

## **ENVIRONMENTAL IMPACT REPORT:**

Specialist ecological study on the potential impacts of the proposed  
Ramphela PV Solar Energy Facility, near Ritchie, Northern Cape

Prepared by

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

David Hoare Consulting cc  
41 Soetdoring Ave  
Lynnwood Manor,  
Pretoria

for

Savannah Environmental (Pty) Ltd  
PO Box 148,  
Sunninghill,  
2197

on behalf of  
Solar Capital (Pty) Ltd

23 October 2011

**DRAFT REPORT: 3<sup>rd</sup> Draft**



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

## **REGULATIONS GOVERNING THIS REPORT**

This report has been prepared in terms the EIA Regulations promulgated under the *National Environmental Management Act* No. 107 of 1998 (NEMA) and is compliant with Regulation 543 Section 32 - Specialist reports and reports on 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 32. (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 32. (2): A person referred to in subregulation (1) must comply with the requirements of regulation (17) i.e is independent

Regulation 33. (3): 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 the proposed Ramphela PV solar energy facility near Ritchie 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**

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

Telephone: 012 804 2281

Cell: 083 284 5111  
Fax: 086 550 2053  
Email: dhoare@lantic.net

## **Summary of expertise**

Dr David Hoare:

- 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 Solar Capital (Pty) Ltd. David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. David Hoare is an independent consultant to Savannah Environmental (Pty) Ltd and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work.

## **Scope and purpose of report**

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

## **Conditions relating to this report**

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

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

## TABLE OF CONTENTS

<b>REGULATIONS GOVERNING THIS REPORT</b> .....	<b>2</b>
APPOINTMENT OF SPECIALIST.....	2
DETAILS OF SPECIALIST .....	2
SUMMARY OF EXPERTISE .....	3
INDEPENDENCE .....	3
SCOPE AND PURPOSE OF REPORT.....	3
CONDITIONS RELATING TO THIS REPORT .....	4
<b>TABLE OF CONTENTS</b> .....	<b>5</b>
<b>INTRODUCTION</b> .....	<b>7</b>
TERMS OF REFERENCE AND APPROACH.....	7
STUDY AREA .....	7
<b>METHODOLOGY</b> .....	<b>8</b>
ASSESSMENT PHILOSOPHY .....	8
PLANT AND ANIMAL SPECIES OF CONCERN .....	9
HABITATS OF CONCERN .....	10
LIMITATIONS .....	10
<b>DESCRIPTION OF STUDY AREA</b> .....	<b>11</b>
LOCATION.....	11
TOPOGRAPHY .....	11
LAND TYPES AND SOILS .....	12
LANDUSE AND LANDCOVER OF THE STUDY AREA .....	13
CLIMATE .....	13
BROAD VEGETATION TYPES OF THE REGION .....	14
<i>Northern Upper Karoo</i> .....	14
CONSERVATION STATUS OF BROAD VEGETATION TYPE .....	14
RED LIST PLANT SPECIES OF THE STUDY AREA.....	15
RED LIST AND PROTECTED ANIMAL SPECIES OF THE STUDY AREA .....	17
PROTECTED TREES .....	18
SENSITIVITY ASSESSMENT .....	18
<b>RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS</b> .....	<b>21</b>
LEGISLATION .....	21
<i>National Environmental Management Act (Act No. 107 of 1998) (NEMA)</i> .....	21
<i>National Forests Act (Act no 84 of 1998)</i> .....	21
<i>National Environmental Management: Biodiversity Act (Act No 10 of 2004)</i> .....	21
<i>Government Notice No. 1477 of 2009: Draft National List of Threatened Ecosystems</i> ....	22
<i>GNR 151: Critically Endangered, Endangered, Vulnerable and Protected Species List</i> .....	22
<i>GNR 1187: Amendment of Critically Endangered, Endangered, Vulnerable and Protected Species List</i> .....	22
<i>Conservation of Agricultural Resources Act (Act No. 43 of 1983) as amended in 2001</i> ...	22
<i>National Water Act (Act No. 36 of 1998)</i> .....	22
<i>National Veld and Forest Fire Act (Act No. 101 of 1998)</i> .....	22
<i>Northern Cape Nature Conservation Act, No. 9 of 2009</i> .....	23
<i>Other Acts</i> .....	23
<b>DESCRIPTION OF INFRASTRUCTURE</b> .....	<b>24</b>
<b>IDENTIFICATION OF RISKS AND POTENTIAL IMPACTS</b> .....	<b>25</b>
DESCRIPTION OF POTENTIAL IMPACTS .....	25
<i>Impact 1: Impacts on indigenous natural vegetation (terrestrial)</i> .....	26
<i>Impact 2: Impacts on threatened plants</i> .....	26
<i>Impact 3: Impacts on protected tree species</i> .....	27

<i>Impact 4: Impacts on threatened animals.....</i>	<i>27</i>
<i>Impact 5: Impacts on protected animals.....</i>	<i>27</i>
<i>Impact 6: Impacts on wetlands and drainage areas.....</i>	<i>27</i>
<i>Impact 7: Establishment and spread of declared weeds and alien invader plants .....</i>	<i>28</i>
<b>ASSESSMENT OF IMPACTS.....</b>	<b>29</b>
PV PLANT .....	29
<i>Impact 1: Loss or fragmentation of indigenous natural vegetation .....</i>	<i>29</i>
<i>Impact 5: Loss of habitat for protected animals .....</i>	<i>30</i>
<i>Impact 6: Damage to wetlands/watercourses .....</i>	<i>31</i>
<i>Impact 7: Establishment and spread of declared weeds and alien invader plants .....</i>	<i>31</i>
OVERHEAD POWERLINES .....	33
<i>Impact 1: Loss or fragmentation of indigenous natural vegetation .....</i>	<i>33</i>
<i>Impact 5: Loss of habitat for protected animals .....</i>	<i>34</i>
<i>Impact 6: Damage to wetlands/watercourses .....</i>	<i>34</i>
<i>Impact 7: Establishment and spread of declared weeds and alien invader plants .....</i>	<i>35</i>
ACCESS ROADS.....	36
<i>Impact 1: Loss or fragmentation of indigenous natural vegetation .....</i>	<i>36</i>
<i>Impact 5: Loss of habitat for protected animals .....</i>	<i>37</i>
<i>Impact 7: Establishment and spread of declared weeds and alien invader plants .....</i>	<i>37</i>
<b>DISCUSSION AND CONCLUSIONS.....</b>	<b>39</b>
CONCLUSION .....	40
<b>MANAGEMENT PLAN .....</b>	<b>42</b>
IMPACTS ON PROTECTED ANIMALS .....	42
IMPACTS DUE TO ALIEN INVASIVE PLANTS.....	43
IMPACTS ON INDIGENOUS NATURAL VEGETATION.....	44
IMPACTS ON WATERCOURSES.....	45
<b>REFERENCES: .....</b>	<b>46</b>
<b>APPENDICES: .....</b>	<b>48</b>
APPENDIX 1: PLANT SPECIES OF CONSERVATION IMPORTANCE (THREATENED, NEAR THREATENED AND DECLINING) THAT HAVE HISTORICALLY BEEN RECORDED IN THE STUDY AREA.....	48
APPENDIX 2: THREATENED VERTEBRATE SPECIES WITH A GEOGRAPHICAL DISTRIBUTION THAT INCLUDES THE CURRENT STUDY AREA. ....	49
APPENDIX 3: LIST OF PROTECTED TREE SPECIES (NATIONAL FORESTS ACT).....	52
APPENDIX 4: CHECKLIST OF PLANT SPECIES RECORDED DURING PREVIOUS BOTANICAL SURVEYS IN THE STUDY AREA AND SURROUNDS. ....	53
APPENDIX 5: ANIMAL SPECIES WITH A GEOGRAPHICAL DISTRIBUTION THAT INCLUDES THE STUDY AREA. ...	61

## INTRODUCTION

### Terms of reference and approach

Savannah Environmental (Pty) Ltd. was appointed by Solar Capital (Pty) Ltd to undertake an application for environmental authorisation through an Environmental Impact Assessment (EIA) for the proposed "Ramphele 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 solar panels with a generating capacity of approximately 100 MW, foundations to support the pv panels, an on-site substation, a short powerline to connect to Eskom's existing Eskom Ritchie Substation located on the north-eastern border of the site, cabling between the project components to be laid underground where practical, internal and external access roads, and a workshop and storage area. The purpose of the EIA is to identify environmental impacts associated with the project.

On 22 June 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 scoping study include:

- to provide a description of the environment that may be affected by the activity and the manner in which the environment may be affected by the proposed project;
- to provide a description and evaluation of potential environmental issues and potential impacts (including direct, indirect and cumulative impacts) that have been identified;
- Direct, indirect and cumulative impacts of the identified issues must be evaluated within the Scoping Report in terms of the following criteria:
  - the **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected;
  - the **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international;
- a statement regarding the potential significance of the identified issues based on the evaluation of the issue/impacts;
- A statement regarding the desk-top evaluation of full site, with high-level identification of potential areas of sensitivity (for input into a sensitivity map)
- identification of potentially significant impacts to be assessed within the EIA phase;
- to provide details regarding the methodology to be adopted in assessing potentially significant impacts in the EIA phase (sufficiently detailed to be included within the Plan of Study for EIA and must include a description of the proposed method of assessing the potential environmental impacts associated with the project).

This report provides details of the results of the EIA phase. The findings of the study are based on a desktop assessment of the study area, including mapping from aerial imagery, and a field assessment of the site.

### Study area

At a regional level the study area falls within the Northern Cape Province directly south of the town of Ritchie, which is 26 km south of Kimberley. 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 Scoping phase study was to review fauna and flora patterns within the study area in order to identify any highly sensitive areas that should be avoided during development. It was therefore necessary to provide checklists of sensitive species that could potentially occur in the study area as well as habitats with high conservation value. For potential species, only those of high conservation concern are provided. It was also intended to provide a draft habitat map of the study area based on available maps and database information. The results of the Scoping 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 Of 2004)

### **Plant and animal species of concern**

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

Lists were compiled specifically for any species of conservation concern previously recorded in the area and any other species with potential conservation value. Historical occurrences of threatened plant species were obtained from the South African National Biodiversity Institute for the quarter degree squares within which the study area is situated.

Regulations published for the National Forests Act provide a list of protected tree species for South Africa. The species on this list were assessed in order to determine which protected tree species have a geographical distribution that coincides with the study area and habitat requirements that may be met by available habitat in the study area.

Provincial and National legislation was evaluated in order to provide lists of any plant or animal species that have protected status. The most important legislation is the following: *National Environmental Management: Biodiversity Act (Act No 10 of 2004)*.

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

- *Habitat requirements*: most Red Data animals have very specific habitat requirements and the presence of these habitat characteristics within the study area were assessed;
- *Habitat status*: in the event that available habitat is considered suitable for these species, the status or ecological condition was assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water-quality plays a major role); and
- *Habitat linkage*: movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to these surrounding habitats and adequacy of these linkages are assessed for the ecological functioning Red Data species within the study area.

For all threatened or protected organisms (flora and fauna) that occur in the general geographical area of the site, a rating of the likelihood of it occurring on site is given as follows:

- LOW: no suitable habitats occur on site / habitats on site do not match habitat description for species;
- MEDIUM: habitats on site match general habitat description for species (e.g. fynbos), but detailed microhabitat requirements (e.g. mountain fynbos on shallow soils overlying Table Mountain sandstone) are absent on the site or are unknown from the descriptions given in the literature or from the authorities;
- HIGH: habitats found on site match very strongly the general and microhabitat description for the species (e.g. mountain fynbos on shallow soils overlying Table Mountain sandstone);
- DEFINITE: species found in habitats on site.

### **Habitats of concern**

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), Northern Cape Biodiversity Conservation Plan (NCBCP). 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.

### **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 directly south of the town of Ritchie (Figure 1), which is approximately 24 km south of Kimberley within the Northern Cape. The site falls within the quarter degree grid 2924BA. The proposed facility would occur on Portion 10 of the Farm Kookfontein and on the Farm Klipdrift 109.

No alternative site is currently being considered for the proposed facility, but the current site is sufficiently large to allow placement of the facility in alternative positions within the site in order to avoid any identified environmental sensitivities. The site was chosen because of the local topography, solar irradiation and access to the electricity grid via the existing Eskom Ritchie substation. The Ritchie substation is less than 300 m from the boundary of the site.

The study area is accessible from Kimberley via the N12 National road (which runs from Gauteng through Kimberley and then southwards). The N12 is the eastern boundary of the site and provides direct access to the site.

### Topography

The topography of the study site is gentle to flat. There is a small rise in the central to mid-

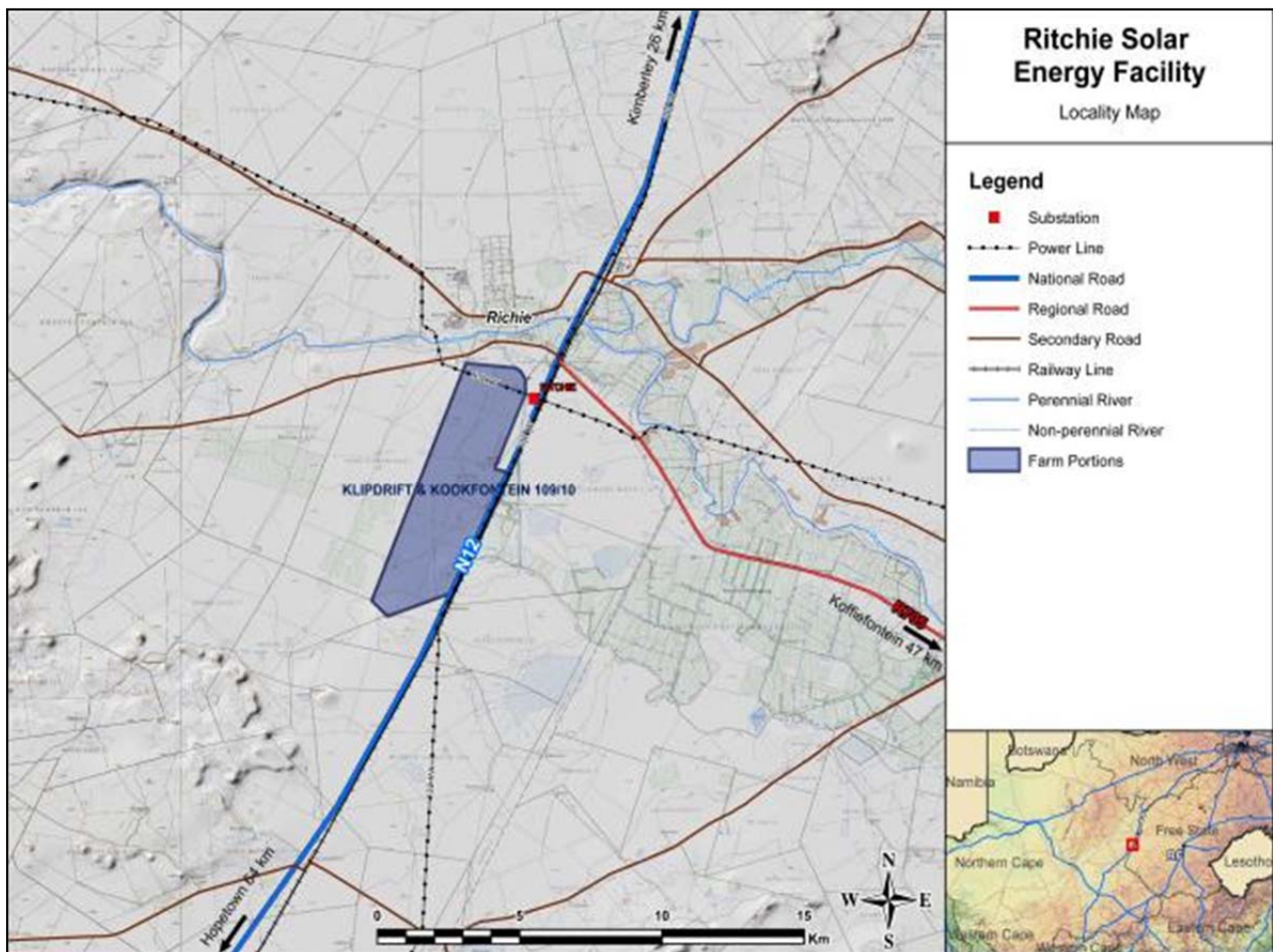


Figure 1: Location of the proposed PV Solar Energy Facility

northern part of the site and another one along the southern boundary. The site rises slightly from north to south. The elevation on site varies from 1110 to 1165 m above sea level, the lowest elevation being in the north-west corner and the highest elevation along the southern boundary. There is one shallow drainage line / watercourse in the north-western corner of the site and a small pan near the southern side. No other hydrological features are apparent on site from aerial imagery or 1:50 000 topocadastral maps. However, the Riet River runs past near to the northern part of the site (Figure 1).

