the other three are not considered to be threatened. The Vulnerable species is *Aloe dichotoma* subsp. *dichotoma* (kokerboom). This species was not found on site.

There are a number of animal species of conservation concern that may occur in habitats within the study area. This includes three mammal species of conservation concern (including three species classified as Near Threatened, the Honey Badger, Littledale's Whistling Rat and the Dassie Rat), three threatened bird species (all classified as VU) of which two species may use the site for breeding purposes (Kori Bustard and Ludwig's bustard) and five near threatened bird species that may be found on site (Secretarybird, Lanner Falcon, Black Stork, Marabou Stork and Sclater's Lark). Habitat requirements for these species are provided in the appendices to this report. None of these species were found on site. The part of the site that is proposed to be developed is adjacent to the N14 national road and there is a regular stream of heavy traffic passing the site. This makes it unlikely that any species that are sensitive to human disturbance, e.g. Kori Bustard and Ludwig's Bustard would be found on site. The site is therefore not considered to be important for threatened animal species. All the potentially affected species have the ability to move away from the path of construction.

One protected amphibian species, the Giant Bullfrog, has a geographical distribution that includes the site. This species is protected according to the National Environmental Management: Biodiversity Act (Act No 10 of 2004). Under this Act, a permit would be required for any activity which is of a nature that may negatively impact on the survival of a listed

protected species. It was evaluated that there was a low probability of this species occurring on site on the basis that no suitable habitat is present on site.

Most of the study area is in a natural condition. A sensitivity analysis identified the drainage lines as the most sensitive feature on site. Lower-lying areas adjacent to the drainage lines were also considered potentially sensitive due to the fact that they are suitable habitat for protected trees. Slightly higher-lying areas were rated as being the least sensitive, although they are still in a natural state. A detailed map of sensitive areas in the northern part of the site is provided in Figure 6.

A risk assessment was undertaken which identified seven 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 threatened plants
3. Impacts on protected tree species
4. Impacts on threatened animals
5. Impacts on wetlands
6. Establishment and spread of declared weeds and alien invader plants

These impacts were assessed for the proposed infrastructure. A summary of the significance of impacts before and after proposed mitigation measures is provided in Table 4 (below). No threatened plant species were found on site or are likely to occur there. This impact was therefore rated as having no significance. The potential impact on animal species of concern was rated as having low significance. Impacts on natural vegetation, protected trees, watercourses and due to uncontrolled spread of alien plants were considered to be the most important negative impacts that would occur if this development proceeded. It is especially important that impacts on watercourses are well-managed so that the ecological functioning of these, especially in down-stream areas, is not highly compromised.

Conclusions

If mitigation measures are put in place, the proposed project is unlikely to have highly significant negative impacts on the ecological receiving environment. Some management and mitigation measures are proposed for reducing some specific impacts. The main impact of concern will be on watercourses and the functioning of these and also due to the loss of individuals of protected trees, especially some large individuals of *Boscia albitrunca*.

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

	Solar arrays		Power lines		
Impact on:	Without mitigation	With mitigation		Without mitigation	With mitigation
1. vegetation	medium (60)	medium (55)	Alt 1 & 3	Low (24)	Low (20)
			Alt 2	medium (36)	medium (32)
2. threatened plants	zero (0)	zero (0)		zero (0)	zero (0)
3. protected trees	medium (50)	medium (50)	Alt 1	Low (24)	low (16)
			Alt 2 & 3	medium (32)	Low (24)
4. threatened animals (habitat)	low (16)	low (16)	Alt 1 & 3	low (9)	low (9)
			Alt 2	low (18)	low (18)
5. birds (collisions)	zero (0)	zero (0)	Alt 1	low (9)	low (9)
			Alt 2 & 3	low (27)	low (18)
6. watercourses	medium (52)	medium (40)	Alt 1 & 3	medium (30)	Low (16)
			Alt 2	medium (48)	medium (30)
7. alien plants	medium (48)	low (16)	Alt 1	medium (30)	low (8)
			Alt 2 & 3	medium (48)	low (16)

*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 from 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 of power line infrastructure,
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 protected trees

