BASIC ASSESSMENT REPORT:

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

Prepared by

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on behalf of
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8 June 2011

DRAFT REPORT: 2nd Draft

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

REGULATIONS GOVERNING THIS REPORT

This report has been prepared in terms the EIA Regulations promulgated under the *National Environmental Management Act* No. 107 of 1998 (NEMA). A Basic Assessment study is undertaken in accordance with Regulation 22 in terms of the EIA Regulations published in Government Notice (GN) R543 of 18 June 2010, in terms of Chapter 5 of Section 24(5) of the National Environmental Management Act (No. 107 of 1998).

Appointment of specialist

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

Details of specialist

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Summary of expertise

Dr David Hoare:

- Registered professional member of The South African Council for Natural Scientific Professions (Ecological Science, Botanical Science), registration number 400221/05.
- Founded David Hoare Consulting cc, an independent consultancy, in 2001.
- Ecological consultant since 1995.
- Conducted, or co-conducted, over 250 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 INCA Kakamas (Pty) Ltd. David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the

consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. David Hoare is an independent consultant to Savannah Environmental (Pty) Ltd and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work. The percentage work received directly or indirectly from the proponent in the last twelve months is zero.

Scope and purpose of report

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

Conditions relating to this report

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

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

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INTRODUCTION

Terms of reference and approach

Savannah Environmental (Pty) Ltd. was appointed by INCA Kakamas (Pty) Ltd to undertake an application for environmental authorisation through a Basic Assessment (BA) process for the proposed "INCA Kakamas PV Solar Energy Facility". The project involves the establishment of a renewable energy facility for power generation and its associated infrastructure, including an array of pv panels with a generating capacity of approximately 10 MW, 22 kV power line to link into the existing Eskom Taaiput substation, workshop area for maintenance and storage and internal access roads. The purpose of the BA is to identify environmental impacts associated with the project.

On 21 March 2011 David Hoare Consulting cc was appointed by Savannah Environmental (Pty) Ltd to undertake an ecological assessment of the study area. The specific terms of reference for the ecological 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;
- an assessment of the significance of direct, indirect and cumulative impacts in terms of standard criteria;
- a statement regarding the potential significance of the identified issues based on the evaluation of the issue/impacts;
- recommendations regarding practical mitigation measures for potentially significant impacts;
- a description of any assumptions, uncertainties and gaps in knowledge;

This report provides details of the results of the Basic Assessment. The findings of the study are based on a desktop assessment of the study area, detailed aerial photography and a detailed field survey of the site.

Study area

At a regional level the study area falls within the Northern Cape Province to the west of the town of Kakamas. A more detailed description of the study area is provided in a section below.

METHODOLOGY

The assessment is to be undertaken in a single phase, a Basic Assessment. The objective of the 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 habitat/sensitivity map of the study area based on available maps and database information.

Assessment philosophy

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

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

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

Species

1. threatened plant species
2. protected trees
3. threatened animal species

Ecosystems

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

Processes

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

It is not the intention to provide comprehensive lists of all species that occur on site, since most of the species on these lists are usually common or widespread species. Rare, threatened, protected and conservation-worthy species and habitats are considered to be the

highest priority, the presence of which are most likely to result in significant negative impacts on the ecological environment. The focus on national and provincial priorities and critical biodiversity issues is in line with National legislation protecting environmental and biodiversity resources, including, but not limited to the following which ensure protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment:

1. Environment Conservation Act (Act 73 of 1989)
2. National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998)
3. National Environmental Management Biodiversity Act, 2004. (Act 10 0f 2004)

Plant and animal species of concern

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

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

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

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

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

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

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

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

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.

Assessment of impacts

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

» The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
» The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high):
» The **duration**, wherein it was indicated whether:
  * the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  * the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  * medium-term (5–15 years) – assigned a score of 3;
  * long term (> 15 years) - assigned a score of 4; or
  * permanent - assigned a score of 5;

» The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
» The **probability** *of occurrence*, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
» the **significance**, was determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
» the **status**, which was described as either positive, negative or neutral.
» the degree to which the impact can be reversed.
» the degree to which the impact may cause irreplaceable loss of resources.
» the degree to which the impact can be mitigated.

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

S=(E+D+M)P

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

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

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

Limitations

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

DESCRIPTION OF STUDY AREA

Location

The study site is situated approximately 2 km west of the town of Kakamas within the Northern Cape (Figure 1). The site falls within the quarter degree grid 2820DC. It is situated just south of the southern banks of the Orange River. The proposed facility would occur on the Remainder of the Farm Kakamas Suid Nedersetting 1178.

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

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

Topography

The study site is situated just to the south of the Orange River. The topography of this area is relatively gentle and slopes in a northerly direction towards the Orange River. The elevation on site varies from 662 to 682 m above sea level.