### 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 number of land types in the study area, namely the Ae and Ag land types (Land Type Survey Staff, 1987). The Ag land type covers the northern two-thirds and the Ae land type the southern third of the site.

The A-group of land types refer to yellow and red soils without water tables belonging to one or more of the following soil forms: Inanda, Kranskop, Magwa, Hutton, Griffin, Clovelly. The Ae landtype consists of red, high base status, > 300 mm deep soils and no dunes whereas the Ag landtype is < 300 mm deep (MacVicar et al. 1974). At least two-thirds of the site is therefore expected to have relatively shallow soils.

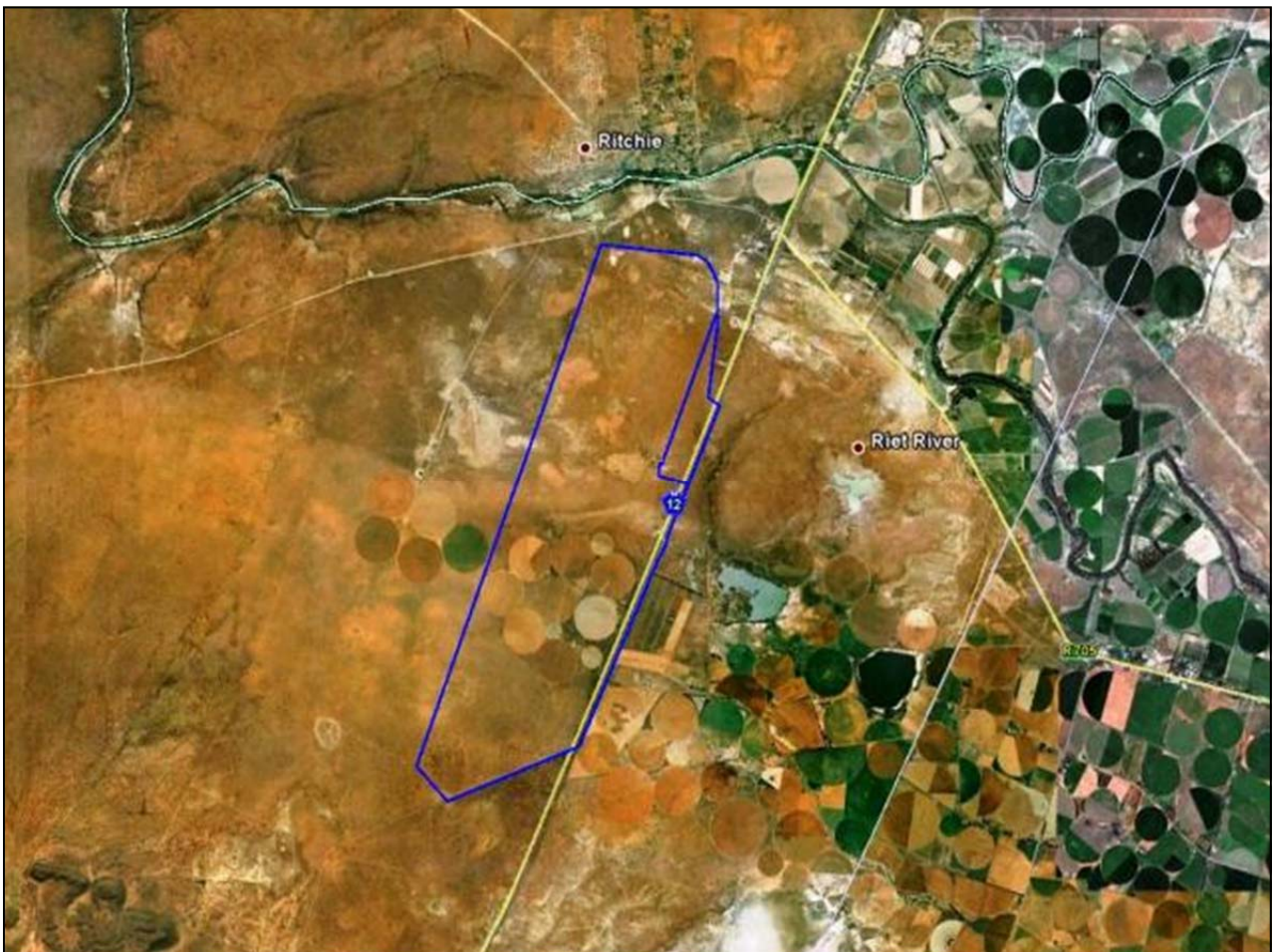


Figure 2: Aerial image of the site and surrounding areas.

## Landuse and landcover of the study area

A landcover map of the study area (Fairbanks *et al.* 2000) indicates that almost the entire site consists of natural vegetation, classified as a mixture of “shrubland and low fynbos” in the north, “unimproved grassland” in the central parts and “thicket and bushland” in the extreme southern portion. There is a small area classified as “cultivated” in the central part of the site. This is confirmed with some small exceptions from 1:50 000 topo-cadastral maps, but aerial imagery indicates a relatively extensive area of cultivation in the central part of the site, taking up almost a quarter of the site. This is part of a more extensive area of cultivation that occurs to the east of the site, associated with the Riet River. These features are mostly visible in an aerial image of the site (Figure 2).

The site is crossed by at least two powerlines emanating from the Eskom Ritchie substation. There are buildings associated with agricultural activities outside the north-eastern corner of the site, but none on site. There are two small patches of excavated land in the northern part of the site, otherwise no other indications of degradation on site.

## Climate

The climate is arid to semi-arid. Rainfall occurs from November to March, but peaks in mid- to late summer (February / March). Mean annual rainfall is 275 mm per year. All areas with less than 400 mm rainfall are considered to be arid. The study area is therefore arid.

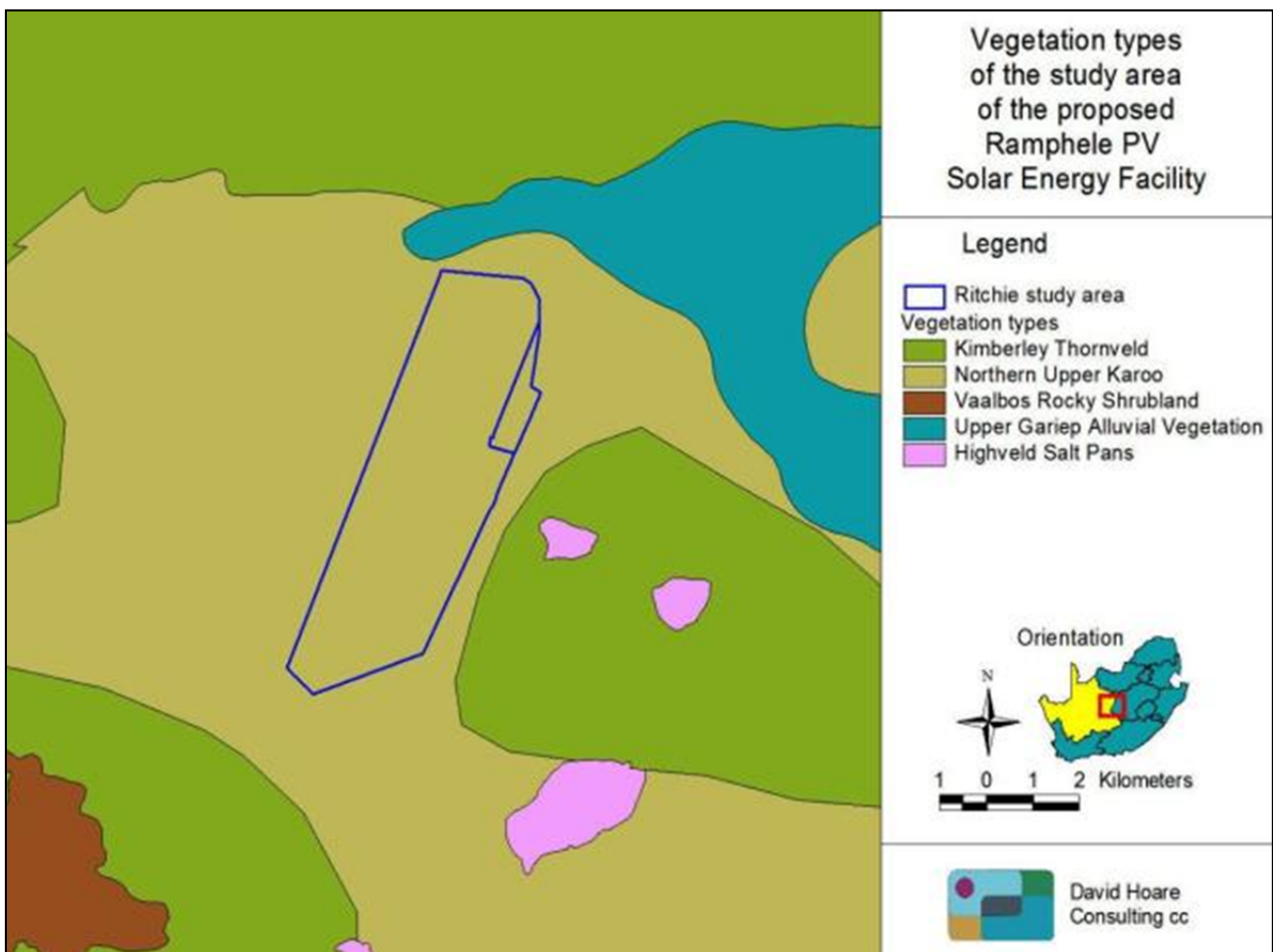


Figure 3: Vegetation types of the site and surrounding areas.

## Broad vegetation types of the region

The study area falls within the Nama-Karoo Biome (Rutherford & Westfall 1986, Mucina & Rutherford 2006) at the boundary with the Kalahari Bushveld Bioregion of the Savanna Biome (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 five vegetation types occurring within the broad study area, namely Northern Upper Karoo, Upper Gariiep Alluvial Vegetation, Kimberley Thornveld, Vaalbos Rocky Shrubland and Highveld Salt Pans (Figure 3). No other vegetation type occurs anywhere near to the site. Only Northern Upper Karoo occurs on the site itself. The Northern Upper Karoo vegetation type is described in more detail below.

### **Northern Upper Karoo**

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

## Conservation status of broad vegetation type

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% of the ecosystem still remaining in a natural state (Driver *et al.* 2005). The vegetation types occurring in the study area (Table 2) are classified as Least Threatened (Driver *et al.* 2005; Mucina *et al.*, 2006).

**Table 1: Determining ecosystem status (from Driver *et al.* 2005). \*BT = biodiversity target (the minimum conservation requirement).**

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

The Draft National List of Threatened Ecosystems (GN1477 of 2009), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists national

vegetation types that are afforded protection on the basis of rates of transformation. The thresholds for listing in this legislation are higher than in the scientific literature, which means there are fewer ecosystems listed in the Draft Ecosystem List versus in the scientific literature. The vegetation type occurring on site (Northern Upper Karoo) is not listed in the Draft National List of Threatened Ecosystems (GN1477 of 2009).

**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 <i>et al.</i> 2005; Mucina <i>et al.</i> , 2006	Draft Ecosystem List (NEMBA)
Northern Upper Karoo	21	0	4	Least Threatened	Not listed
Kimberley Thornveld	16	2	18	Least Threatened	Not listed
Vaalbos Rocky Shrubland	16	2	2	Least Threatened	Not listed
Upper Gariep Alluvial Vegetation	31	2	22	Vulnerable	Not listed
Highveld Salt Pans	24	0	4	Least Threatened	Not listed

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

### Red List plant species of the study area

Lists of plant species of conservation concern previously recorded in the quarter degree grids in which the study area is situated were obtained from the South African National Biodiversity Institute. These are listed in Appendix 1. This list includes all species recorded from the grid in which the study area is located as well as all neighbouring grids (9 grids in total). Where possible, additional species that could occur in similar habitats, as determined from database searches and literature sources, but have not been recorded in these grids are also listed.

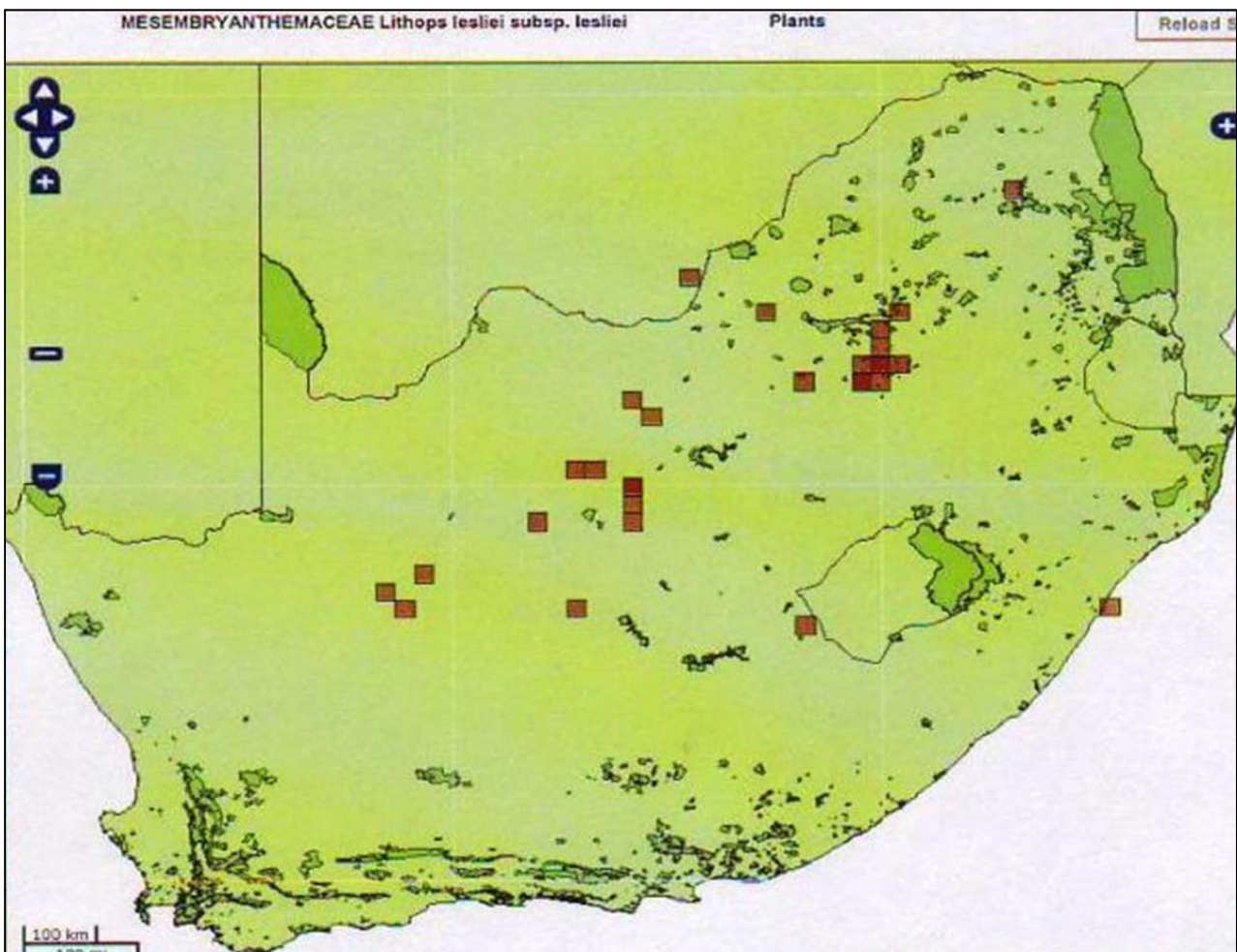
There is one species on this list, *Acacia erioloba*, which is listed as Declining (see Table 3 for explanation of categories). This species occurs in savanna, semi-desert and desert areas, on deep sandy soils and along drainage lines in very arid areas, and sometimes in rocky outcrops. The species is listed as Declining, which is not a threatened or near threatened category. The species is also widespread in the arid parts of South Africa. This species does not occur on site.