OBJECTIVE: Limit impacts on protected trees	
Project component/s	Any infrastructure that may affect protected trees
Potential Impact	Loss of single individuals or groups of protected trees
Activity/risk source	Constructionof power line and solar array infrastructure Construction of new access roads
Mitigation: Target/Objective	Target: limit loss of individuals of protected trees Time period: construction

Mitigation: Action/control	Responsibility	Timeframe
(1) Where possible, position power line infrastructure so that individuals of protected trees are not affected, especially large (old) individuals. (2) Use existing access roads as far as possible (3) Undertake a walkthrough survey of the selected power line route, once tower positions are known, in order to determine the exact number of individuals of each species that will be affected. (4) If it is not possible to avoid destroying or damaging trees, a permit is required from Dept. of Forestry for removal of trees or damage to trees. The permit requires the identity, number, size and condition of each tree that will be affected. (5) Avoid damaging large individuals of protected trees that are close to the edge of the proposed solar array.	Environmental management team, management (environmental officer)	Construction

Performance Indicator	No loss of trees outside direct footprint
Monitoring	• None required

Bird collisions with power lines

OBJECTIVE: Limit impacts on threatened birds due to collisions with power lines	
Project component/s	Overhead power lines
Potential Impact	Loss of individuals of threatened bird species (especially Bustards) due to collisions with overhead power lines.
Activity/risk source	Operation of power line
Mitigation: Target/Objective	Target: limit loss of individuals of threatened birds due to collision with overhead power lines Time period: operation

Mitigation: Action/control	Responsibility	Timeframe
(1) Attach devices to overhead power lines to make them more visible to affected bird species. The exact nature of such devices should be determioned in consulation with a bird specialist.	Environmental management team, management (environmental officer)	Operation

Performance Indicator	No loss of threatned birds due to collisions with power lines
Monitoring	• Bird mortality along power line due to collisions

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. (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. (4) Ensure that powerline tower structures are placed outside watercourses (a minimum of 50 m away)	Construction team, management, environmental control officer	Planning, construction

Performance Indicator	No permanent power line infrastructure within watercourses
Monitoring	• None

Impacts on indigenous natural vegetation

OBJECTIVE: Control loss of/disruption to indigenous 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 of power line and dollar array infrastructure Construction of new access roads
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 and/or the servitude of the power line. (2) Limit unnecessary impacts on surrounding natural vegetation, e.g. driving around in the veld, use access roads only (3) Before construction, demarcate servitude and ensure that construction impacts are contained within this area. (4) Use existing access roads as far as possible (5) Locate construction camps outside of sensitive areas	Construction team, management (environmental officer)	Construction

Performance Indicator	Minimum loss of natural vegetation outside of the exact footprint of the proposed project
Monitoring	• Ongoing monitoring of area by environmental control officer during construction

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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
FABACEAE	Acacia erioloba	Declining	Savanna, semi-desert and desert areas, deep sandy soils and along drainage lines in very arid areas, sometimes in rocky outcrops.	HIGH
ASPHODALACEAE	Aloe dichotoma subsp. dichotoma	VU	North-facing rocky slopes (particularly dolomite) in the south of its range.	HIGH
FABACEAE	Caesalpiniabracteata	VU	This species is only known from below the AugrabiesFalls near the Orange River and Klein Pella on granite. BlouputsKarroidThornveld.	LOW, nearest locality is 70 km away
AMARYLLIDACEAE	Crinum bulbispermum	Declining	Scattered from the Northern Cape on the banks of the Orange River eastwards through the Free State, Lesotho to Mpumalanga and KwaZulu-Natal. Recorded in the drainage basins of the Orange and VaalRivers practically throughout their lengths, and also in the catchment areas of the Pongola and the TugelaRivers. Near rivers, streams, seasonal pans and in damp depressions.	HIGH
MESEMBRYANTHEMACEAE	Dinteranthuswilmotianus	NT	Orange river basin, from Augrabies to Eendoorn area near Warmbad in southern Namibia. Alluvial gravel soils.	LOW
APOCYNACEAE	Hoodia gordonii	Declining	Wide variety of arid habitats	HIGH