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

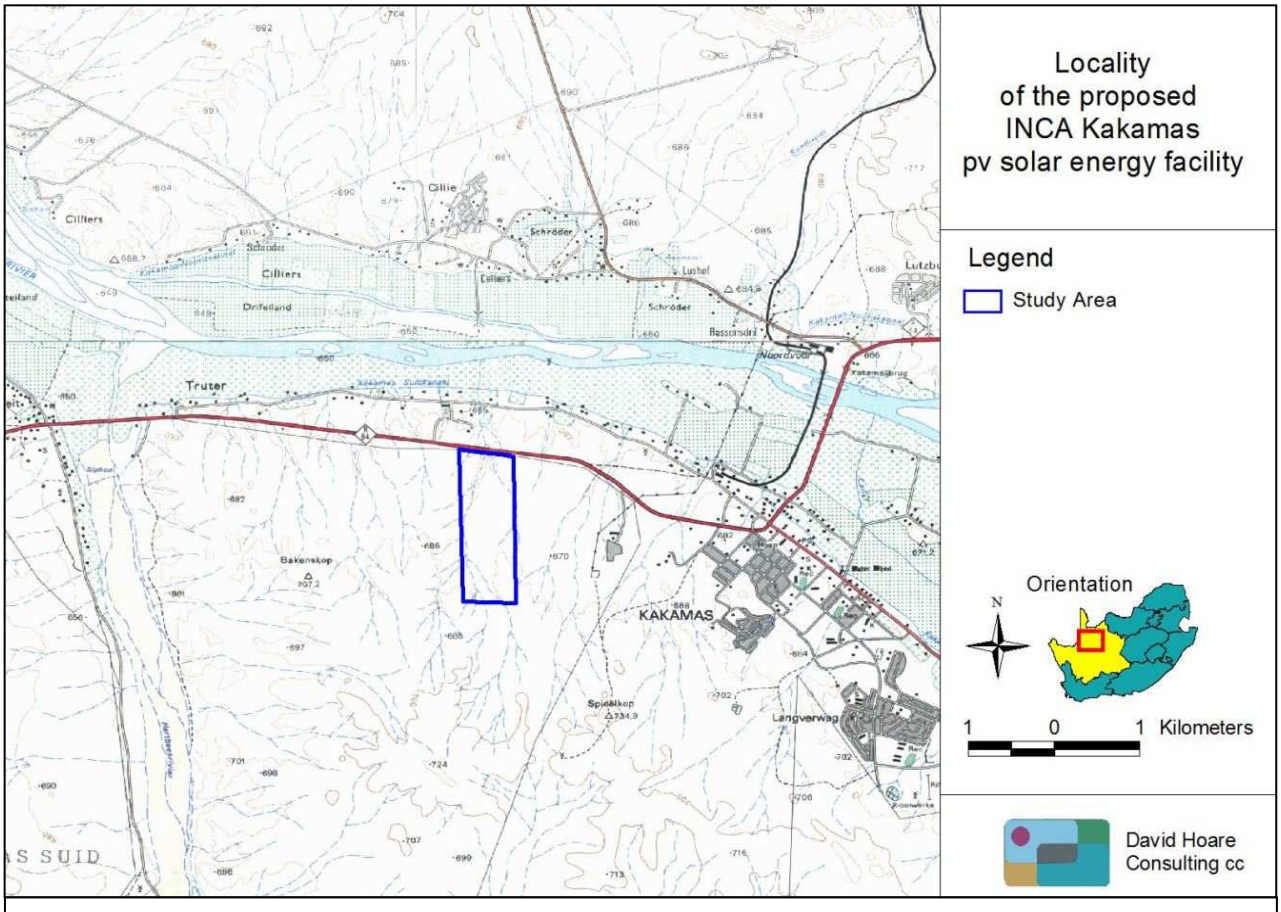

Figure 1: Location of the proposed Solar Power Plant

drain in a northerly direction towards the Orange River.

Land types and soils

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

The A-group of land types refer to yellow and red soils without water tables belonging to one or more of the following soil forms: Inanda, Kranskop, Magwa, Hutton, Griffin, Clovelly. The Ag landtype consists of red, high base status, < 300 mm deep soils and no dunes (MacVicar et al. 1974). The soils on site are therefore expected to be relatively shallow, although probably reasonably fertile.

Climate

The climate is arid to semi-arid. Rainfall occurs from November to April, but peaks in mid- to late summer (February / March). Mean annual rainfall is 140 mm to 170 mm per year. All areas with less than 400 mm rainfall are considered to be arid. The study area can therefore be considered to be arid to very arid. Water for irrigation of cultivated areas is obtained from the Orange River.