Another species, *Lithops lesliei* subsp. *lesliei* is listed as Near Threatened. This species has been previously recorded on site (Tania Anderson, pers. comm.). Information from the SANBI website indicates that this species has not been previously listed in the grid in which the site is located, nor any neighbouring grid. The site is, however, within its overall distribution range and is known from other research to occur on site. This species is found primarily in arid grasslands, usually in rocky places, growing under the protection of forbs and grasses. The main threats to this species are muthi harvesting, which has recently become the biggest threat to its persistence, followed by succulent collectors and habitat destruction.

A comment from WESSA: NC indicated that a “Red Data listed plant species...*Lithops lesliei* subsp. *lesliei* var *hornii*” occurs on site. Current taxonomic information indicates that var. *hornii* is not a valid taxonomic entity and that the taxon is only recognised to subspecies level. The taxon, *Lithops lesliei* subsp. *lesliei*, is listed as Near Threatened. The comment from WESSA:NC indicates that “it is only known from three localities within a very limited area of distribution (around Ritchie) and has very specific habitat requirements”. The comment applies only to the variety (var *hornii*), whereas the total known distribution of the recognised taxon is shown in Figure 4, which shows 25 grids in which it occurs.

**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



**Figure 4: Distribution of *Lithops lesliei* subsp. *lesliei* (<http://sibis.sanbi.org>).**

IUCN / Orange List category	Definition	Class
DDX	Data Deficient: unknown species	Data Deficient

### Red List and protected animal species of the study area

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

There is one mammal species of low conservation concern that could occur in available habitats in the study area, the Brown Hyaena. This is a species classified nationally as near threatened (NT). There are therefore no threatened (CR, EN or VU) species that have a probability of occurring on site. The Brown Hyaena is a highly mobile animal that will move away during construction. The footprint of the proposed is small compared to the overall range of an individual of this species. It is therefore considered highly unlikely that this species will be affected by the development of the proposed infrastructure on site.

There are some mammal species that could occur on site that are protected according to the National Environmental Management: Biodiversity Act (Act No 10 of 2004), including the following that could occur in habitats on site: Black-footed Cat, Brown Hyaena, Honey Badger, Cape Fox and South African Hedgehog. As for the Brown Hyaena (discussed in the previous paragraph), these are all, except for the hedgehog, highly mobile animals that will not be affected by the development of the proposed infrastructure. The hedgehog occurs in a wide variety of habitats, on condition there is ample ground cover, but avoids mesic habitats. They prefer grass and Bushveld with a good covering of leaves and other debris. They are known to occur in Karoo vegetation and could occur on site. However, they occur in such low densities in their natural environment (Hallam 2011) that it was considered unlikely that more than a very small number of individuals could potentially be affected. They are more likely to occur within or close to the low rocky outcrops on site.

There are four threatened bird species (Kori Bustard, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, all VU) and four Near Threatened bird species (Lanner Falcon, Marabou Stork, Peregrine Falcon, Secretarybird) that have a medium probability of utilising available habitats in the study area for foraging. In no case was the site considered to be ideal foraging habitat for any of these species. None of the species was considered to have a likelihood of utilising habitats on site for breeding. The site is therefore not considered to be critical habitat for any threatened or near threatened bird species, although eight species may forage across the site. The proximity of Ritchie to the site would be a deterrent to any ground-foraging species, such as the bustards. The other species are mostly aerial foragers that have wide ranges.

The Giant Bullfrog is the only amphibian species with a distribution that includes the study area and which could occur on site. This species is classified as Least Concern globally and Near threatened in South Africa. It is, however, protected under the National Environmental Management: Biodiversity Act and any impacts on a specimen of this species or that may negatively affect the survival of the species would require a permit. The Giant Bullfrog inhabits a variety of vegetation types where it breeds in seasonal, shallow, grassy pans in flat, open areas. It was considered that there was a medium probability of the species occurring on site, where it is likely to occur in proximity to small pans that occur there.

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

There are no threatened species of potential concern for the site, although four threatened bird species have a distribution that includes the site. The protected species (according to National legislation) of potential concern for the site are as follows:

- South African Hedgehog,
- Giant Bullfrog.

### Protected trees

Tree species protected under the National Forest Act are listed in Appendix 3. There are two that have a geographical distribution that includes the study area, *Boscia albitrunca* (Shepherd's Tree / Witgatboom / !Xhi) and *Acacia erioloba* (Camel Thorn, Kameeldoring).

*Boscia albitrunca* occurs in semi-desert areas and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils. It is usually quite common where it is found.

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. The site is at the very edge of its distribution range.

Neither species was recorded on site within the footprint of the proposed infrastructure.

### Sensitivity assessment

The sensitivity assessment identifies those parts of the study area that have high conservation value or that may be sensitive to disturbance. Areas of potential sensitivity are shown in Figure 4. An explanation of the different sensitivity classes is given in Table 4.

**Table 4: Explanation of sensitivity ratings.**

Sensitivity	Factors contributing to sensitivity
VERY HIGH	<p>Indigenous natural areas that are highly positive for the following:</p> <ul style="list-style-type: none"> <li>• <u>High</u> intrinsic biodiversity value (<u>high</u> species richness and/or turnover, presence of species of concern, unique ecosystems).</li> <li>• <u>Low</u> ability to respond to disturbance (low resilience, dominant species very old).</li> <li>• <u>High</u> conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk).</li> <li>• <u>High</u> value ecological goods &amp; services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value)</li> <li>• <u>Protected</u> 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)</li> </ul>
HIGH	<p>Indigenous natural areas that are moderately positive for the following:</p> <ul style="list-style-type: none"> <li>• <u>Moderate</u> intrinsic biodiversity value (<u>moderate</u> species richness and/or turnover, presence of species of concern).</li> <li>• <u>Moderate</u> ability to respond to disturbance (<u>moderate</u> resilience, dominant species of intermediate age).</li> <li>• <u>Moderate</u> conservation status (low proportion remaining intact, moderately fragmented, habitat for species that are at risk).</li> </ul>

	<ul style="list-style-type: none"> <li>• <u>Moderate</u> value ecological goods &amp; services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value).</li> </ul> <p>And may also be positive for the following:</p> <ul style="list-style-type: none"> <li>• <u>Protected</u> 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)</li> </ul>
MEDIUM-HIGH	Indigenous natural areas that are positive for <u>one</u> or <u>two</u> of the factors listed above.
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.

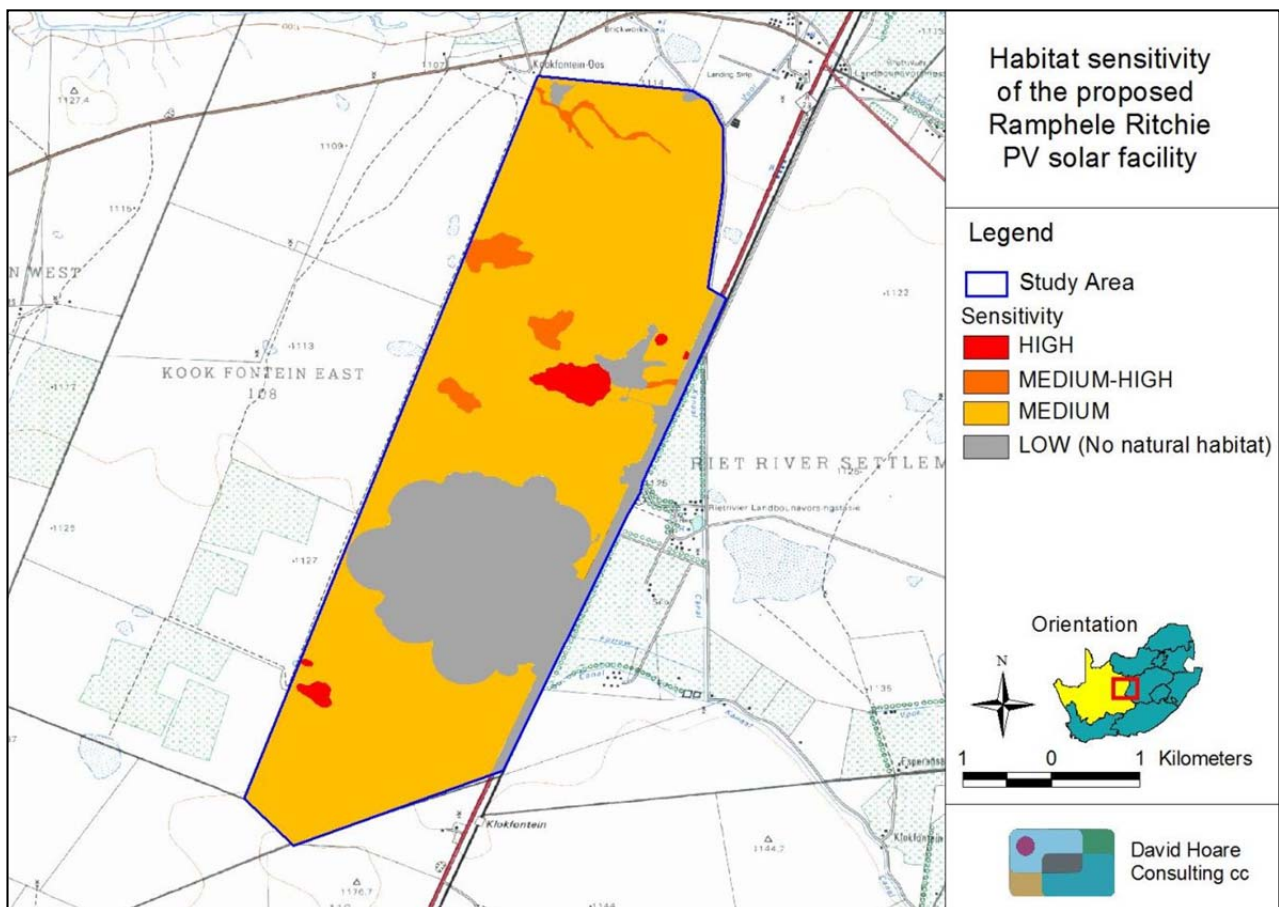
Areas containing untransformed natural vegetation of conservation concern, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to have low sensitivity. The information provided in the preceding sections was used to compile a map of remaining natural habitats and areas important for maintaining ecological processes in the study area. Detailed mapping from aerial photographs was used to provide information on the location of sensitive features. There are a number of features that need to be taken into account in order to evaluate sensitivity in the study area. These include the following:

1. Non-perennial drainage lines and small pans: this represents a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal. Wetlands are protected according to the National Water Act and the National Environmental Management Act.
2. Occurrence of a Near Threatened plant species on site, *Lithops lesliei* subsp. *lesliei*. This species is found primarily in arid grasslands, usually in rocky places, growing under the protection of forbs and grasses. There is a low rocky outcrop on site where this species has been previously recorded.

These factors have been taken into account in evaluating sensitivity within the study area (Figure 4). The sensitivity classification is as follows:

1. HIGH: (i) All of the pans on site are classified as having high sensitivity (see Table 3 and Figure 4). They are protected according to the National Water Act (Act 36 of 1998). Ecologically, they are areas that provide moderate value ecosystem goods and services. (ii) Low rocky outcrop in which a population of a Near Threatened plant species definitely occurs.
2. MEDIUM-HIGH: (i) Drainage lines on site. They are too dry and ephemeral to contain wetlands. (ii) Low rocky outcrops that contain habitat that is potentially suitable for a Near Threatened plant species.
3. MEDIUM: The majority of the study area is classified as having medium sensitivity (see Table 4 and Figure 3). These are areas of natural vegetation that are not considered to be particularly sensitive for any specific reason, but are in a natural state.

This sensitivity map (Figure 4) is based on a combination of a desktop study, aerial photograph interpretation and a field assessment.



**Figure 5: Ecological sensitivity of the study area.**

## 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 (according to Section 15(1)) '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'. GN 1042 provides a list of protected tree species (amends GN 1012).

Forests

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

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

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

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

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

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

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

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

- (1) Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.

- (2) Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.
- (3) The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

***Government Notice No. 1477 of 2009: Draft National List of Threatened Ecosystems***

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

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

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

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

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

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

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

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

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

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

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

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

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

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

### ***Northern Cape Nature Conservation Act, No. 9 of 2009***

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

- No person may hunt, import, export, transport, keep, possess, breed or trade in a specimen of a protected animal.
- Boundary fences may not be altered in such a way as to prevent wild animals from freely moving onto or off of a property;
- Aquatic habitats may not be destroyed or damaged;
- The owner of land upon which an invasive species is found (plant or animal) must take the necessary steps to eradicate or destroy such species.

The Act provides lists of protected species for the Province.

### ***Other Acts***

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

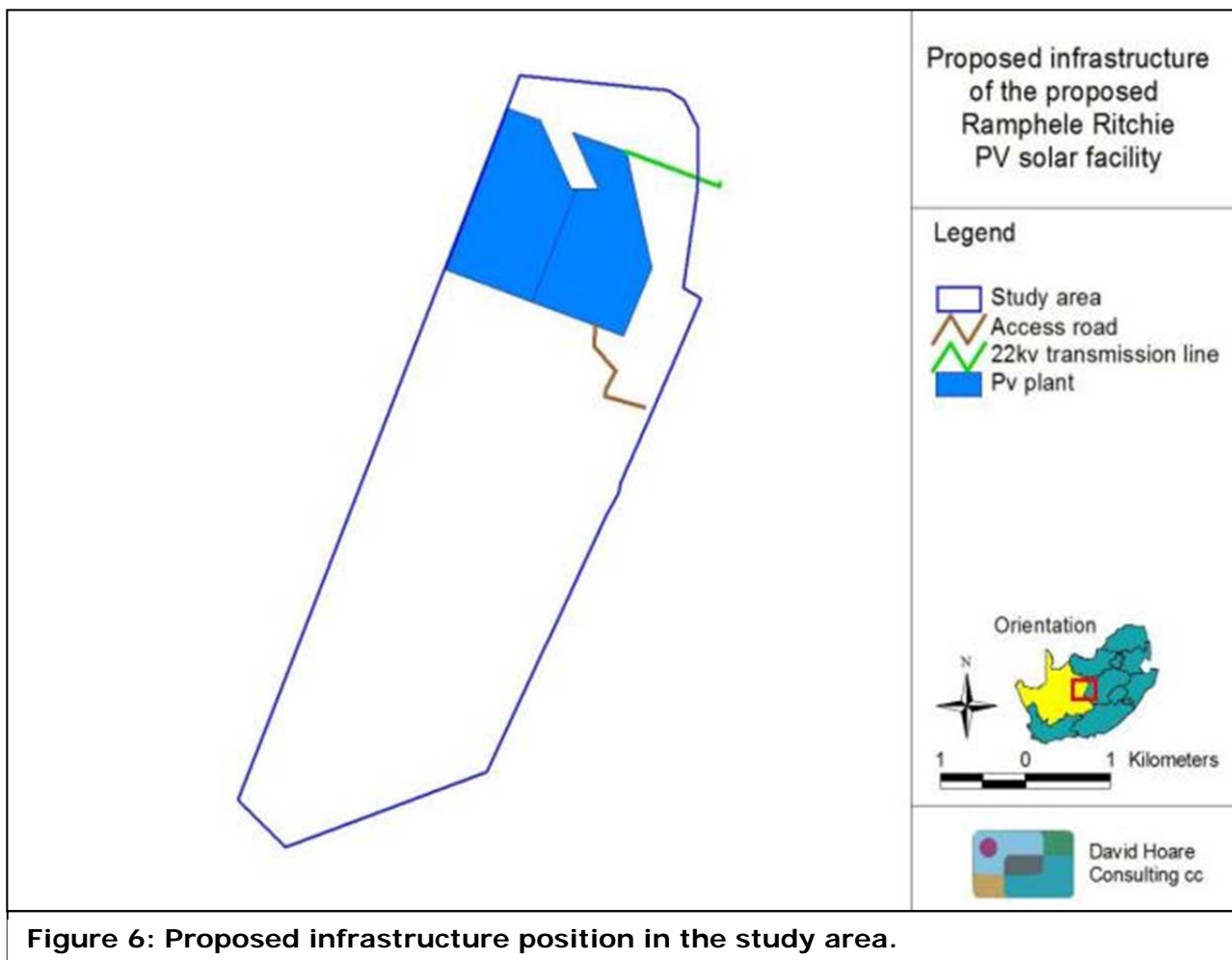
- Integrated Coastal Zone Management Act (Act No. 24 of 2008)
- National Environmental Management Protected Areas Act (Act No. 57 of 2003)
- Marine Living Resources Act (Act No. 18 of 1998)
- Sea Birds and Seals Protection Act (Act No. 46 of 1973)
- Mountain Catchment Areas Act (Act No. 63 of 1970)
-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

## DESCRIPTION OF INFRASTRUCTURE

The position of the proposed infrastructure within the study area is indicated in Figure 6. This shows 2 PV panel arrays (blue areas in Figure 6). These will be linked by internal access roads to the national road that runs past the eastern side of the site. Overhead powerlines will carry power from the PV panel arrays to the Eskom Ritchie substation. These will be 22 kV powerlines. The proposed overhead powerlines will be approximately 1 km long.