* 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	*Dicerosbicornisbicornis*	Wide variety of habitats, but currently only occurs in game reserves.	CR	CR	**NONE**, only occurs in game reserves
Honey badger	*Mellivoracapensis*	Wide variety of habitats. Probably only in natural habitats.	NT	LC	**HIGH**, overall geographical distribution includes this area, habitat is suitable.
Darling's horseshoe bat	*Rhinolophusdarlingii*	Savanna, rossting in caves and sub-terranean habitats	NT	LC	**LOW**, recorded in nearby grid, on edge of distribution; suitable probably does not occur on site.
Dent's horseshoe bat	*Rhinolophusdenti*	Savanna, nama-Karoo, succulent Karoo, distribution follows rivers. Caves and subterranean habitats. Aerial insectivore.	NT	LC	**LOW**, on edge of distribution; suitable habitat may occur on site or may be vagrant from Orange River valley.
Littledale's whistling rat	*Parotomyslittledalei*	Desert, Karoo. Sandy or gravel open plains. Tends to excavate burrow beneath a shrub, but will also contruct stick nest at the base of a shrub. Herbivorous, favouring leaves of Zygophullum and Mesembryanthemaceae.	NT	LC	**HIGH**, site is in core of distribution range. Habitat suitable on site.
Dassie Rat	*Petromustypicus*	Rocky barren areas on rocky outcrops and koppies. Flat rock crevices. Eats soft vegetable matter, including leaves of shrubs and flowers of many Asteraceae.	NT	LC	**HIGH**, site is in core of distribution range. Suitable habitat probablyoccurs on site.

[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 28 October 2010.

AMPHIBIANS

Common name	Species	Habitat	Status	Likelihood of occurrence
Giant Bullfrog	*Pyxicephalusadspersus*	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**, on edge of known distribution range and suitable habitat unlikely to occur 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 Branch 1988.
[4]Status according to Groombridge 1994.

BIRDS

Common name	Species	Habitat	Status	Importance of site for species
Tawny Eagle	*Aquila rapax*	Woodland and savanna to semi-arid savanna or grassland with scattered Acacia trees. Site on edge of range. Borderline uncommon resident in study area.	VU[1] NT[2] Protected (NEMBA)	LOW, breeding, LOW, foraging
Black Stork	*Ciconianigra*	Feeds in or around marshes, dams, rivers and estuaries; breeds in mountainous regions. Uncommon resident in study area.	NT	LOW, breeding, MEDIUM, foraging
Marabou Stork	*Leptoptiloscrumeniferus*	Open to semi-arid woodland, bushveld, fishing villages, rubbish tips, lake shores. Uncommon resident in study area.	NT	LOW, breeding, MEDIUM, foraging
Martial Eagle	*Polemaetusbellicosus*	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
Kori Bustard	*Ardeotiskori*	Semi-arid regions, within the 100 - 600 mm rainfall isohyet. Also occurs throughout dryer west, particularly in the Nama-Karoo. Diet consists of insects, reptiles, rodents and vegetable matter. Breeding peaks from October to January. In the semi-arid western parts of South Africa, favours tree-lined watercourses. Common to very common resident in study area.	VU[1] LC[2] Protected (NEMBA)	MEDIUM, breeding, HIGH, foraging
Ludwig's Bustard	*Neotisludwigii*	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. Uncommon to common resident in study area.	VU[1] EN[2] Protected (NEMBA)	MEDIUM, breeding, HIGH, 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, HIGH, foraging
Lanner Falcon	*Falco biarmicus*	Widespread species, occurring in Afrotropics, Middle East and western Palearctic. Common resident in study area.	NT	LOW, breeding, MEDIUM, foraging
Sclater's Lark	*Spizocorysclateri*	Endemic to South Africa and southern Namibia. Confined to Nama Karoo, concentrated in the Northern Cape. Uncommon resident in study area.	NT	MEDIUM, breeding, HIGH, 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*
Adansoniadigitata	*Afzeliaquanzensis*
Balanites subsp. *maughamii*	*Barringtoniaracemosa*
Bosciaalbitrunca	*Brachystegiaspiciformis*
Breonadiasalicina	*Bruguieragymnhorrhiza*
Cassipoureaswaziensis	*Catha edulis*
Ceriopstagal	*Cleistanthusschlectheri* var. *schlechteri*
Colubrinanicholsonii	*Combretumimberbe*
Curtisiadentata	*Elaedendron (Cassine) transvaalensis*
Erythrophysatransvaalensis	*Eucleapseudebenus*
Ficustrichopoda	*Leucadendronargenteum*
Lumnitzeraracemosa var. *racemosa*	*Lydenburgiaabottii*
Lydenburgiacassinoides	*Mimusopscaffra*
Newtoniahildebrandtii var. *hildebrandtii*	*Ocoteabullata*
Ozoroanamaensis	*Philenopteraviolacea* (*Lonchocarpuscapassa*)
Pittosporumviridiflorum	*Podocarpuselongatus*
Podocarpusfalcatus	*Podocarpushenkelii*
Podocarpuslatifolius	*Proteacomptonii*
Proteacurvata	*Prunusafricana*
Pterocarpusangolensis	*Rhizophoramucronata*
Sclerocaryabirrea subsp. *caffra*	*Securidacalongependunculata*
Sideroxyloninerme subsp. *inerme*	*Tephrosiapondoensis*
Warburgiasalutaris	*Widdringtoniacedarbergensis*
Widdringtoniaschwarzii	