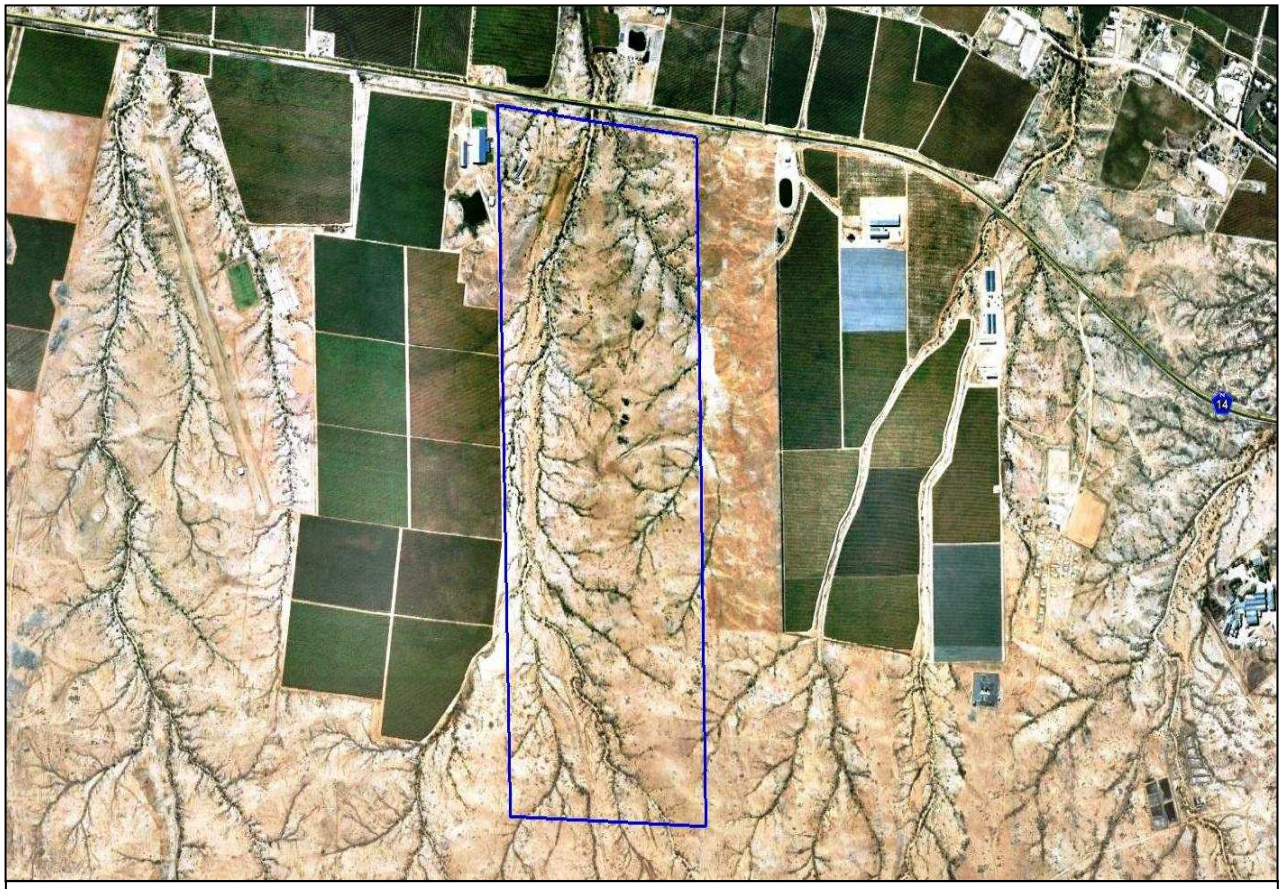

Figure 2: Google image of the site.

Landuse and landcover of the study area

A landcover map of the study area (Fairbanks *et al*. 2000) indicates that the entire site consists of natural vegetation. The 1:50 000 topocadastral map of the site also indicates that the site is in a completely natural state, with no infrastructure indicated for the site. However, a Google image of the site (Figure 2) shows a small area of cultivation, two buildings and a gravel access road in the north-western part of the site. The north-eastern part of the site is also degraded to some extent due to earthworks of some nature. These patterns were confirmed during the field survey of the site.

Except for the southern part of the site, the entire site is surrounded by cultivation and, in the northern part, is abutted by the national road. The site is therefore largely natural, but is surrounded almost completely by transformed habitat.

Although the site is in a natural state, there is evidence that it is regularly traversed by local farm workers moving between orchards on each side of the site. There are footprints in most of the large drainage lines that indicate that there is regular pathways being used on site. In addition, there is garbage discarded on site and evidence that secluded parts of the site are used for ablutions.

Broad vegetation types of the region

The study area falls within the Nama-Karoo Biome (Rutherford & Westfall 1986, Mucina & Rutherford 2006). The most recent and detailed description of the vegetation of this region is part of a national map (Mucina, Rutherford & Powrie, 2005; Mucina *et al*. 2006). This map shows one vegetation type occurring within the study site, namely Bushmanland Arid Grassland. This vegetation type is described in more detail below.

Bushmanland Arid Grassland
This vegetation type occurs on extensive, relatively flat plains and is sparsely vegetated by tussock grasses, including *Stipagrostis ciliata*, *Aristida adscensionis*, *Aristida congesta*, *Enneapogon desvauxii*, *Eragrostis nindensis*, *Schmidtia kalahariensis* and *Stipagrostis obtusa*. In some years after good rains there are abundant displays of annual herbs (Mucina et al. 2006). There are no known endemics in this vegetation type (Mucina *et al*. 2006), but does contain endemics belonging to the Griqualand West or Gariep Centres of Endemism (van Wyk & Smith 2001), namely *Aizoon asbestinum*, *Maerua gilgii*, *Ruschia muricata* and *Aloe gariepensis*. The vegetation type also contains the protected tree species, *Acacia erioloba* (camel thorn)*, Acacia haematoxylon* (grey camel thorn) and *Boscia albitrunca* (shepherd's bush). At a national scale this vegetation type has been transformed only a small amount and 27% is conserved in Augrabies Falls National Park; it is not therefore considered to be a threatened vegetation type (Mucina *et al*. 2006).

Conservation status of broad vegetation types

On the basis of a scientific approach used at national level by SANBI (Driver *et al*. 2005), vegetation types can be categorised according to their conservation status which is, in turn, assessed according to the degree of transformation relative to the expected extent of each vegetation type. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. The original extent of a vegetation type is as presented in the most recent national vegetation map (Mucina,

Rutherford & Powrie 2005) and is the extent of the vegetation type in the absence of any historical human impact. On a national scale the thresholds are as depicted in Table 1, as determined by best available scientific approaches (Driver *et al*. 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver et al. 2005).