The main infrastructure components to be assessed for the proposed solar energy facility are as follows:

1. photovoltaic plant facility,
2. overhead power lines, and
3. access roads.



**Figure 6: Proposed infrastructure position in the study area.**

## 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.

### 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)***

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

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

Most of the site is in a natural state. The vegetation type on site is Northern Upper Karoo, classified as Least Threatened. There are specific parts of the site with conditions that may support the presence of a Near Threatened plant species, otherwise the areas within the proposed footprint of the infrastructure is classified as having medium sensitivity and conservation value.

### ***Impact 2: Impacts on threatened plants***

Plant species are especially vulnerable to infrastructure development due to the fact that they cannot move out of the path of the construction activities, but are also affected by overall loss of habitat.

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

1. fragmentation of populations of affected species;
2. reduction in area of occupancy of affected species; and
3. loss of genetic variation within affected species.

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

There are no threatened plant species likely to occur on site, but there is one Near Threatened plant species that has been previously recorded on site. This is the small succulent, *Lithops lesliei* subsp. *lesliei*. The plant occurs in arid grasslands, usually in rocky places, growing under the protection of forbs and grasses. On site, it has been recorded in the low rocky outcrop adjacent to the homestead. There are other low rocky outcrops with similar habitat in which this species could occur, i.e. is favourable for supporting metapopulation dynamics.

### ***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(l)(d) of the National Forests Act, 1998 (Act No. 84 of 1998). In terms of section 15(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".

Two species have a geographical distribution that includes the study area, *Boscia albitrunca* and *Acacia erioloba*. These species do not occur in any part of the study area. This potential impact is therefore not applicable to the current proposal.

### ***Impact 4: Impacts on threatened animals***

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 no threatened animal species likely to occur on site. This potential impact is therefore not applicable to the current proposal.

### ***Impact 5: Impacts on protected animals***

There are two protected mammal species and ten protected bird species that could occur on site, although the likelihood is not considered to be high. The two species of greatest concern are the South African Hedgehog and the Giant Bullfrog due to the fact that permanent habitat for individuals of these species may be affected, whereas the site constitutes only foraging habitat for birds and they will be affected to a negligible extent. Neither of the mammal species are considered to be threatened or near threatened.

### ***Impact 6: Impacts on wetlands and drainage areas***

The site is in a very arid area. There is one drainage line on site and one small pan. According to the National Water Act, these are classified as water resources. Construction may lead to some direct or indirect loss of or damage to some of these areas or changes to the catchment of these areas. This may affect the hydrology of the landscape or lead to loss of habitat for species that depend on this habitat type.

### ***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 activities) and negative grazing practices (Zachariades *et al.* 2005). Exotic species are often more prominent near infrastructural disturbances than further away (Gelbard & Belnap 2003, Watkins *et al.* 2003). Consequences of this may include:

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

Potential weeds with a distribution centred on arid regions of the country include *Salsola kali*, *Atriplex lindleyi*, *Opuntia ficus-indica*, *Opuntia imbricata*, *Prosopis glandulosa*, *Prosopis velutina*, *Atriplex numularia*, and *Nicotiana glauca*. The shrub, *Prosopis glandulosa*, is potentially the most problematic and is widely distributed in the Northern Upper Karoo vegetation type. This species invades riverbeds, riverbanks and drainage lines in semi-arid and arid regions. There is therefore the potential for alien plants to spread or invade following disturbance on site.

## ASSESSMENT OF IMPACTS

Impacts are assessed for each component of infrastructure for the proposed solar energy facility. There is therefore a separate assessment for the photovoltaic plant facility, overhead power lines and access roads.

### PV plant

The PV array will be in a single block in the northern part of the site (Figure 6).

#### ***Impact 1: Loss or fragmentation of indigenous natural vegetation***

The vegetation type on site is Northern Upper Karoo, which is classified as Least Threatened. Terrestrial vegetation on site is therefore not considered to be of high conservation value. The footprint of the pv array is approximately 320 ha.

Extent: The impact will occur at the site of the proposed pv array. The construction of the pv array potentially affects a moderate proportion of natural vegetation on site and is scored as local.

Duration: The impact will occur during construction, but will be permanent.

Magnitude: At a local scale, the impact is likely to result in a slight impact on processes, which is scored as low.

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

#### Mitigation measures:

1. Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint of the pv power plant.

<b><i>Nature: Loss of habitat within indigenous natural vegetation types</i></b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b><i>Extent</i></b>	local (1)	local (1)
<b><i>Duration</i></b>	permanent (5)	permanent (5)
<b><i>Magnitude</i></b>	Low (4)	low (3)
<b><i>Probability</i></b>	definite (5)	definite (5)
<b><i>Significance</i></b>	<b>medium (50)</b>	<b>medium (45)</b>
<b><i>Status (positive or negative)</i></b>	negative	negative
<b><i>Reversibility</i></b>	Not reversible	Not reversible
<b><i>Irreplaceable loss of resources?</i></b>	Yes	Yes
<b><i>Can impacts be mitigated?</i></b>	Only to a small extent	
<b><i>Mitigation:</i></b> (1) Avoid unnecessary impacts on natural vegetation surrounding the pv power plant. Impacts should be contained, as much as possible, within the footprint of the infrastructure.		
<b><i>Cumulative impacts:</i></b> Soil erosion, alien invasions may lead to additional loss of habitat that will exacerbate this impact.		
<b><i>Residual Impacts:</i></b> Some loss of this vegetation type will definitely occur.		

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

**Impact 5: Loss of habitat for protected animals**

There are two protected mammal species where individuals could be dependent on habitats on site, the Southern African Hedgehog and the Giant Bullfrog. The hedgehog may occur as a small number of individuals on site and the bullfrog may occur within the small pan to the south-east of the PV array. The pv array may affect habitat for these species due to the area that it takes up and the fact that it covers areas suitable for these species.

Extent: The impact will occur at the site of the proposed pv power plant. It is scored as local.

Duration: The impact will occur during construction, but will be permanent (loss of habitat).

Magnitude: Impacts could result in a slight impact on population processes, which is scored as low.

Probability: It is highly improbable that there will be an impact on the hedgehog and improbable that there will be an impact on the bullfrog.

Mitigation measures: Unnecessary impacts on terrestrial habitats outside the footprint of the infrastructure and drainage lines/pans should be avoided. If any individuals will be affected by the proposed pv arrays, a permit is required according to the National Environmental Management: Biodiversity Act.

<b>Nature: Impacts on individuals of threatened animal species (Riverine Rabbit)</b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	local (1)	local (1)
<b>Duration</b>	permanent (5)	permanent (5)
<b>Magnitude</b>	low (4)	small (2)
<b>Probability</b>	Hedgehog: Highly improb (1) Bullfrog: improbable (2)	Hedgehog: Highly improb (1) Bullfrog: improbable (2)
<b>Significance</b>	<b>Hedgehog: low (10)</b> <b>Bullfrog: low (20)</b>	<b>Hedgehog: low (8)</b> <b>Bullfrog: low (16)</b>
<b>Status (positive or negative)</b>	negative	negative
<b>Reversibility</b>	Reversible	Reversible
<b>Irreplaceable loss of resources?</b>	No	No
<b>Can impacts be mitigated?</b>	To some degree	
<b>Mitigation:</b>		
(1) Avoid impacts on natural habitats outside the footprint of the proposed infrastructure. (2) Educate personnel as to the protected status of species that could occur on site and the requirement that no individuals of these species may be killed. (3) If any individuals will be affected by the proposed pv arrays, a permit is required according to the National Environmental Management: Biodiversity Act.		
<b>Cumulative impacts:</b>		
None		
<b>Residual Impacts:</b>		
Unlikely to be residual impacts.		

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

**Impact 6: Damage to wetlands/watercourses**

There are very small parts of the site that have been mapped as watercourses or pans. The proposed footprint of the solar array is adjacent to the upper reaches one of these watercourses. This watercourse runs just outside the northern boundary of the site. It is too dry and ephemeral to be considered to be a wetland. Construction may lead to some 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 effect.

Magnitude: In the long-term, impacts could result in a slight impact on processes, which is scored as low.

Probability: According to the provided layout, it is possible that the impact will occur and is scored as probable.

Mitigation measures:

1. Impacts must be limited to the footprint of the infrastructure and not permitted to infringe on the watercourse.

<b>Nature: Damage to wetland areas resulting in hydrological impacts</b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	local and surroundings (2)	local and surroundings (2)
<b>Duration</b>	Long-term (4)	Long-term (4)
<b>Magnitude</b>	Low (4)	Low (3)
<b>Probability</b>	Probable (4)	Improbable (2)
<b>Significance</b>	<b>medium (40)</b>	<b>low (18)</b>
<b>Status (positive or negative)</b>	negative	negative
<b>Reversibility</b>	Reversible with effective rehabilitation	Reversible
<b>Irreplaceable loss of resources?</b>	Yes	Yes
<b>Can impacts be mitigated?</b>	To some degree	
<b>Mitigation:</b> (1) Impacts must be limited to the footprint of the infrastructure and not permitted to infringe on the watercourse.		
<b>Cumulative impacts:</b> Soil erosion, alien invasions, may all lead to additional impacts on watercourse habitats that will exacerbate this impact.		
<b>Residual Impacts:</b> 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**

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.

**Extent:** The impact will occur at the site of the proposed pv plant, but could potentially spread into the surrounding landscape, depending on the habitat and the alien species that could potentially invade the site. The impact will therefore be evaluated at a scale of site and surroundings.

**Duration:** The impact will occur for the duration of the operation of the facility, which will be 20 years or more. This is long-term.

**Magnitude:** The impact is likely to be low and could result in a slight impact on processes.

**Probability:** It is assessed as probable that this impact will occur in the absence of control measures.

**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 to avoid establishment of a soil seed bank. An ongoing monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

<b>Nature: Establishment and spread of declared weeds and alien invader plants</b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	Site & surroundings (2)	Site & surroundings (2)
<b>Duration</b>	long-term (4)	long-term (4)
<b>Magnitude</b>	low (4)	small (2)
<b>Probability</b>	probable (4)	improbable (2)
<b>Significance</b>	<b>medium (40)</b>	<b>low (16)</b>
<b>Status (positive or negative)</b>	negative	negative
<b>Reversibility</b>	Reversible	Reversible
<b>Irreplaceable loss of resources?</b>	Yes	Yes
<b>Can impacts be mitigated?</b>	To some degree	
<b>Mitigation:</b>		
<ul style="list-style-type: none"> <li>(1) keep disturbance of indigenous vegetation to a minimum</li> <li>(2) rehabilitate disturbed areas as quickly as possible</li> <li>(3) do not translocate soil stockpiles from areas with alien plants</li> <li>(4) control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove</li> <li>(5) establish an ongoing monitoring programme to detect and quantify any aliens that may become established</li> </ul>		
<b>Cumulative impacts:</b>		
Soil erosion, habitat loss, damage to wetlands may all lead to additional impacts that will exacerbate this impact.		
<b>Residual Impacts:</b>		
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 powerlines

Overhead powerlines will carry power from the PV panel arrays to the Eskom Ritchie substation, which is in the north-eastern corner of the study area. These will be 22 kV powerlines. The proposed overhead powerlines will be approximately 1 km long. (Figure 6).

### ***Impact 1: Loss or fragmentation of indigenous natural vegetation***

The vegetation types on site is Northern Upper Karoo, which is classified as Least Threatened. Terrestrial vegetation on site is therefore not considered to be of high conservation value.

Extent: The impact will occur at the site of the proposed overhead powerlines. The construction of the powerline potentially affects a very small proportion of natural vegetation on site and is scored as local.

Duration: The impact will occur during construction. Indications from existing powerlines on site is that the base of tower structures becomes revegetated. The impact will therefore be medium-term.

Magnitude: At a local scale, the impact is likely to result in no impact on processes, which is scored as minor.

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

#### Mitigation measures:

1. Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint of the tower structures and/or the servitude of the powerline.
2. Service roads in the servitude must be properly maintained to avoid erosion impacts.

<b><i>Nature: Loss of habitat within indigenous natural vegetation types</i></b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b><i>Extent</i></b>	local (1)	local (1)
<b><i>Duration</i></b>	Medium-term (2)	Medium-term (2)
<b><i>Magnitude</i></b>	minor (3)	minor (2)
<b><i>Probability</i></b>	probable (3)	probable (3)
<b><i>Significance</i></b>	<b>low (18)</b>	<b>low (15)</b>
<b><i>Status (positive or negative)</i></b>	negative	negative
<b><i>Reversibility</i></b>	Not reversible	Not reversible
<b><i>Irreplaceable loss of resources?</i></b>	Yes	Yes
<b><i>Can impacts be mitigated?</i></b>	No	
<b><i>Mitigation:</i></b>		
(1) Avoid unnecessary impacts on natural vegetation surrounding the powerline servitude. Impacts should be contained, as much as possible, within the footprint of the infrastructure.		
(2) Service roads must be properly maintained to avoid erosion impacts.		
<b><i>Cumulative impacts:</i></b>		
Soil erosion may lead to additional loss of habitat that will exacerbate this impact.		
<b><i>Residual Impacts:</i></b>		

None.

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

### ***Impact 5: Loss of habitat for protected animals***

There are two protected mammal species where individuals could be dependent on habitats on site, the Southern African Hedgehog and the Giant Bullfrog. The hedgehog may occur as a small number of individuals on site and the bullfrog may occur within the small pan to the south-east of the PV array. The overhead powerlines occupy a very small area of habitat that may be suitable for these species and it is considered highly unlikely that they will be affected. This potential impact is therefore not applicable to this infrastructure component and is scored as having zero significance.

### ***Impact 6: Damage to wetlands/watercourses***

There are very small parts of the site that have been mapped as watercourses or pans. The proposed powerline crosses the edge of the upper reaches one of these watercourses. This watercourse runs just outside the northern boundary of the site, with some parts entering the site in places. It is too dry and ephemeral to be considered to be a wetland. 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 powerline, 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 will be low and may cause a slight impact on processes.

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

#### Mitigation measures:

2. The 1:100 year floodline should be determined in order to establish the location of the edge of the drainage area affected.
3. Power line tower structures should be kept a minimum of 30 m outside the edge of the watercourse.
4. If infrastructure is to be located within this area, there is a legal obligation to apply for a Water Use Licence for any areas that may be affected, since they are classified in the National Water Act as a water resource.

<b><i>Nature: Damage to wetland areas resulting in hydrological impacts</i></b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b><i>Extent</i></b>	local and surroundings (2)	local and surroundings (2)
<b><i>Duration</i></b>	Long-term (4)	Long-term (4)
<b><i>Magnitude</i></b>	Low (4)	Small (2)
<b><i>Probability</i></b>	Probable (3)	Highly improbable (1)
<b><i>Significance</i></b>	<b>medium (30)</b>	<b>low (8)</b>
<b><i>Status (positive or negative)</i></b>	negative	negative
<b><i>Reversibility</i></b>	Reversible with effective	Reversible

	rehabilitation	
<b>Irreplaceable loss of resources?</b>	Yes	Yes
<b>Can impacts be mitigated?</b>	To some degree	
<b>Mitigation:</b>		
<p>(1) Impacts must be limited to the footprint of the infrastructure and not permitted to infringe on the watercourse.</p> <p>(2) Power line tower structures should be kept a minimum of 30 m from the edge of the watercourse.</p> <p>(3) If not, there is a legal obligation to apply for a Water Use Licence for any watercourse that may be affected, since they are classified in the National Water Act as a water resource.</p>		
<b>Cumulative impacts:</b>		
Soil erosion, alien invasions, may all lead to additional impacts on watercourse habitats that will exacerbate this impact.		
<b>Residual Impacts:</b>		
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**

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.