Acacia erioloba, Acacia haematoxylon, Bosciaalbitrunca, *Eucleapseudebenus*have 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.

*Azolla filiculoides
*Phalaris canariensis
*Prosopis glandulosa var. glandulosa
*Prosopis glandulosa var. torreyana
*Prosopis velutina
*Salsola kali
*Setaria italica
*Verbesina encelioides var. encelioides
Acacia mellifera subsp. detinens
Adenium oleifolium
Adenolobus garipensis
Aloe claviflora
Aloe hereroensis var. hereroensis
Amellus tridactylus subsp. arenarius
Anacampseros baeseckei
Anacampseros filamentosa subsp. filamentosa
Anacampseros filamentosa subsp. namaquensis
Anacampseros filamentosa subsp. tomentosa
Anthephora pubescens
Aptosimum lineare var. lineare
Aptosimum procumbens
Aptosimum spinescens
Arctotis leiocarpa
Aristida congesta subsp. congesta
Aristida vestita var. vestita
Atriplex semibaccata var. typica
Augea capensis
Avonia albissima
Babiana flabellifolia
Barleria lichtensteiniana
Barleria rigida Nees
Blepharis mitrata
Brachiaria glomerata
Cenchrus ciliaris
Centropodia glauca
Colchicum melanthoides subsp. melanthoides
Commiphora gracilifrondosa
Cotyledon orbiculata var. dactylopsis
Crassula muscosa var. muscosa
Crinum bulbispermum
Cyperus usitatus
Dicoma capensis
Dimorphotheca polyptera
Dinteranthus wilmotianus
Dipcadi gracillimum
Echinochloa stagnina
Enneapogon desvauxii
Enneapogon scaber
Eragrostis annulata
Eragrostis biflora
Eragrostis brizantha
Eragrostis porosa
Eragrostis procumbens
Eragrostis rotifer

Eriocephalus ambiguus
Eriospermum bakerianum subsp. bakerianum
Eriospermum roseum
Felicia muricata Nees subsp. muricata
Ferraria variabilis
Galenia sarcophylla
Geigeria filifolia
Geigeria ornativa
Geigeria pectidea
Geigeria pectidea
Gisekia africana var. africana
Gnidia polycephala
Grielum humifusum var. humifusum
Gymnosporia linearis subsp. lanceolata
Helichrysum micropoides
Heliophila minima
Heliophila trifurca
Hermannia abrotanoides
Hermannia bicolor
Hermannia minutiflora
Hermannia spinosa
Hirpicium echinus
Hoodia gordonii
Jamesbrittenia integerrima
Kedrostis capensis
Kohautia cynanchica
Lapeirousia littoralis subsp. caudata
Leucosphaera bainesii
Lotononis rabenaviana
Lycium pumilum
Manulea schaeferi
Melinis repens
Mesembryanthemum crystallinum
Mesembryanthemum guerichianum
Monechma genistifolium subsp. australe
Monechma spartioides
Monsonia luederitziana
Nerine laticoma
Nymania capensis
Ornithoglossum vulgare
Oxalis lawsonii
Oxygonum alatum var. alatum
Parkinsonia africana
Peliostomum leucorrhizum
Phaeoptilum spinosum
Polygala seminuda
Portulaca hereroensis
Prenia tetragona
Psilocaulon articulatum
Psilocaulon coriarium
Psilocaulon subnodosum
Pteronia leucoclada
Pteronia mucronata
Requienia sphaerosperma
Rhigozum obovatum
Rhigozum trichotomum
Ruschia canonotata