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.

According to scientific literature (Driver et al. 2005; Mucina et al., 2006), the vegetation type that occurs in the study area is listed as Least Threatened (Table 2). This vegetation type 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 *et al*. 2005; Mucina *et al*., 2006	Draft Ecosystem List (NEMBA)
Bushmanland Arid Grassland	21	1	1	Least Threatened	Not listed

The Siyanda Environmental Management Framework (Environomics 2010) identifies Bushmanland Arid Grassland as being a medium conservation priority in the Siyanda area (Environomics 2010). No conservation areas for this vegetation type are proposed anywhere near to Kakamas. The site is therefore not within a proposed conservation area (Environomics 2010).

Critical Biodiversity Areas have been identified for all municipal areas of the Northern Cape Province and are published on the SANBI website (bgis.sanbi.org). These maps identify threatened vegetation types (Lower Gariep Alluvial Vegetation) and a corridor area as the areas of concern in the study area (Figure 3). The threatened vegetation type is Lower Gariep Alluvial Vegetation within the Orange River. It is classified as a CBA2, which is a near natural landscape with intermediate level of irreplaceability or some flexibility in terms of area required to meet biodiversity targets and are approaching but have not passed their limits of acceptable change (see Table 3). The corridor area is classified as an Ecological Support Area (ESA), which are areas that are moderately to significantly disturbed but still able to maintain basic functionality. The corridor is, however, identified as an important terrestrial migration corridor in which basic ecological functionality needs to be maintained.

Table 3. Relationship between Critical Biodiversity Area categories (CBAs) and land management objectives.

CBA category	Land management objective
PA and CBA1 *PA = Protected areas*	*Natural landscapes:* • Ecosystems and species fully intact and undisturbed. • Areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If biodiversity features targeted in these areas are lost then targets will not be met. • Landscapes that are at or past their limits of acceptable change.
CBA2	*Near natural landscapes:* • Ecosystems and species largely intact and undisturbed. • Areas with intermediate irreplaceability or some flexibility in terms of area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets. • Landscapes are approaching but have not passed their limits of acceptable change.
Ecological Support Areas (ESAs)	*Functional landscapes:* • Ecosystems that are moderately to significantly disturbed but still able to maintain basic functionality. • Individual species or other biodiversity indicators may be severely disturbed or reduced. • These are areas with low irreplaceability with respect to biodiversity pattern targets only.