Extent: The impact will occur at the site of the proposed powerline, but could potentially spread into the surrounding landscape, depending on the alien species that could potentially invade the site. The impact will therefore be evaluated at a scale of site and surroundings.

Duration: The impact will occur for the duration of the operation of the facility, which will be 20 years or more. This is long-term.

Magnitude: The impact is likely to be low and may result in a slight impact on processes.

Probability: It is assessed as probable that this impact will occur in the absence of control measures.

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 to avoid establishment of a soil seed bank. An ongoing monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

<b>Nature: Establishment and spread of declared weeds and alien invader plants</b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	Site & surroundings (2)	Site & surroundings (2)

<b>Duration</b>	long-term (4)	long-term (4)
<b>Magnitude</b>	low (4)	small (2)
<b>Probability</b>	probable (4)	improbable (2)
<b>Significance</b>	<b>medium (40)</b>	<b>low (16)</b>
<b>Status (positive or negative)</b>	negative	negative
<b>Reversibility</b>	Reversible	Reversible
<b>Irreplaceable loss of resources?</b>	Yes	Yes
<b>Can impacts be mitigated?</b>	To some degree	
<b>Mitigation:</b>		
<ul style="list-style-type: none"> <li>(1) keep disturbance of indigenous vegetation to a minimum</li> <li>(2) rehabilitate disturbed areas as quickly as possible</li> <li>(3) do not translocate soil stockpiles from areas with alien plants</li> <li>(4) control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove</li> <li>(5) establish an ongoing monitoring programme to detect and quantify any aliens that may become established</li> </ul>		
<b>Cumulative impacts:</b>		
Soil erosion, habitat loss, damage to wetlands may all lead to additional impacts that will exacerbate this impact.		
<b>Residual Impacts:</b>		
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.

## Access roads

There is a single access road to the eastern side of the site (Figure 6). This links to the national road that runs past the eastern side of the site. The access road is primarily through previously altered habitats.

### **Impact 1: Loss or fragmentation of indigenous natural vegetation**

The vegetation types on site is Northern Upper Karoo, which is classified as Least Threatened. Terrestrial vegetation on site is therefore not considered to be of high conservation value. Most of the access road is through previously disturbed areas and along an existing road.

Extent: The impact will occur at the site of the proposed access roads. The construction of the access roads potentially affects a very small proportion of natural vegetation on site and is scored as local.

Duration: The impact will occur during construction, but will be permanent.

Magnitude: At a local scale, the impact is likely to result in no impact on processes, which is scored as minor.

Probability: According to the provided layout, which indicates that the main access road will occur in the position of an existing track, it is probable that the impact will occur.

#### Mitigation measures:

1. Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint/servitude of the access road.

**Nature: Loss of habitat within indigenous natural vegetation types**

	Without mitigation	With mitigation
<b>Extent</b>	local (1)	local (1)
<b>Duration</b>	permanent (5)	permanent (5)
<b>Magnitude</b>	minor (2)	minor (1)
<b>Probability</b>	probable (3)	probable (3)
<b>Significance</b>	<b>low (24)</b>	<b>low (21)</b>
<b>Status (positive or negative)</b>	negative	negative
<b>Reversibility</b>	Not reversible	Not reversible
<b>Irreplaceable loss of resources?</b>	Yes	Yes
<b>Can impacts be mitigated?</b>	Only to a small extent	
<b>Mitigation:</b>		
(1) Avoid unnecessary impacts on natural vegetation surrounding the access roads. Impacts should be contained, as much as possible, within the footprint of the infrastructure.		
<b>Cumulative impacts:</b>		
None.		
<b>Residual Impacts:</b>		
Some loss of this vegetation type is likely to occur, but it is a very small proportion of the site.		

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

#### **Impact 5: Loss of habitat for protected animals**

There are two protected mammal species where individuals could be dependent on habitats on site, the Southern African Hedgehog and the Giant Bullfrog. The hedgehog may occur as a small number of individuals on site and the bullfrog may occur within the small pan to the south-east of the PV array. The access road occupies a very small area of habitat that may be suitable for these species and it is considered highly unlikely that they will be affected. Most of the access road is through previously disturbed areas. This potential impact is therefore not applicable to this infrastructure component and is scored as having zero significance.

#### **Impact 7: Establishment and spread of declared weeds and alien invader 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.

**Extent:** The impact will occur at the site of the proposed access road, but could potentially spread into the surrounding landscape, depending on the alien species that could potentially invade the site. The impact will therefore be evaluated at a scale of site and surroundings.

**Duration:** The impact will occur for the duration of the operation of the facility, which will be 20 years or more. This is long-term.

**Magnitude:** The impact is likely to be small and will not result in a significant impact on processes.

**Probability:** It is assessed as probable that this impact will occur in the absence of control measures.

**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 to avoid establishment of a soil seed bank. An ongoing monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

<b>Nature: Establishment and spread of declared weeds and alien invader plants</b>		
	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	Site & surroundings (2)	Site & surroundings (2)
<b>Duration</b>	long-term (4)	long-term (4)
<b>Magnitude</b>	small (3)	small (2)
<b>Probability</b>	probable (4)	improbable (2)
<b>Significance</b>	<b>medium (36)</b>	<b>low (16)</b>
<b>Status (positive or negative)</b>	negative	negative
<b>Reversibility</b>	Reversible	Reversible
<b>Irreplaceable loss of resources?</b>	Yes	Yes
<b>Can impacts be mitigated?</b>	To some degree	
<b>Mitigation:</b>		
<ul style="list-style-type: none"> <li>(1) keep disturbance of indigenous vegetation to a minimum</li> <li>(2) rehabilitate disturbed areas as quickly as possible</li> <li>(3) do not translocate soil stockpiles from areas with alien plants</li> <li>(4) control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove</li> <li>(5) establish an ongoing monitoring programme to detect and quantify any aliens that may become established</li> </ul>		
<b>Cumulative impacts:</b>		
Soil erosion, habitat loss, damage to wetlands may all lead to additional impacts that will exacerbate this impact.		
<b>Residual Impacts:</b>		
Will probably be very low if control measures are effectively applied		

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

## DISCUSSION AND CONCLUSIONS

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

Local factors that may lead to parts of the study area having elevated ecological sensitivity are the presence of low rocky outcrops that are habitat similar to that in which a Near Threatened plant species occurs and the presence of drainage areas and a small pan.

There are no threatened animal species of potential concern for the site, although four threatened bird species have a distribution that includes the site. The site is not considered to be important habitat for these species. There are two animal species protected according to National legislation that could occur on site and may be affected by loss of habitat, the South African Hedgehog and the Giant Bullfrog.

There are two protected tree species that occurs in the area, *Boscia albitrunca* (shepherd's tree) and *Acacia erioloba* (camel thorn), but neither of these occur on site.

There is one Near Threatened plant species that has been previously recorded on site. This is the small succulent, *Lithops lesliei* subsp. *lesliei*. The plant occurs in arid grasslands, usually in rocky places, growing under the protection of forbs and grasses. On site, it has been recorded in the low rocky outcrop adjacent to the homestead, which is not affected by the proposed infrastructure. There are other low rocky outcrops on site with similar habitat in which this species could occur, but the species was not found in these areas.

The study area is in a mostly natural condition, except for an area of cultivation in the centre of the site that takes up approximately a quarter of the area of the site. Degraded and transformed areas on site are classified as having low ecological sensitivity and conservation value. Other natural areas are classified as having medium sensitivity and specific habitats of concern are classified as having medium-high (low rocky outcrops) or high (watercourses) sensitivity and conservation value.

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

1. Loss or fragmentation of indigenous natural vegetation
2. Impacts on threatened or near threatened plant species
3. Impacts on protected tree species
4. Impacts on threatened animals
5. Impacts on protected animals
6. Impacts on watercourses, drainage areas and pans
7. Establishment and spread of declared weeds and alien invader plants

Impacts were assessed after collection of relevant data in the field. A summary of the significance of impacts before and after mitigation is given in Table 4 below. This shows that the potential impact on natural vegetation by the PV solar arrays is the only impact with a significance of "medium" after mitigation. This significance score is due to the fact that the impact will be permanent and will definitely occur. All other potential impacts are either "low" or can be reduced to "low" with mitigation. Impacts on threatened plants, threatened animals and protected trees were of zero significance for this project.

## **Conclusion**

The overall impacts of this proposed project are of low or moderate significance. With mitigation measures implemented, it should be possible to reduce all negative impacts to low significance, except for the significance of impacts on natural vegetation, which remains medium. Taking this assessment into consideration, this project is supported from an ecological point of view.

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

Impact	PV power plant		Overhead powerlines		Access roads	
	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation
<b>1. vegetation</b>	medium (50)	medium (45)	low (18)	low (15)	low (24)	low (21)
<b>5. protected animals: hedgehog</b>	low (20)	low (16)	zero (0)	zero (0)	zero (0)	zero (0)
<b>bulfrog</b>	low (10)	low (8)				
<b>6. watercourses</b>	medium (40)	low (18)	medium (30)	low (8)	zero (0)	zero (0)
<b>7. alien plants</b>	medium (40)	low (16)	medium (40)	low (16)	medium (36)	low (16)

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

## MANAGEMENT PLAN

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

### Impacts on protected animals

OBJECTIVE: Limit impacts on protected animals		
Project component/s	Any infrastructure or activity that will result in disturbance to habitat suitable for protected animal species or to individuals of protected animal species	
Potential Impact	Loss of habitat suitable for protected animals or direct loss of individuals of protected animals	
Activity/risk source	Construction, operation, environmental management	
Mitigation: Target/Objective	Target: no significant impacts on individuals of protected animal species within project control area Time period: construction, operation	
Mitigation: Action/control	Responsibility	Timeframe
(1) Ensure that construction impacts are contained within the footprint of the proposed infrastructure and do not spread into surrounding natural areas. (2) Educate personnel as to the protected status of species that could occur on site and the requirement that no individuals of these species may be killed. (3) If any individuals will be affected by the proposed pv arrays, a permit is required according to the National Environmental Management: Biodiversity Act.	Construction team, management (environmental officer),	construction, operation
Performance Indicator	No loss of individuals of protected animal species	
Monitoring	<ul style="list-style-type: none"> <li>Mortality of individuals of Southern African Hedgehog or Giant Bullfrog</li> </ul>	

## Impacts due to alien invasive plants

### OBJECTIVE: Control alien invasive plants

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

Mitigation: Action/control	Responsibility	Timeframe
(1) avoid creating conditions in which alien plants may become established: <ol style="list-style-type: none"> <li>a. keep disturbance of indigenous vegetation to a minimum</li> <li>b. rehabilitate disturbed areas as quickly as possible</li> <li>c. do not import soil from areas with alien plants</li> </ol> (2) establish an ongoing 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	<ul style="list-style-type: none"> <li>• Ongoing monitoring of area by environmental control officer during construction</li> <li>• Ongoing monitoring of area by environmental manager during operation</li> <li>• 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.</li> </ul>

## Impacts on indigenous natural vegetation

OBJECTIVE: Control loss of indigenous natural vegetation		
Project component/s	Any infrastructure or activity that will result in disturbance to natural areas	
Potential Impact	Loss of indigenous natural vegetation due to construction activities	
Activity/risk source	Construction	
Mitigation: Target/Objective	Target: minimal loss of natural vegetation Time period: construction	
Mitigation: Action/control	Responsibility	Timeframe
(1) The construction impacts must be contained to the footprint of the infrastructure. (2) Rehabilitate any disturbed areas immediately to stabilize landscapes.	Construction team, management (environmental officer),	construction
Performance Indicator	No loss of natural vegetation outside planned footprint of infrastructure.	
Monitoring	<ul style="list-style-type: none"> <li>None</li> </ul>	

## 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
<p>(1) Construction impacts must be limited to the direct footprint of the infrastructure and should not be permitted to spread into surrounding areas, such as watercourses.</p> <p>(2) Ensure that powerline tower structures are placed outside watercourses (a minimum of 50 m away)</p> <p>(3) 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.</p>	Construction team, management, environmental control officer	Planning, construction

Performance Indicator	No permanent infrastructure within watercourses
Monitoring	<ul style="list-style-type: none"> <li>None</li> </ul>

## REFERENCES:

- ALEXANDER, G. & MARAIS, J. 2007. A guide to the reptiles of southern Africa. Struik, Cape Town.
- BARNES, K.N. (ed.) (2000) The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.
- BRANCH, W.R. (1988) South African Red Data Book—Reptiles and Amphibians. South African National Scientific Programmes Report No. 151.
- CHITTENDEN, H. 2007. Roberts bird guide: a comprehensive field guide to over 950 bird species in southern Africa. John Voelcker Bird Book Fund, Cape Town.
- DENT, M.C., LYNCH, S.D. & SCHULZE, R.E. 1989. Mapping mean annual and other rainfall statistics in southern Africa. Department of Agricultural Engineering, University of Natal. ACRU Report No. 27. Massachusetts: Clark University.
- DRIVER, A., MAZE, K., ROUGET, M., LOMBARD, A.T., NEL, J., TURPIE, J.K., COWLING, R.M., DESMET, P., GOODMAN, P., HARRIS, J., JONAS, Z., REYERS, B., SINK, K and STRAUSS, T. 2005. National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia 17. South African National Biodiversity Institute, Pretoria.
- DU PREEZ, L. & CARRUTHERS, V. 2009. A complete guide to the frogs of southern Africa. Random House Struik, Cape Town.
- FAIRBANKS, D.H.K., THOMPSON, M.W., VINK, D.E., NEWBY, T.S., VAN DEN BERG, H.M & EVERARD, D.A. 2000. The South African Land-Cover Characteristics Database: a synopsis of the landscape. *S.Afr.J.Science* 96: 69-82.
- FRIEDMANN, Y. & DALY, B. (eds.) 2004. The Red Data Book of the Mammals of South Africa: A Conservation Assessment: CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa.
- GERMISHUIZEN, G., MEYER, N.L., STEENKAMP, Y and KEITH, M. (eds.) (2006). A checklist of South African plants. Southern African Botanical Diversity Network Report No. 41, SABONET, Pretoria.
- HALLAM, S.L. 2011. Heterothermy and seasonal patterns of metabolic rate in the southern African hedgehog (*Atelerix frontalis*). MSc thesis, Nelson Mandela Metropolitan University, Port Elizabeth.
- HARTMANN, M.O. 1988. The soils of the Eastern Cape. In: M.N. Bruton & F.W. Gess. (ed.) Towards an environmental plan for the Eastern Cape. Rhodes University, Grahamstown.
- HENNING, S.F. & HENNING, G.A. 1989. South African Red Data Book - Butterflies. *South African National Scientific Programmes* No. 158, Foundation for Research Development, CSIR, Pretoria.
- IUCN (2001). *IUCN Red Data List categories and criteria: Version 3.1*. IUCN Species Survival Commission: Gland, Switzerland.
- MACVICAR, C. N., SCOTNEY, D. M. SKINNER, T. E. NIEHAUS, H. S. & LOUBSER, J. H., 1974. A classification of land (climate, terrain form, soil) primarily for rainfed agriculture. *S. Afr. J. Agric. Extension*, 3(3): 1-4.
- MARAIS, J. 2004. A complete guide to the snakes of southern Africa. Struik Publishers, Cape Town.
- MILLS, G. & HES, L. 1997. The complete book of southern African mammals. Struik Publishers, Cape Town.
- MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. and KLOEPFER, D. (eds.) 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington, DC.
- MONADJEM, A., TAYLOR, P.J., COTTERILL, E.P.D. & SCHOEMAN, M.C. 2010. Bats of southern and central Africa. Wits University Press, Johannesburg.
- MUCINA, L, BREDEKAMP, G.J., **HOARE, D.B** & MCDONALD, D.J. 2000. A National Vegetation Database for South Africa *South African Journal of Science* 96: 1–2.