Ruschia griquensis
Ruschia vulvaria
Salix mucronata subsp. mucronata
Salsola barbata
Salsola tuberculata
Schmidtia kalahariensis
Searsia lancea
Searsia pendulina
Selago divaricata
Selago paniculata
Senecio consanguineus
Senna italica subsp. arachoides
Sericocoma avolans
Sida rhombifolia subsp. rhombifolia
Solanum burchellii
Stipagrostis amabilis
Stipagrostis ciliata var. capensis
Stipagrostis obtusa
Stipagrostis uniplumis var. uniplumis
Suaeda caespitosa
Tamarix usneoides x T. ramosissima
Tapinanthus oleifolius
Tephrosia dregeana var. dregeana
Thesium hystricoides
Tragus berteronianus Schult.
Tribulus pterophorus
Tribulus zeyheri subsp. zeyheri
Triraphis ramosissima
Wahlenbergia denticulata var. denticulata
Zygophyllum dregeanum
Zygophyllum simplex

Appendix 5: Species protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004)
(as updated in R. 1187, 14 December 2007)

CRITICALLY ENDANGERED SPECIES
Reptilia
Loggerhead sea turtle
Leatherback sea turtle
Hawksbill sea turtle

Aves
Wattled crane
Blue swallow
Egyptian vulture
Cape parrot

Mammalia
Riverine rabbit
Rough-haired golden mole

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

ENDANGERED SPECIES
Reptilia
Green turtle
Giant girdled lizard
Olive ridley turtle
Geometric tortoise

Aves
Blue crane
Grey crowned crane
Saddle-billed stork
Bearded vulture
White-backed vulture
Cape vulture
Hooded vulture

Pink-backed pelican
Pel's fishing owl
Lappet-faced vulture

Mammalia
Robust golden mole
Tsessebe
Black rhinoceros
Mountain zebra
African wild dog
Gunning's golden mole
Oribi
Red squirrel
Four-toed elephant-shrew

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

VULNERABLE SPECIES
Aves
White-headed vulture
Tawny eagle
Kori bustard
Black stork
Southern banded snake eagle
Blue korhaan
Taita falcon
Lesser kestrel
Peregrine falcon
Bald ibis
Ludwig's bustard
Martial eagle
Bataleur
Grass owl

Mammalia
Cheetah
Samango monkey
Giant golden mole
Giant rat
Bontebok
Tree hyrax

Roan antelope
Pangolin
Juliana's golden mole
Suni
Large-eared free-tailed bat
Lion
Leopard
Blue duiker

Flora
Aloe albida
Encephalartos cycadifolius
Encephalartos eugene-maraisii
Encephalartos ngovanus
Merwilla plumbea
Zantedeschia jucunda

PROTECTED SPECIES
Amphibia
Giant bullfrog
African bullfrog

Reptilia
Gaboon adder
Namaqua dwarf adder
Smith's dwarf chameleon
Armidillo girdled lizard
Nile crocodile
African rock python

Aves
Southern ground hornbill
African marsh harrier
Denham's bustard
Jackass penguin

Mammalia
Cape clawless otter
South African hedgehog
White rhinoceros
Black wildebeest
Spotted hyaena
Black-footed cat
Brown hyaena
Serval
African elephant
Spotted-necked otter
Honey badger
Sharpe's grysbok
Reedbuck
Cape fox

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