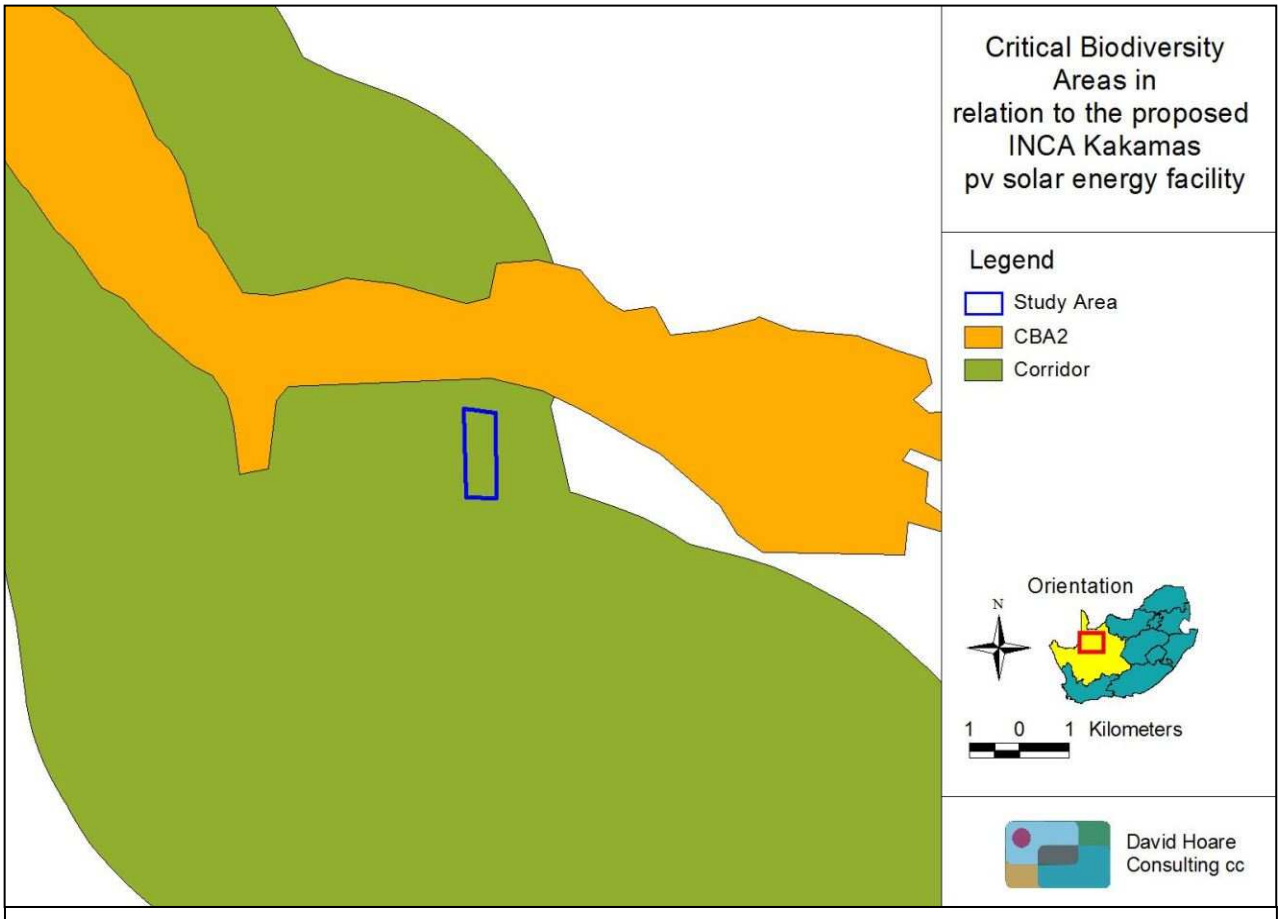

Figure 3: Critical Biodiversity Areas of the site and surrounding areas.

Other Natural Areas (ONAs) and Transformed	Production landscapes: manage land to optimize sustainable utilization of natural areas.

Red List plant species of the study area

Lists of plant species previously recorded in the quarter degree grids in which the study area is situated were obtained from the South African National Biodiversity Institute. These are listed in Appendix 1. Additional species that could occur in similar habitats, as determined from database searches and literature sources, but have not been recorded in these grids are also listed. There are seven species on this list that have a geographical distribution that could include the site.

The species on this list were evaluated to determine the likelihood of any of them occurring on site on the basis of habitat suitability. Of the species that are considered to occur within the geographical area under consideration, there is one threatened species that could occur in habitats that are available in the study area, *Aloe dichotoma* subsp. *dichotoma*. According to IUCN Ver. 3.1 (IUCN, 2001) this species is listed as Vulnerable. This species was evaluated as having a medium probability of occurring on site. Two individuals were found on site, both medium-sized and in good health. The geographical co-ordinates of these two individuals are as follows: Specimen 1: South 28.77424 East 20.58481, Specimen 2 South 28.77428 East 20.58858.

There are also two species listed as Near threatened (*Dinteranthus wilmotianus* and *Hoodia officinalis* subsp. *officinalis*) and two species listed as Declining (*Acacia erioloba* and *Hoodia gordonii*) that could occur on site (see Table 4 for explanation of categories). Species listed as Near threatened and Declining are a low conservation priority and not considered to be threatened.

Table 4: Explanation of IUCN Ver. 3.1 categories (IUCN, 2001), and Orange List categories (Victor & Keith, 2004).

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

Red List animal species of the study area

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

There are three mammal species of low conservation concern that could occur in available habitats in the study area. This includes three species classified nationally as Near Threatened (Friedmann & Daly 2004), i.e. the Honey Badger, Littledale's Whistling Rat and Dent's Horseshoe Bat, all three of which are classified as Least Concern globally (according to the IUCN website, accessed on 28 April 2011).

There are two threatened bird species (both VU) and two Near Threatened bird species that have a medium probability of utilising available habitats in the study area, either for foraging or breeding. The two species most likely to use parts of the site for breeding are the Kori Bustard and Ludwig's Bustard, both listed in South Africa as Vulnerable (Barnes 2000, Chittenden 2007). According to the IUCN website (accessed on 28 April 2011), Kori's Bustard is listed globally as Least Concern and Ludwig's Bustard as Endangered. The species that may use the site for foraging are the Secretarybird and Sclater's Lark, both listed as Near Threatened in South Africa (Barnes 2000, Chittenden 2007). The Secretarybird is listed on the IUCN website (accessed on 28 April 2011) as globally Least Concern.

After a detailed field assessment of the site, it was considered unlikely that Ludwig's Bustard would occur there. This is based on the fact that there is a regular presence of humans on site and in the surrounding orchards. Field experience of Ludwig's Bustard is that it avoids humans and flies away when it detects them, even from far away. In addition, the vegetation on site is very sparse and offers little cover for individual birds. It is therefore considered unlikely that the site constitutes important habitat for this species and that it is unlikely that any of these birds would be found regularly on site.

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 (according to the IUCN website, accessed on 28 April 2011) and Near threatened in South Africa (Branch 1988, du Preez & Carruthers 2009). It is, however, protected under the National Environmental Management: Biodiversity Act. A field assessment of the site indicates that there are no suitable areas on site for this species and that the site is unlikely to be important habitat for Giant Bullfrogs. Nevertheless, if any individuals should ever be found on site, steps would need to be taken to protect them.

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

In summary, the following animal species of conservation concern could potentially occur on site and may therefore be of concern for development of the study area:

1. Ludwig's Bustard (EN) (considered unlikely to occur there),
2. Kori Bustard (VU/LC),
3. Sclater's Lark (NT),

Protected animals

There are a number of animal species protected under the Northern Cape Nature Conservation Act of 2009 (Act 9 of 2009). These are listed in Appendix 6. According to the Northern Cape Nature Conservation Act, "*No person shall without a permit hunt, import, export, transport, keep, possess, breed or trade in a specimen of a* (*specially*) *protected animal* ". The Act does not imply that habitat for these species should be regarded as sensitive and appears to be primarily concerned with protecting individual animals from hunting or trading. No permit requirements are contained in the Act for cases where such individuals may occur on land for which an application for development is being considered (as in the current case).