- MUCINA, L. AND RUTHERFORD, M.C. (editors) (2006). Vegetation map of South Africa, Lesotho and Swaziland: an illustrated guide. *Strelitzia* 19, National Botanical Institute, Pretoria.
- MUCINA, L. AND RUTHERFORD, M.C. (editors) 2006. Vegetation map of South Africa, Lesotho and Swaziland: an illustrated guide. *Strelitzia* 19, South African National Biodiversity Institute, Pretoria.
- MUCINA, L., RUTHERFORD, M.C. AND POWRIE, I.W. (editors) 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 SCALE SHEET MAPS South African National Biodiversity Institute, Pretoria.
- MUCINA, L., RUTHERFORD, M.C., **HOARE, D.B.** & POWRIE, L.W. 2003. VegMap: The new vegetation map of South Africa, Lesotho and Swaziland. In: Pedrotti, F. (ed.) Abstracts: Water Resources and Vegetation, 46<sup>th</sup> Symposium of the International Association for Vegetation Science, June 8 to 14 – Napoli, Italy.
- MUCINA, L., RUTHERFORD, M.C., PALMER, A.R., MILTON, S.J., SCOTT, L., VAN DER MERWE, B., **HOARE, D.B.**, BEZUIDENHOUT, H., VLOK, J.H.J., EUSTON-BROWN, D.I.W., POWRIE, L.W. & DOLD, A.P. 2006. *Nama-Karoo Biome*. In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- MUELLER-DOMBOIS, D. AND ELLENBERG, H. 1974. Aims and methods of vegetation ecology. Wiley, New York.
- PASSMORE, N.I. & CARRUTHERS, V.C. (1995) South African Frogs; a complete guide. Southern Book Publishers and Witwatersrand University Press. Johannesburg.
- RUTHERFORD, M.C. & WESTFALL, R.H. (1994). Biomes of southern Africa: an objective categorization. *Memoirs of the Botanical Survey of South Africa* No. 63.
- TOLLEY, K. & BURGER, M. 2007. Chameleons of southern Africa. Struik Publishers, Cape Town.

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

Sources: South African National Biodiversity Institute in Pretoria.

Family	Taxon	Status	Habitat	Likelihood of occurrence on site
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
MESEMBRYANTHEMACEAE	Lithops lesliei subsp. lesliei	Near Threatened	Arid grasslands, usually in rocky places, growing under the protection of forbs and grasses	DEFINITE

\* 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 <sup>1</sup>	National status	Global status <sup>2</sup>	Likelihood of occurrence
Black rhinoceros	<i>Diceros bicornis bicornis</i>	Wide variety of habitats, but currently only occurs in game reserves.	CR	CR	<b>NONE</b> , only occurs in game reserves
Brown hyaena	<i>Hyaena brunnea</i>	Savana, shrubland, grassland, urban areas.	NT	NT	<b>HIGH</b> , overall geographical distribution includes this area, habitat is suitable.
Geoffroy's horseshoe bat	<i>Rhinolophus clivosus</i>	Caves and subterranean habitats; fynbos, shrubland, grassland, succulent and Nama-karoo; insectivore	NT	LC	<b>MEDIUM</b> , overall geographical distribution includes this area, general habitat is suitable - presence of caves unknown, but improbable.
Natal long-fingered bat	<i>Miniopterus natalensis</i>	Caves and sub-terranean habitats in Fynbos, savanna, woodland, succulent and Nama Karoo, grassland; cave-dwelling aerial insectivore.	NT	LC	<b>MEDIUM</b> , overall geographical distribution includes this area, general habitat is suitable - presence of caves unknown, but improbable.
Honey badger	<i>Mellivora capensis</i>	Wide variety of habitats. Probably only in natural habitats.	NT	LC	<b>HIGH</b> , overall geographical distribution includes this area, habitat is suitable.
Spotted-necked otter	<i>Lutra maculicollis</i>	Water storage areas, rivers, streams, creeks, wetlands.	NT	LC	<b>LOW</b> , no suitable habitat on site.
African weasel	<i>Poecilogale albinucha</i>	Moist grassland or woodland with more than 700 mm rainfall per year and where flourishing populations of small rodents occur. Grassland, scrub woodland.	DD	LC	<b>MEDIUM</b> , overall geographical distribution includes this area, general habitat is suitable

<sup>1</sup>Distribution and national status according to Friedmann & Daly 2004.

<sup>2</sup>Global status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. ([www.iucnredlist.org](http://www.iucnredlist.org)). Downloaded on 23 June 2011.

**AMPHIBIANS**

Common name	Species	Habitat	Status	Likelihood of occurrence
Giant Bullfrog	<i>Pyxicephalus adspersus</i>	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 <sup>1</sup> LC <sup>2</sup> Protected (NEMBA)	<b>MEDIUM</b> , within known distribution range, suitable habitat possibly occurs on site (small pan with grassland).

<sup>1</sup>Status according to Minter et al. 2004.

<sup>2</sup>Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. ([www.iucnredlist.org](http://www.iucnredlist.org)). Downloaded on 11 September 2010.

**REPTILES**

Common name	Species	Habitat	Status <sup>3</sup>	Likelihood of occurrence
None				

<sup>3</sup>Distribution according to Alexander & Marais 2007.

<sup>4</sup>Status according to Alexander & Marais 2007.

**BIRDS**

Common name	Species	Habitat	Status	Importance of site for species
Black Stork	<i>Ciconia nigra</i>	Feeds in or around marshes, dams, rivers and estuaries; breeds in mountainous regions. Uncommon resident in study area.	NT Protected (NEMBA)	LOW, breeding, MEDIUM,

Common name	Species	Habitat	Status	Importance of site for species
				foraging
Cape Vulture	<i>Gyps coprotheres</i>	Mostly mountainous country, or open country with inselbergs and escarpments; less commonly in savanna or desert. Uncommon resident in study area.	VU Protected (NEMBA)	LOW, breeding, LOW, foraging
Greater Flamingo	<i>Phoenicopterus ruber</i>	Large bodies of shallow water, both inland and coastal; saline and brackish waters preferred. Common resident in study area.	NT	LOW, breeding, LOW, foraging
Greater Painted Snipe	<i>Rostratula benghalensis</i>	Marshes, swamps, edges of lakes, dams, ponds and streams, with marginal vegetation. Uncommon resident in study area.	NT	LOW, breeding, LOW, foraging
Kori Bustard	<i>Ardeotis kori</i>	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 resident in study area.	VU <sup>1</sup> LC <sup>2</sup> Protected (NEMBA)	LOW, breeding, MEDIUM, foraging
Lanner Falcon	<i>Falco biarmicus</i>	Widespread species, occurring in Afrotropics, Middle East and western Palearctic. Occurs in mountains or open country from semidesert to woodland and agricultural land; also cities (Durban, Harare). Common resident in study area.	NT	LOW, breeding, MEDIUM, foraging
Lappetfaced Vulture	<i>Torgos tracheliotus</i>	Savanna to desert. Roosts in trees at night. Common resident in study area.	VU Protected (NEMBA)	LOW, breeding, LOW, foraging
Lesser Flamingo	<i>Phoenicopterus minor</i>	Larger brackish or saline inland and coastal waters. Common resident in study area.	NT	LOW, breeding, LOW, foraging
Lesser Kestrel	<i>Falco naumanni</i>	Open grassveld, mainly on highveld, usually near towns or farms. Common non-breeding migrant in study area.	VU	LOW, breeding, MEDIUM, foraging
Ludwig's Bustard	<i>Neotis ludwigii</i>	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 resident in study area.	VU <sup>1</sup> EN <sup>2</sup> Protected (NEMBA)	LOW, breeding, MEDIUM, foraging
Marabou Stork	<i>Leptoptilos crumeniferus</i>	Open to semi-arid woodland, bushveld, fishing villages, rubbish tips, lake shores. Uncommon resident in study area.	NT	LOW, breeding, MEDIUM, foraging
Martial Eagle	<i>Polemaetus bellicosus</i>	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. Common resident in study area.	VU <sup>1</sup> NT <sup>2</sup> Protected (NEMBA)	LOW, breeding, MEDIUM, foraging
Peregrine Falcon	<i>Falco peregrinus</i>	Cliffs, mountains, steep gorges; may hunt over open grassland, farmland and forests; rarely enters cities to hunt pigeons. Uncommon non-breeding migrant in study area.	NT Protected (NEMBA)	LOW, breeding, MEDIUM, foraging
Secretarybird	<i>Sagittarius serpentarius</i>	Widespread across South Africa, occurring in savanna and open grassland from coastal regions to high altitudes, but avoids thick bush and forest. Sensitive	NT	LOW, breeding, MEDIUM,

Common name	Species	Habitat	Status	Importance of site for species
		to disturbance and high human population numbers - higher numbers usually found in conservation areas. Common resident in study area.		foraging
Tawny Eagle	<i>Aquila rapax</i>	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 <sup>1</sup> NT <sup>2</sup> Protected (NEMBA)	LOW, breeding, LOW, foraging
White-backed Vulture	<i>Gyps africanus</i>	Savanna and bushveld. Roosts in trees at night, often rests on ground by day; drinks and bathes regularly at waterholes. Uncommon resident in study area.	VU <sup>1</sup> NT <sup>2</sup> Protected (NEMBA)	LOW, breeding, LOW, foraging
Yellow-billed Stork	<i>Mycteria ibis</i>	Mainly inland waters; rivers, dams, pans, floodplains, marshes; less often estuaries. Uncommon non-breeding migrant in study area.	NT	LOW, breeding, LOW, foraging

<sup>1</sup>Status according to Barnes 2000.

<sup>2</sup>Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. ([www.iucnredlist.org](http://www.iucnredlist.org)). Downloaded on 11 September 2010.

### Appendix 3: List of protected tree species (National Forests Act).

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

*Boscia albitrunca* and *Acacia erioloba* 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.**

(Species from quarter degree grid in which the site is located as well as surrounding grids in which similar vegetation is found)

*Abutilon austro-africanum* Hochr.  
*Acacia erioloba* E.Mey.  
*Acacia haematoxylon* Willd.  
*Acacia haematoxylon* Willd.  
*Acacia hebeclada* DC. subsp. *hebeclada*  
*Acacia karroo* Hayne  
*Acacia mellifera* (Vahl) Benth. subsp. *detinens* (Burch.) Brenan  
*Acacia tortilis* (Forssk.) Hayne subsp. *heteracantha* (Burch.) Brenan  
*Acrotome inflata* Benth.  
*Aerva leucura* Moq.  
*Albuca tortuosa* Baker  
*Aloe broomii* Schönland var. *broomii*  
*Aloe claviflora* Burch.  
*Aloe grandidentata* Salm-Dyck  
*Alternanthera pungens* Kunth  
*Amaranthus dinteri* Schinz subsp. *dinteri* var. *a*  
*Amaranthus praetermissus* Brenan  
*Amaranthus standleyanus* Parodi ex Covas  
*Amellus tridactylus* DC. subsp. *arenarius* (S.Moore) Rommel  
*Amellus tridactylus* DC. subsp. *tridactylus*  
*Amphiglossa triflora* DC.  
*Antheophora pubescens* Nees  
*Antizoma angustifolia* (Burch.) Miers ex Harv.  
*Aptosimum indivisum* Burch. ex Benth.  
*Aptosimum marlothii* (Engl.) Hiern  
*Aptosimum spinescens* (Thunb.) F.E.Weber  
*Arctotis venusta* Norl.  
*Aristida adscensionis* L.  
*Aristida congesta* Roem. & Schult. subsp. *barbicollis* (Trin. & Rupr.) De Winter  
*Aristida congesta* Roem. & Schult. subsp. *congesta*  
*Aristida meridionalis* Henrard  
*Aristida scabrivalvis* Hack. subsp. *scabrivalvis*  
*Aristida stipitata* Hack. subsp. *graciliflora* (Pilg.) Melderis  
*Aristida vestita* Thunb.  
*Asclepias meyeriana* (Schltr.) Schltr.  
*Asparagus cooperi* Baker  
*Asparagus cooperi* Baker  
*Asparagus exuvialis* Burch. forma *exuvialis*  
*Asparagus glaucus* Kies  
*Asparagus laricinus* Burch.  
*Asparagus mucronatus* Jessop  
*Asparagus suaveolens* Burch.  
*Atriplex cinerea* Poir. subsp. *bolusii* (C.H.Wright) Aellen var. *genuina* Aellen  
*Atriplex lindleyi* Moq. subsp. *inflata* (F.Muell.) Paul G.Wilson  
*Atriplex nummularia* Lindl. subsp. *nummularia*  
*Atriplex semibaccata* R.Br. var. *appendiculata* Aellen  
*Barleria irritans* Nees  
*Barleria rigida* Nees  
*Berkheya pinnatifida* (Thunb.) Thell. subsp. *pinnatifida*  
*Brachiaria eruciformis* (Sm.) Griseb.  
*Brachiaria marlothii* (Hack.) Stent  
*Brachystelma burchellii* (Decne.) Peckover var. *burchellii*

Brachystelma foetidum Schltr.  
 Bromus catharticus Vahl  
 Bromus diandrus Roth  
 Bulbine abyssinica A.Rich.  
 Bulbine favosa (Thunb.) Schult. & Schult.f  
 Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines  
 Calobota cuspidosa (Burch.) Boatwr. & B.-E.van Wyk  
 Cenchrus ciliaris L.  
 Cenchrus incertus M.A.Curtis  
 Chaenostoma halimifolium Benth.  
 Chascanum pinnatifidum (L.f.) E.Mey. var. pinnatifidum  
 Chasmatophyllum musculinum (Haw.) Dinter & Schwantes  
 Cheilanthes eckloniana (Kunze) Mett.  
 Cheilanthes hirta Sw. var. hirta  
 Chenopodium album L.  
 Chenopodium ambrosioides L.  
 Chenopodium glaucum L.  
 Chenopodium mucronatum Thunb.  
 Chloris virgata Sw.  
 Chrysocoma ciliata L.  
 Chrysopogon serrulatus Trin.  
 Cineraria aspera Thunb.  
 Citrullus lanatus (Thunb.) Matsum. & Nakai  
 Cladophascum gymnomitrioides (Dixon) Dixon  
 Cleome angustifolia Forssk. subsp. diandra (Burch.) Kers  
 Cleome gynandra L.  
 Cleome monophylla L.  
 Cleome rubella Burch.  
 Coccinia sessilifolia (Sond.) Cogn.  
 Commelina africana L. var. barberae (C.B.Clarke) C.B.Clarke  
 Commelina africana L. var. lancispatha C.B.Clarke  
 Commicarpus pentandrus (Burch.) Heimerl  
 Convolvulus boedeckerianus Peter  
 Convolvulus dregeanus Choisy  
 Convolvulus multifidus Thunb.  
 Convolvulus ocellatus Hook.f. var. ocellatus  
 Convolvulus sagittatus Thunb.  
 Conyza bonariensis (L.) Cronquist  
 Crassula corallina Thunb. subsp. corallina  
 Crotalaria griquensis L.Bolus  
 Crotalaria sphaerocarpa Perr. ex DC. subsp. sphaerocarpa  
 Cucumis africanus L.f.  
 Cucumis heptadactylus Naudin  
 Cucumis myriocarpus Naudin subsp. leptodermis (Schweick.) C.Jeffrey & P.Halliday  
 Cucumis myriocarpus Naudin subsp. myriocarpus  
 Cucumis zeyheri Sond.  
 Cucumis zeyheri Sond.  
 Cullen tomentosum (Thunb.) J.W.Grimes  
 Cymbopogon pospischilii (K.Schum.) C.E.Hubb.  
 Cynanchum orangeanum (Schltr.) N.E.Br.  
 Cynodon dactylon (L.) Pers.  
 Cynodon incompletus Nees  
 Cynodon transvaalensis Burt Davy  
 Cyperus bellus Kunth  
 Cyperus indecorus Kunth var. decurvatus (C.B.Clarke) Kük.  
 Cyperus laevigatus L.  
 Cyperus longus L. var. tenuiflorus (Rottb.) Boeck.

*Cyperus marginatus* Thunb.  
*Cyperus rotundus* L. subsp. *rotundus*  
*Cyperus usitatus* Burch.  
*Datura ferox* L.  
*Dichilus gracilis* Eckl. & Zeyh.  
*Diclis petiolaris* Benth.  
*Dicoma capensis* Less.  
*Dicoma macrocephala* DC.  
*Digitaria argyrograpta* (Nees) Stapf  
*Digitaria eriantha* Steud.  
*Diospyros austro-africana* De Winter var. *microphylla* (Burch.) De Winter  
*Diospyros lycioides* Desf. subsp. *lycioides*  
*Dipcadi glaucum* (Burch. ex Ker Gawl.) Baker  
*Dipcadi gracillimum* Baker  
*Dipcadi marlothii* Engl.  
*Ehretia alba* Retief & A.E.van Wyk  
*Ehretia rigida* (Thunb.) Druce subsp. *rigida*  
*Elephantorrhiza elephantina* (Burch.) Skeels  
*Enneapogon cenchroides* (Licht. ex Roem. & Schult.) C.E.Hubb.  
*Enneapogon desvauxii* P.Beauv.  
*Enneapogon scaber* Lehm.  
*Enneapogon scoparius* Stapf  
*Eragrostis annulata* Rendle ex Scott-Elliot  
*Eragrostis bicolor* Nees  
*Eragrostis biflora* Hack. ex Schinz  
*Eragrostis cilianensis* (All.) Vignolo ex Janch.  
*Eragrostis curvula* (Schrad.) Nees  
*Eragrostis echinochloidea* Stapf  
*Eragrostis homomalla* Nees  
*Eragrostis homomalla* Nees  
*Eragrostis lehmanniana* Nees var. *chaunantha* (Pilg.) De Winter  
*Eragrostis lehmanniana* Nees var. *lehmanniana*  
*Eragrostis mexicana* (Hornem.) Link subsp. *virescens* (J.Presl.) S.D.Koch & Sánchez Vega  
*Eragrostis micrantha* Hack.  
*Eragrostis nindensis* Ficalho & Hiern  
*Eragrostis obtusa* Munro ex Ficalho & Hiern  
*Eragrostis porosa* Nees  
*Eragrostis procumbens* Nees  
*Eragrostis superba* Peyr.  
*Eragrostis tef* (Zuccagni) Trotter  
*Eragrostis trichophora* Coss. & Durieu  
*Eragrostis truncata* Hack.  
*Eragrostis x pseud-obtusa* De Winter  
*Eriocephalus karoocicus* M.A.N.Müll.  
*Erucastrum griquense* (N.E.Br.) O.E.Schulz  
*Eucalyptus camaldulensis* Dehnh.  
*Euclea crispa* (Thunb.) Gürke subsp. *ovata* (Burch.) F.White  
*Euphorbia fusca* Marloth  
*Euphorbia inaequilatera* Sond. var. *inaequilatera*  
*Euphorbia mixta* N.E.Br.  
*Euphorbia rectirama* N.E.Br.  
*Euphorbia serpens* Kunth  
*Euryops subcarnosus* DC. subsp. *vulgaris* B.Nord.  
*Eustachys paspaloides* (Vahl) Lanza & Mattei  
*Fagopyrum esculentum* Moench  
*Felicia fascicularis* DC.  
*Felicia muricata* (Thunb.) Nees subsp. *cinerascens* Grau

*Felicia muricata* (Thunb.) Nees subsp. *muricata*  
*Felicia ovata* (Thunb.) Compton  
*Fingerhuthia africana* Lehm.  
*Fockea angustifolia* K.Schum.  
*Fumaria parviflora* Lam. var. *parviflora*  
*Galenia exigua* Adamson  
*Galenia exigua* Adamson  
*Galenia filiformis* (Thunb.) N.E.Br.  
*Galenia pubescens* (Eckl. & Zeyh.) Druce  
*Gazania krebsiana* Less. subsp. *serrulata* (DC.) Roessler  
*Geigeria filifolia* Mattf.  
*Gisekia pharnacioides* L. var. *pharnacioides*  
*Gleditsia triacanthos* L.  
*Gnaphalium filagopsis* Hilliard & B.L.Burt  
*Gnidia polycephala* (C.A.Mey.) Gilg  
*Gomphocarpus fruticosus* (L.) Aiton f. subsp. *fruticosus*  
*Gomphocarpus tomentosus* Burch. subsp. *tomentosus*  
*Goniomitrium africanum* (Müll.Hal.) Broth.  
*Grewia flava* DC.  
*Haemanthus humilis* Jacq. subsp. *humilis*  
*Harpagophytum procumbens* (Burch.) DC. ex Meisn. subsp. *procumbens*  
*Haworthia venosa* (Lam.) Haw. subsp. *tessellata* (Haw.) M.B.Bayer  
*Helichrysum arenicola* M.D.Hend.  
*Helichrysum argyrosphaerum* DC.  
*Helichrysum caespititium* (DC.) Harv.  
*Helichrysum cerastioides* DC. var. *cerastioides*  
*Helichrysum lineare* DC.  
*Helichrysum zeyheri* Less.  
*Heliophila digitata* L.f.  
*Heliophila minima* (Stephens) Marais  
*Heliophila trifurca* Burch. ex DC.  
*Heliotropium ciliatum* Kaplan  
*Heliotropium curassavicum* L.  
*Heliotropium lineare* (A.DC.) Gürke  
*Heliotropium nelsonii* C.H.Wright  
*Hermannia argillicola* Dinter ex Friedr.-Holzh.  
*Hermannia bicolor* Engl. & Dinter  
*Hermannia bryoniifolia* Burch.  
*Hermannia burkei* Burt Davy  
*Hermannia cernua* Thunb.  
*Hermannia comosa* Burch. ex DC.  
*Hermannia erodioides* (Burch. ex DC.) Kuntze  
*Hermannia jacobefolia* (Turcz.) R.A.Dyer  
*Hermannia linearifolia* Harv.  
*Hermannia tomentosa* (Turcz.) Schinz ex Engl.  
*Hermestaedtia odorata* (Burch.) T.Cooke var. *odorata*  
*Hertia kraussii* (Sch.Bip.) Fourc.  
*Hertia pallens* (DC.) Kuntze  
*Heteropogon contortus* (L.) Roem. & Schult.  
*Hibiscus marlothianus* K.Schum.  
*Hibiscus pusillus* Thunb.  
*Hibiscus trionum* L.  
*Hirpicium echinus* Less.  
*Indigastrum argyraeum* (Eckl. & Zeyh.) Schrire  
*Indigofera alternans* DC. var. *alternans*  
*Ipomoea bolusiana* Schinz  
*Jamesbrittenia albiflora* (I.Verd.) Hilliard

*Jamesbrittenia atropurpurea* (Benth.) Hilliard subsp. *atropurpurea*  
*Jamesbrittenia aurantiaca* (Burch.) Hilliard  
*Juncus rigidus* Desf.  
*Kalanchoe paniculata* Harv.  
*Kedrostis africana* (L.) Cogn.  
*Kohautia cynanchica* DC.  
*Kyllinga alba* Nees  
*Kyphocarpa angustifolia* (Moq.) Lopr.  
*Lactuca inermis* Forssk.  
*Laggera decurrens* (Vahl) Hepper & J.R.I.Wood  
*Lantana rugosa* Thunb.  
*Lapeirousia plicata* (Jacq.) Diels subsp. *plicata*  
*Lasiopogon glomerulatus* (Harv.) Hilliard  
*Ledebouria undulata* (Jacq.) Jessop  
*Lepidium africanum* (Burm.f.) DC. subsp. *divaricatum* (Aiton) Jonsell  
*Leptochloa fusca* (L.) Kunth  
*Lessertia pauciflora* Harv. var. *pauciflora*  
*Leucas capensis* (Benth.) Engl.  
*Limeum aethiopicum* Burm.f. var. *aethiopicum*  
*Limeum fenestratum* (Fenzl) Heimerl var. *fenestratum*  
*Limeum sulcatum* (Klotzsch) Hutch. var. *sulcatum*  
*Lolium multiflorum* x *L. perenne*  
*Lotononis crumanina* Burch. ex Benth.  
*Lotononis curtii* Harms  
*Lycium arenicola* Miers  
*Lycium cinereum* Thunb.  
*Lycium hirsutum* Dunal  
*Lycium horridum* Thunb.  
*Lycium pillifolium* C.H.Wright  
*Lycium schizocalyx* C.H.Wright  
*Massonia jasminiflora* Burch. ex Baker  
*Medicago laciniata* (L.) Mill. var. *laciniata*  
*Medicago sativa* L.  
*Melia azedarach* L.  
*Melinis repens* (Willd.) Zizka subsp. *grandiflora* (Hochst.) Zizka  
*Melinis repens* (Willd.) Zizka subsp. *repens*  
*Melolobium calycinum* Benth.  
*Melolobium candicans* (E.Mey.) Eckl. & Zeyh.  
*Melolobium microphyllum* (L.f.) Eckl. & Zeyh.  
*Menodora africana* Hook.  
*Mestoklema copiosum* N.E.Br. ex Glen  
*Mestoklema tuberosum* (L.) N.E.Br. ex Glen  
*Miscanthus capensis* (Nees) Andersson  
*Monechma incanum* (Nees) C.B.Clarke  
*Moraea pallida* (Baker) Goldblatt  
*Moraea polystachya* (Thunb.) Ker Gawl.  
*Nananthus aloides* (Haw.) Schwantes  
*Nananthus vittatus* (N.E.Br.) Schwantes  
*Nemesia pubescens* Benth. var. *pubescens*  
*Nenax microphylla* (Sond.) T.M.Salter  
*Nerine laticoma* (Ker Gawl.) T.Durand & Schinz  
*Nicotiana glauca* Graham  
*Ocimum americanum* L. var. *americanum*  
*Olea europaea* L. subsp. *africana* (Mill.) P.S.Green  
*Ornithogalum flexuosum* (Thunb.) U. & D.Müll.-Doblies  
*Ornithoglossum vulgare* B.Nord.  
*Oropetium capense* Stapf

*Osteospermum muricatum* E.Mey. ex DC. subsp. *muricatum*  
*Osteospermum spinescens* Thunb.  
*Osyris compressa* (P.J.Bergius) A.DC.  
*Osyris lanceolata* Hochst. & Steud.  
*Oxalis haedulipes* T.M.Salter  
*Oxalis pes-caprae* L. var. *pes-caprae*  
*Panicum coloratum* L. var. *coloratum*  
*Panicum impeditum* Launert  
*Panicum schinzii* Hack.  
*Panicum stapfianum* Fourc.  
*Parkinsonia aculeata* L.  
*Pegolettia retrofracta* (Thunb.) Kies  
*Peliostomum leucorrhizum* E.Mey. ex Benth.  
*Pentarrhinum insipidum* E.Mey.  
*Pentzia calcarea* Kies  
*Pentzia globosa* Less.  
*Pentzia incana* (Thunb.) Kuntze  
*Pentzia lanata* Hutch.  
*Pentzia quinquefida* (Thunb.) Less.  
*Phalaris minor* Retz.  
*Phragmites australis* (Cav.) Steud.  
*Phyllanthus cephalantha* Sond.  
*Phyllanthus maderaspatensis* L.  
*Phyllanthus parvulus* Sond. var. *garipensis* (E.Mey. ex Drège) Radcl.-Sm.  
*Phyllanthus parvulus* Sond. var. *parvulus*  
*Phyllobolus splendens* (L.) Gerbaulet subsp. *pentagonus* (L.Bolus) Gerbaulet  
*Plantago lanceolata* L.  
*Platycarphella parvifolia* (S.Moore) V.A.Funk & H.Rob.  
*Pogonarthria squarrosa* (Roem. & Schult.) Pilg.  
*Pollichia campestris* Aiton  
*Polygala ephedroides* Burch.  
*Polygala seminuda* Harv.  
*Polygala seminuda* Harv.  
*Polypogon monspeliensis* (L.) Desf.  
*Portulaca kermesina* N.E.Br.  
*Prosopis chilensis* (Molina) Stuntz  
*Prosopis glandulosa* Torr. var. *glandulosa*  
*Prosopis glandulosa* Torr. var. *torreyana* (Benson) M.C.Johnst.  
*Prosopis velutina* Wooton  
*Pseudoschoenus inanis* (Thunb.) Oteng-Yeb.  
*Psilocaulon coriarium* (Burch. ex N.E.Br.) N.E.Br.  
*Psilocaulon granulicaule* (Haw.) Schwantes  
*Pteronia glauca* Thunb.  
*Pteronia sordida* N.E.Br.  
*Ptychlobium biflorum* (E.Mey.) Brummitt subsp. *biflorum*  
*Pulicaria scabra* (Thunb.) Druce  
*Radyera urens* (L.f.) Bullock  
*Ranunculus multifidus* Forssk.  
*Raphionacme hirsuta* (E.Mey.) R.A.Dyer  
*Raphionacme velutina* Schltr.  
*Rhigozum obovatum* Burch.  
*Rhigozum trichotomum* Burch.  
*Rhynchosia totta* (Thunb.) DC. var. *totta*  
*Riccia albolimbata* S.W.Arnell  
*Riccia nigrella* DC.  
*Riccia okahandjana* S.W.Arnell  
*Riccia pottsiana* Sim

*Rosenia humilis* (Less.) K.Bremer  
*Rumex lanceolatus* Thunb.  
*Salix mucronata* Thunb. subsp. *mucronata*  
*Salsola aellenii* Botsch.  
*Salsola aphylla* L.f.  
*Salsola calluna* Fenzl ex C.H.Wright  
*Salsola glabrescens* Burt Davy  
*Salsola henriciae* I.Verd.  
*Salsola kalaharica* Botsch.  
*Salsola rabieana* I.Verd.  
*Salsola tuberculata* (Moq.) Fenzl  
*Salvia repens* Burch. ex Benth. var. *repens*  
*Salvia stenophylla* Burch. ex Benth.  
*Schinus molle* L.  
*Schismus barbatus* (Loefl. ex L.) Thell.  
*Schkuhria pinnata* (Lam.) Kuntze ex Thell.  
*Schmidtia kalahariensis* Stent  
*Schmidtia pappophoroides* Steud.  
*Scirpoides dioecus* (Kunth) Browning  
*Searsia erosa* (Thunb.) Moffett  
*Searsia pyroides* (Burch.) Moffett var. *gracilis* (Engl.) Moffett  
*Searsia tridactyla* (Burch.) Moffett  
*Searsia undulata* (Jacq.) T.S.Yi, A.J.Mill. & J.Wen  
*Selago centralis* Hilliard  
*Selago geniculata* L.f.  
*Selago paniculata* Thunb.  
*Selago saxatilis* E.Mey.  
*Senecio consanguineus* DC.  
*Senna italica* Mill. subsp. *arachoides* (Burch.) Lock  
*Sericorema remotiflora* (Hook.f.) Lopr.  
*Sesamum capense* Burm.f.  
*Sesamum triphyllum* Welw. ex Asch. var. *triphyllum*  
*Sesbania punicea* (Cav.) Benth.  
*Setaria italica* (L.) P.Beauv.  
*Setaria pumila* (Poir.) Roem. & Schult.  
*Setaria verticillata* (L.) P.Beauv.  
*Sida chrysantha* Ulbr.  
*Solanum burchellii* Dunal  
*Solanum capense* L.  
*Solanum catombelense* Peyr.  
*Solanum lichtensteinii* Willd.  
*Solanum supinum* Dunal var. *supinum*  
*Sporobolus albicans* (Nees ex Trin.) Nees  
*Sporobolus coromandelianus* (Retz.) Kunth  
*Sporobolus fimbriatus* (Trin.) Nees  
*Sporobolus ioclados* (Trin.) Nees  
*Sporobolus ludwigii* Hochst.  
*Sporobolus rangei* Pilg.  
*Sporobolus tenellus* (Spreng.) Kunth  
*Stachys spathulata* Burch. ex Benth.  
*Stipagrostis ciliata* (Desf.) De Winter var. *capensis* (Trin. & Rupr.) De Winter  
*Stipagrostis namaquensis* (Nees) De Winter  
*Stipagrostis obtusa* (Delile) Nees  
*Stipagrostis uniplumis* (Licht.) De Winter var. *neesii* (Trin. & Rupr.) De Winter  
*Stipagrostis uniplumis* (Licht.) De Winter var. *uniplumis*  
*Suaeda fruticosa* (L.) Forssk.  
*Sutherlandia frutescens* (L.) R.Br.