Those species protected according to the Northern Cape Nature Conservation Act of 2009 (Act 9 of 2009) that have a geographical distribution that includes the site and that may, therefore, occur on site are listed in Appendix 5, marked with the letter "P". A large proportion of the species (except for the most common) are protected according to the Northern Cape Nature Conservation Act of 2009 (Act 9 of 2009).

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

Those species protected according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) that have a geographical distribution that includes the site are listed in Appendix 5, marked with the letter "N". This includes the following species: White Rhinoceros, Black Rhinoceros, Hartmann's Mountain Zebra, Cape Clawless Otter, Honey Badger, Leopard, Cape Fox, Giant Bullfrog, Black Stork, Kori Bustard, Lesser Kestrel, Ludwig's Bustard, Martial Eagle and Peregrine Falcon. Due to various factors, including habitat preference, available habitat on site and occurrence of species outside protected areas, not all these species are likely to occur on site. Those that are considered to have the potential to occur on site are the Honey Badger, Cape Fox and Kori Bustard. A field survey of the site indicates that none of these species are likely to occur on site. This is due to the close proximity of humans – there are agricultural areas on both sides of the site and permanent labourer homesteads in the north-western corner of the site. These species are likely to avoid humans and their domestic pets, such as dogs.

Protected trees

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

The tree *Acacia erioloba* occurs in dry woodland along watercourses in arid areas where underground water is present as well as on deep Kalahari sands. One individual of these species occurs on the boundary of the site next to the main road. This is a common pattern in this area with many large trees of this species occurring within the road reserve. No individuals were found on the site itself.

Acacia haematoxylon occurs on deep Kalahari sand between dunes or along dry watercourses. No individuals were found on site or nearby.

Boscia albitrunca occurs in semi-desert areas and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils. Two individuals of this species were found on site, both within very close proximity to drainage lines. The geographical co-ordinates of these two individuals are as follows: Specimen 1: South 28.76528 East 20.58435, Specimen 2 South 28.77674 East 20.58849.

Euclea pseudobenus occurs in semi-desert and desert areas, usually along watercourses and in depressions. It could occur in hills or on flats. Its main distribution is closer to the Richtersveld and no individuals have been sighted close to Upington. No individuals were recorded on site.

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 potentially high sensitivity are shown in Figure 4. Areas containing untransformed natural vegetation of conservation concern, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered potentially sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to have low sensitivity. The information provided in the preceding sections was used to compile a map of remaining