Tagetes minuta L.  
Talinum arnotii Hook.f.  
Tarchonanthus camphoratus L.  
Tephrosia burchellii Burt & Davy  
Tetragonia arbuscula Fenzl  
Themeda triandra Forssk.  
Thesium hystrioides A.W.Hill  
Thesium hystrix A.W.Hill  
Trachyandra laxa (N.E.Br.) Oberm. var. laxa  
Trachyandra saltii (Baker) Oberm. var. saltii  
Tragus berteronianus Schult.  
Tragus koelerioides Asch.  
Tragus racemosus (L.) All.  
Trichodesma angustifolium Harv. subsp. angustifolium  
Trichostomum brachydontium Bruch  
Triraphis purpurea Hack.  
Trochomeria debilis (Sond.) Hook.f.  
Troglophyton capillaceum (Thunb.) Hilliard & B.L.Burt subsp. capillaceum  
Urochloa panicoides P.Beauv.  
Ursinia nana DC. subsp. leptophylla Prassler  
Vahlia capensis (L.f.) Thunb. subsp. ellipticifolia Bridson  
Viscum rotundifolium L.f.  
Wahlenbergia denticulata (Burch.) A.DC. var. denticulata  
Wahlenbergia nana Brehmer  
Wahlenbergia nodosa (H.Buek) Lammers  
Zygophyllum incrustatum E.Mey. ex Sond.  
Zygophyllum microcarpum Licht. ex Cham. & Schtdl.  
Zygophyllum simplex L.

## Appendix 5: Animal species with a geographical distribution that includes the study area.

Notes:

1. Species of conservation concern are in red lettering.
2. Species protected according to the Northern Cape Nature Conservation Act, No. 9 of 2009, marked with "P"
3. Species protected according to the National Environmental Management: Biodiversity Act of 2004 (Act 10 of 2000) marked with "N"

### Mammals:

<sup>P</sup>Red hartebeest  
<sup>P</sup>Springbok  
<sup>P</sup>Black wildebeest  
<sup>P</sup>Blue wildebeest  
<sup>N<sup>P</sup></sup>Black rhinoceros  
Klipspringer  
<sup>P</sup>Gemsbok  
<sup>P</sup>Steenbok  
<sup>P</sup>Mountain reedbuck  
<sup>P</sup>Common duiker  
<sup>P</sup>Kudu  
Rock hyrax  
<sup>N<sup>P</sup></sup>Cape clawless otter  
<sup>P</sup>Water mongoose  
Black-backed jackal  
Caracal  
<sup>P</sup>Yellow mongoose  
<sup>N<sup>P</sup></sup>Black-footed cat  
<sup>P</sup>African wild cat  
<sup>P</sup>Small grey mongoose  
<sup>P</sup>Slender mongoose  
<sup>P</sup>Small-spotted genet  
<sup>N<sup>P</sup></sup>Brown hyaena  
<sup>P</sup>Striped polecat  
<sup>N</sup>Spotted-necked otter  
<sup>N<sup>P</sup></sup>Honey badger  
<sup>P</sup>Bat-eared fox  
African weasel  
<sup>P</sup>Aardwolf  
<sup>P</sup>Suricate  
<sup>N<sup>P</sup></sup>Cape fox  
Natal long-fingered bat  
<sup>P</sup>Cape serotine bat  
<sup>P</sup>Egyptian slit-faced bat  
Geoffroy's horseshoe bat  
<sup>P</sup>Egyptian free-tailed bat  
<sup>N</sup>South African hedgehog  
<sup>P</sup>Reddish-grey musk shrew  
<sup>P</sup>Cape/Desert hare  
<sup>P</sup>Scrub/Savannah hare  
<sup>P</sup>Smith's red rock rabbit  
Chacma baboon

<sup>P</sup>Namaqua rock mouse  
Common mole-rat  
<sup>P</sup>Short-tailed gerbil  
<sup>P</sup>Hairy-footed gerbil  
<sup>P</sup>Woodland dormouse  
<sup>P</sup>Porcupine  
<sup>P</sup>Large-eared mouse  
<sup>P</sup>Multimammate mouse  
<sup>P</sup>Springhare  
<sup>P</sup>Striped mouse  
<sup>P</sup>Pouched mouse  
<sup>P</sup>Kreb's fat mouse  
<sup>P</sup>Highveld gerbil  
<sup>P</sup>Bushveld gerbil  
<sup>P</sup>Cape ground squirrel  
<sup>P</sup>Rock elephant shrew

### Reptiles:

Puff adder  
Horned adder  
Cape cobra  
Highveld garter snake  
Boomslang  
Karoo whip snake  
Kalahari sand snake  
Crossed whip snake  
Spotted skaapsteker  
Striped skaapsteker  
Herald Snake  
<sup>P</sup>Brown house snake  
<sup>P</sup>Aurora house snake  
<sup>P</sup>Common brown water snake  
<sup>P</sup>Mole snake  
<sup>P</sup>Sundevall's shovel-snout  
<sup>P</sup>Common slug-eater  
<sup>P</sup>Common wolf snake  
<sup>P</sup>Common egg-eater  
Delalande's beaked blind snake  
Peter's worm snake  
<sup>P</sup>Southern rock agama  
<sup>P</sup>Common ground agama  
<sup>P</sup>Common flap-necked chameleon  
<sup>P</sup>Rock monitor

- <sup>P</sup>Water monitor
- <sup>P</sup>Spotted sandveld lizard
- <sup>P</sup>Namaqua sand lizard
- <sup>P</sup>Spotted sand lizard
- <sup>P</sup>Cape spade-snouted worm lizard
- <sup>P</sup>Cape skink
- <sup>P</sup>Kalahari tree skink
- <sup>P</sup>Western rock skink
- <sup>P</sup>Variegated skink
- <sup>P</sup>Karoo girdled lizard
- Bibron's tubercled gecko
- Cape gecko
- Common barking gecko
- Marico gecko
- <sup>P</sup>Marsh terrapin
- <sup>P</sup>Greater padloper
- <sup>P</sup>Leopard tortoise
- <sup>P</sup>Serrated tent tortoise

### **Amphibians**

- <sup>P</sup>Guttural toad
- <sup>P</sup>Western olive toad
- <sup>P</sup>Raucous toad
- <sup>P</sup>Southern pygmy toad
- <sup>P</sup>Bubbling kassina
- <sup>P</sup>Common platanna
- <sup>P</sup>Boettger's caco
- <sup>P</sup>Common river frog
- <sup>P</sup>Cape river frog
- <sup>P</sup><sup>N</sup>Giant bullfrog
- <sup>P</sup>Tremolo sand frog
- <sup>P</sup>Tandy's sand frog

### **Birds:**

- <sup>P</sup>Abdim's Stork
- <sup>P</sup>African Black Duck
- <sup>P</sup>African Fish Eagle
- <sup>P</sup>African Hoopoe
- <sup>P</sup>African Jacana
- <sup>P</sup>African Marsh Harrier
- <sup>P</sup>African Marsh Warbler
- <sup>P</sup>African Pied Wagtail
- <sup>P</sup>African Rail
- <sup>P</sup>African Skimmer
- <sup>P</sup>African Spoonbill
- <sup>P</sup>Alpine Swift
- <sup>P</sup>Anteating Chat
- <sup>P</sup>Ashy Tit
- <sup>P</sup>Baillon's Crake
- <sup>P</sup>Banded Martin
- <sup>P</sup>Barn Owl
- <sup>P</sup>Black Crake
- <sup>P</sup>Black Crow
- <sup>P</sup>Black Eagle
- <sup>P</sup>Black Harrier

- <sup>P</sup>Black Kite
- <sup>P</sup><sup>N</sup>**Black Stork, NT**
- <sup>P</sup>Black Swift
- <sup>P</sup>Blackbreasted Snake Eagle
- <sup>P</sup>Blackcheeked Waxbill
- <sup>P</sup>Blackchedsted Prinia
- <sup>P</sup>Blackcrowned Night Heron
- <sup>P</sup>Blackheaded Heron
- <sup>P</sup>Blacknecked Grebe
- <sup>P</sup>Blackshouldered Kite
- <sup>P</sup>Blacksmith Plover
- <sup>P</sup>Blackthroated Canary
- <sup>P</sup>Blackwinged Pratincole
- <sup>P</sup>Blackwinged Stilt
- <sup>P</sup>Blue Crane
- <sup>P</sup>Blue Korhaan
- <sup>P</sup>Blue Waxbill
- <sup>P</sup>Bluecheeked Bee-eater
- <sup>P</sup>Bokmakierie
- <sup>P</sup>Booted Eagle
- <sup>P</sup>Bradfield's Lark
- <sup>P</sup>Bradfield's Swift
- <sup>P</sup>Brownhooded Kingfisher
- <sup>P</sup>Brownthroated Martin
- <sup>P</sup>Brubru
- <sup>P</sup>Buffy Pipit
- <sup>P</sup>Burchell's Coucal
- <sup>P</sup>Burchell's Courser
- <sup>P</sup>Cape Bunting
- <sup>P</sup>Cape Penduline Tit
- <sup>P</sup>Cape Reed Warbler
- <sup>P</sup>Cape Robin
- <sup>P</sup>Cape Shoveller
- <sup>P</sup>Cape Sparrow
- <sup>P</sup>Cape Teal
- <sup>P</sup>Cape Turtle Dove
- <sup>P</sup><sup>N</sup>**Cape Vulture, VU**
- <sup>P</sup>Cape Wagtail
- <sup>P</sup>Capped Wheatear
- <sup>P</sup>Cardinal Woodpecker
- <sup>P</sup>Caspian Plover
- <sup>P</sup>Cattle Egret
- <sup>P</sup>Chat Flycatcher
- <sup>P</sup>Chestnutbanded Plover
- <sup>P</sup>Common Moorhen
- <sup>P</sup>Common Quail
- <sup>P</sup>Common Sandpiper
- <sup>P</sup>Common Waxbill
- <sup>P</sup>Crested Barbet
- <sup>P</sup>Crimsonbreasted Shrike
- <sup>P</sup>Crowned Plover
- <sup>P</sup>Curlew
- <sup>P</sup>Curlew Sandpiper
- <sup>P</sup>Dabchick
- <sup>P</sup>Darter
- <sup>P</sup>Desert Cisticola
- <sup>P</sup>Diederik Cuckoo

P Doublebanded Courser  
 P Dusky Sunbird  
 P Eastern Clapper Lark  
 P Egyptian Goose  
 P Ethiopian Snipe  
 P Eurasian Bee-eater  
 P Eurasian Golden Oriole  
 P Eurasian Marsh Warbler  
 P Eurasian Nightjar  
 P Eurasian Roller  
 P Eurasian Swallow  
 P Eurasian Swift  
 P Fairy Flycatcher  
 P Familiar Chat  
 P Fantailed Cisticola  
 P Fawncoloured Lark  
 P Feral Pigeon  
 P Fiscal Flycatcher  
 P Fiscal Shrike  
 P Forktailed Drongo  
 P Fulvous Duck  
 P Gabar Goshawk  
 P Garden Warbler  
 P Giant Eagle Owl  
 P Giant Kingfisher  
 P Glossy Ibis  
 P Glossy Starling  
 P Golden Bishop  
 P Goldenbreasted Bunting  
 P Goldentailed Woodpecker  
 P Goliath Heron  
 P Grassveld Pipit  
 P Great Crested Grebe  
 P Great Reed Warbler  
 P Great Sparrow  
 P Great Spotted Cuckoo  
 P Great White Egret  
 P **Greater Flamingo, NT**  
 P Greater Honeyguide  
 P Greater Kestrel  
 P **Greater Painted Snipe, NT**  
 P Greater Striped Swallow  
 P Greenbacked Heron  
 P Greenshank  
 P Grey Heron  
 P Grey Hornbill  
 P Greybacked Cisticola  
 P Greybacked Finchlark  
 P Greyheaded Gull  
 P Groundscraper Thrush  
 P Gymnogene  
 P Hadedda Ibis  
 P Hamerkop  
 P Helmeted Guineafowl  
 P Horus Swift  
 P Hottentot Teal  
 P House Martin

P House Sparrow  
 P Icterine Warbler  
 P Jackal Buzzard  
 P Jacobin Cuckoo  
 P Kalahari Robin  
 P Karoo Robin  
 P Karoo Thrush  
 P Kittlitz's Plover  
 P Knobbilled Duck  
 P<sup>N</sup> **Kori Bustard, VU**  
 P Small Buttonquail  
 P **Lanner Falcon, NT**  
 P<sup>N</sup> **Lappetfaced Vulture, VU**  
 P Larklike Bunting  
 P Laughing Dove  
 P Layard's Titbabbler  
 P **Lesser Flamingo, NT**  
 P Lesser Grey Shrike  
 P Lesser Honeyguide  
 P<sup>N</sup> **Lesser Kestrel, VU**  
 P Levallant's Cisticola  
 P Lilacbreasted Roller  
 P Little Bittern  
 P Little Egret  
 P Little Stint  
 P Little Swift  
 P Longbilled Crombec  
 P Longtailed Widow  
 P<sup>N</sup> **Ludwig's Bustard, VU**  
 P Maccoa Duck  
 P Malachite Kingfisher  
 P **Marabou Stork, NT**  
 P Marico Flycatcher  
 P Marsh Owl  
 P Marsh Sandpiper  
 P<sup>N</sup> **Martial Eagle, VU**  
 P Masked Weaver  
 P Melba Finch  
 P Mountain Chat  
 P Namaqua Dove  
 P Namaqua Sandgrouse  
 P Natal Francolin  
 P Neddicky  
 P Old World Painted Snipe  
 P Orange River Francolin  
 P Orange River White-eye  
 P Orangethroated Longclaw  
 P Osprey  
 P Ostrich  
 P Pale Chanting Goshawk  
 P Palewinged Starling  
 P Palm Swift  
 P Paradise Flycatcher  
 P Paradise Whydah  
 P Pearlbreasted Swallow  
 P<sup>N</sup> **Peregrine Falcon, NT**  
 P Pied Avocet

P Pied Barbet  
 P Pied Crow  
 P Pied Kingfisher  
 P Pied Starling  
 P Pinkbilled Lark  
 P Pintailed Whydah  
 P Pirit Batis  
 P Purple Gallinule  
 P Purple Heron  
 P Pygmy Falcon  
 P Quail Finch  
 P Red Bishop  
 P Redbacked Shrike  
 P Redbilled Firefinch  
 Redbilled Quelea  
 P Redbilled Teal  
 P Redbreasted Swallow  
 P Redcapped Lark  
 P Redchested Cuckoo  
 P Redcrested Korhaan  
 P Redeyed Bulbul  
 P Redeyed Dove  
 P Redfaced Mousebird  
 P Redheaded Finch  
 P Redknobbed Coot  
 P Reed Cormorant  
 P Ringed Plover  
 P Rock Bunting  
 P Rock Kestrel  
 P Rock Martin  
 P Rock Pigeon  
 P Ruff  
 P Rufouscheeked Nightjar  
 P Rufouseared Warbler  
 P Rufousnaped Lark  
 P Sacred Ibis  
 P Sand Martin  
 P Sanderling  
 P Scalyfeathered Finch  
 P Scimitarbilled Woodhoopoe  
 P **Secretarybird, NT**  
 P Shafttailed Whydah  
 P Shorttoed Rockthrush  
 P Sicklewinged Chat  
 P Sociable Weaver  
 P South African Cliff Swallow  
 P South African Shelduck  
 P Southern Greyheaded Sparrow  
 P Southern Pochard  
 P Southern Yellowbilled Hornbill  
 P Spikeheeled Lark  
 P Spotted Dikkop  
 P Spotted Eagle Owl  
 P Spotted Flycatcher  
 P Spurwinged Goose  
 P Squacco Heron  
 P Steelblue Widowfinch

P Steppe Buzzard  
 P Stonechat  
 P Swallowtailed Bee-eater  
 P<sup>N</sup> **Tawny Eagle, VU**  
 P Temminck's Courser  
 P Threebanded Plover  
 P Threestreaked Tchagra  
 P Titbabbler  
 P Violeteared Waxbill  
 P Wattled Starling  
 P Whimbrel  
 P Whiskered Tern  
 P White Stork  
 P Whitebacked Duck  
 P Whitebacked Mousebird  
 P<sup>N</sup> **Whitebacked Vulture, VU**  
 P Whitebreasted Cormorant  
 P Whitebrowed Sparrowweaver  
 P Whitefaced Duck  
 P Whitefaced Owl  
 P Whitefronted Bee-eater  
 P Whiterumped Swift  
 P Whitethroated Canary  
 P Whitethroated Swallow  
 P Whitewinged Korhaan  
 P Whitewinged Tern  
 P Willow Warbler  
 P Wood Sandpiper  
 P Yellow Canary  
 P Yellow Wagtail  
 P Yellowbellied Eremomela  
 P Yellowbilled Duck  
 P Yellowbilled Egret  
 P Yellowbilled Kite  
 P **Yellowbilled Stork, NT**