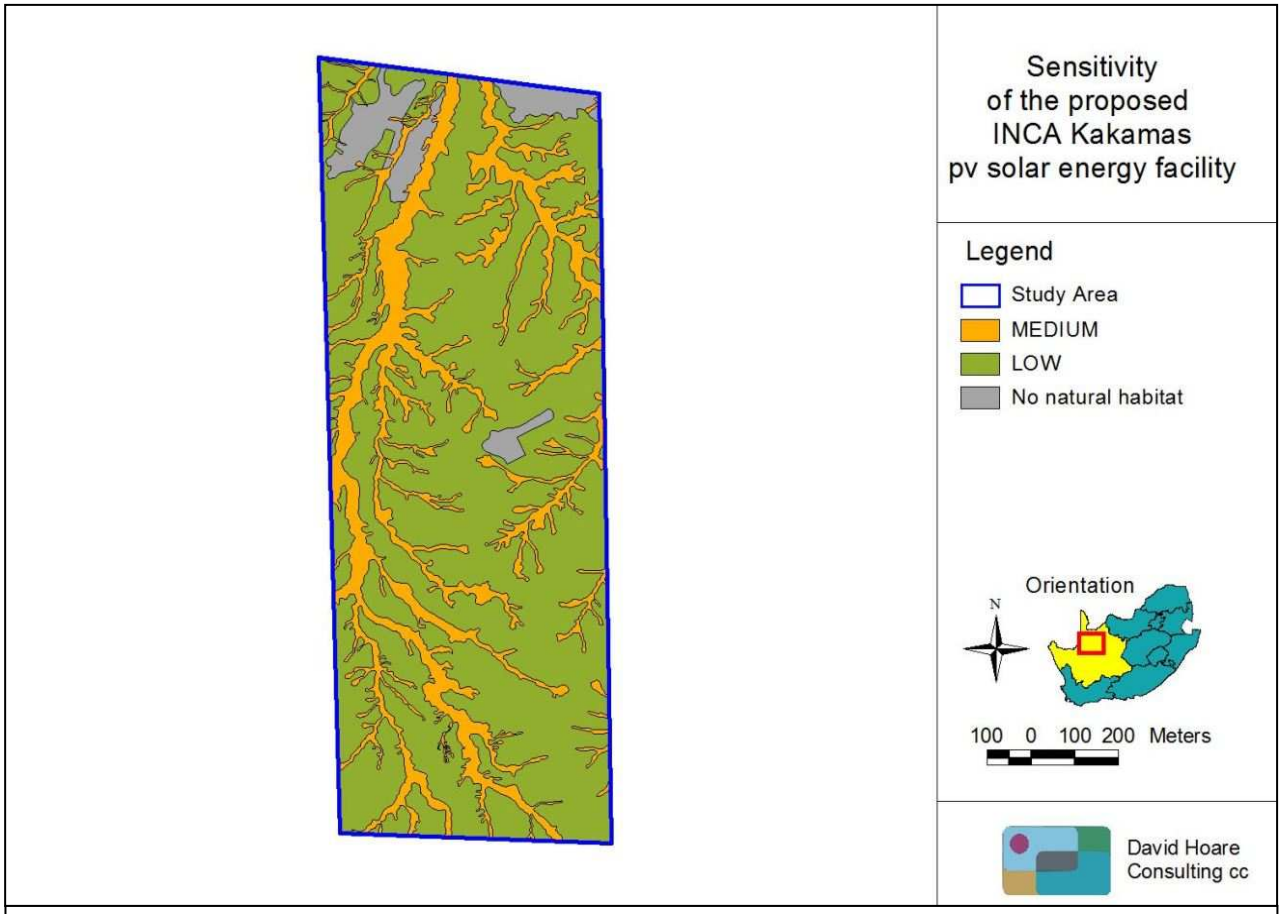

Figure 4: Potentially sensitive areas of the study area.

natural habitats and areas important for maintaining ecological processes in the study area. 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 watercourses: this represents a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal;
2. Occurrence of individuals of protected trees, that have been observed on site;
3. Occurrence of the study area within an area classified as being within a corridor area and therefore having some conservation value.

These factors have been taken into account in evaluating sensitivity within the study area. Watercourses are considered to be the most sensitive features on site. From a sensitivity point of view, the higher order drainage lines are more important to protect than the very ephemeral ones. The drainage lines on site tend to be deeply incised with very steep banks. This makes them potentially less stable than drainage lines in a flat landscape.

RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS

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

Legislation

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

NEMA requires, inter alia, that:

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

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

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

The ECA states that:

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

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

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

National Forests Act (Act no 84 of 1998)

Protected trees

According to this act, the Minister may declare a tree, group of trees, woodland or a species of trees as protected. The prohibitions provide that (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 No. 43 of 1983) as amended in 2001

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

- Category 1 plants: are prohibited and must be controlled.
- Category 2 plants: (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread.

- Category 3 plants: (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading thereof, except within the floodline of watercourses and wetlands.

National Water Act

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

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

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

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

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

Northern Cape Nature Conservation Act, No. 9 of 2009

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

- 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)

IDENTIFICATION OF RISKS AND DESCRIPTION OF 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 and/or woodland and wetland vegetation that leads to direct or indirect loss of such habitat.
- Impacts on ecosystem function: this includes impacts on any processes or factors that maintain ecosystem health and character, including the following:
    - disruption to nutrient-flow dynamics;
    - impedance of movement of material or water;
    - habitat fragmentation;
    - changes to abiotic environmental conditions;
    - changes to disturbance regimes, e.g. increased or decreased incidence of fire;
    - changes to successional processes;
    - effects on pollinators;
    - increased invasion by alien plants.

Changes to factors such as these may lead to a reduction in the resilience of plant communities and ecosystems or loss or change in ecosystem function.

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

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

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

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

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

Description of potential impacts

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

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

It has been established that the most widespread vegetation type on site is Bushmanland Arid Grassland, which is classified as Least Threatened. The site is within an area classified as a corridor area in the Northern Cape. These are areas that are not necessarily in pristine condition, but which are important to maintain in an ecologically functional state as ecological support areas. Recommended land management within such areas is to limit any further habitat loss or, where hard transformation is proposed, only to permit it with appropriate biodiversity offsets. The current site is situated between existing cultivated areas. It is therefore considered unlikely that development of the site will compromise ecological connectivity within this corridor area. Some loss of natural habitat will occur, but this will be insignificant in comparison to the total area of the vegetation type concerned or the width of the corridor area (10 km wide).

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

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

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

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

There are very few threatened species listed for the area surrounding the site. This is unfortunately due to the fact that this is an extremely undercollected area floristically speaking

and the local flora is not well documented. There may, therefore, be a number of species that occur within this area for which there are no records. There are seven known Red List or Orange List plant species that have a geographic distribution that includes the site. This includes one species classified as Vulnerable, two as Near threatened and two as Declining. Only the Vulnerable species (*Aloe dichotoma* subsp. *dichotoma*) is of concern for this assessment. Two individuals of this species were recorded on site.

Impact 3: Impacts on protected tree species

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

A number of species have a geographic distribution that includes the study area appear on this list, including the following: *Acacia erioloba, Acacia haematoxylon, Boscia albitrunca* and *Euclea pseudebenus*. Only *Boscia albitrunca* occurs on site. Two individuals were recorded during the field survey.

Impact 4: Impacts on threatened animals

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

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

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

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

There are two bird species of potential conservation concern that may make use of habitats on site, either for foraging or breeding. These are the Kori Bustard (listed globally as Least Concern and nationally as Vulnerable) and Sclater's Lark (listed as Near Threatened). The Secretarybird (listed nationally as Near Threatened and globally as Least Concern) may also be found on site.

Kori Bustard (VU) occurs in semi-arid regions, within the 100 - 600 mm rainfall isohyet, particularly in the Nama-Karoo. It is found open plains of the karoo, in highveld grassland, in Kalahari sandveld, in arid scrub, in Namib Desert, in lightly wooded savanna and in bushveld. It favours tree-lined watercourses, which are found on site. It is a common to very common

resident in the study area and therefore has a high probability of utilizing the habitat on site. It has not been previously recorded in the grid or in any of the nearby grids associated with the Orange River, but has been recorded at a relatively high reporting rate in adjacent grids. No individuals were observed on site, but it is still possible that it occurs there. The species is protected according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004). Any activities on site that are "*of a nature that may negatively impact on the survival of a listed threatened or protected species*" would require a permit in terms of this Act.

Sclater's Lark (NT) is endemic to South Africa and southern Namibia and is confined to the Nama Karoo, concentrated in the Northern Cape. It is an uncommon resident in the study area, but is nowhere common in its entire geographic range. It is of lower conservation concern than the other two species described above and is not considered to be threatened. It is not listed as protected according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).

Impact 5: Impacts on wetlands and drainage areas

Nature: The site is in a very arid area. There are no proper wetlands on site, but there are a number of dry stream beds and drainage areas. At the bottom end of the site close to the national road, these tend to be steep-sided mini gorges. According to the National Water Act, these are classified as wetlands or water resources. Construction may lead to some direct or indirect loss of or damage to some of these areas or changes to the catchment of these areas. This may affect the hydrology of the landscape or lead to loss of habitat for species that depend on this habitat type. Dry river beds and drainage lines are an important habitat for a number of species in the study area, including those with a restricted distribution or species with an elevated conservation status.

Impact 6: Establishment and spread of declared weeds and alien invader plants

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

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

No concentrations of alien plants occur on site. 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.

ASSESSMENT 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.

No infrastructure layout plans were provided for this assessment. It is therefore assumed that any and/or all parts of the site will be affected. Impacts are assessed for grouped components of infrastructure for the proposed pv solar plant, as follows:

- solar array, internal access roads and ancillary infrastructure (buildings),
- overhead power line to Taaiput substation (22kV).

Solar array, roads and buildings

The pv solar array, internal access roads and other required infrastructure will have an impact in terms of direct loss of habitat.

Impact 1: Impacts on indigenous natural vegetation (terrestrial)

Duration: The impact will be permanent due to the fact that clearing of vegetation for construction purposes cannot be reversed.

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

Magnitude: The potential magnitude of this impact will be small due to the small area of vegetation likely to be affected relative to the overall extent of the vegetation type concerned.

Probability: It is highly likely that there will be impacts on natural vegetation. There is some area of old cultivation on site. If the infrastructure is placed within this area then there will be no impact on natural habitat. If not, there will definitely be an impact on natural habitat.

Potential significance: The significance of this impact could potentially be of low significance (see table below).

Mitigation measures: Unnecessary impacts on surrounding natural vegetation, especially to the south of the site, must be avoided. The construction impacts must be contained to the footprint of the infrastructure. Disturbed areas beyond the footprint of the infrastructure must be rehabilitated as quickly as possible. Where possible, the infrastructure should be placed within existing disturbed areas on site.

Nature: Loss of habitat within indigenous natural vegetation		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	permanent (5)	permanent (5)
Magnitude	small (1)	small (1)
Probability	Highly probable (4)	probable (3)
Significance	**low (28)**	**low (21)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible

Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some extent	
Mitigation: (1) Avoid unnecessary impacts on natural vegetation surrounding infrastructure. Impacts should be contained, as much as possible, within the footprint of the infrastructure. (2) If possible, infrastructure should be placed within existing disturbed areas on site, or close to these.		
Cumulative impacts: Soil erosion, alien invasions may lead to additional loss of habitat that will exacerbate this impact.		
Residual Impacts: Some loss of this vegetation type will occur, but this is insignificant relative to the total extent of the vegetation type.		

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

Impact 2: Impacts on threatened plants

Duration: The impact will be permanent due to the fact that clearing of vegetation for construction purposes cannot be reversed and any plants destroyed will be permanently lost. More importantly, loss of suitable habitat for any of these species means that the plants cannot become re-established.

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

Magnitude: The potential magnitude of this impact is likely to be low for the vulnerable species (*Aloe dichotoma* subsp. *dichotoma*). Two individuals of the species occurs on site. The overall impact will therefore be on small numbers of individuals within a localized area.

Probability: It is definite that there could be impacts on populations of the Threatened species, *Aloe dichotoma* subsp. *dichotoma*. This is based on the fact that there are two individuals of this species occurring on site and the fact that the solar energy facility probably requires large areas of land. Natural vegetation will have to be cleared in order to build the facility and therefore individuals of this species are likely to be affected.

Potential significance: The significance of this impact could potentially be of low significance (see table below).

Mitigation measures: Plants that occur on site should be rescued and planted at a suitable locality adjacent to the infrastructure, either in a natural area where it will not be disturbed further or as a horticultural subject somewhere within the development, for example, at the main entrance or in a garden.

Nature: Destruction/permanent loss of individuals of threatened plant species		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (1)
Probability	Definite (5)	Definite (5)
Significance	**medium (40)**	**medium (35)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Partially	
Mitigation: (1) Rescue any plants that will be affected and plant them in adjacent habitat where they will not be disturbed		

further.
Cumulative impacts: Loss of habitat, soil erosion, alien invasions may all lead to additional impacts that will exacerbate this impact.
Residual Impacts: None likely

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

Impact 3: Impacts on protected tree species

Duration: The impact would be permanent due to the fact that clearing of trees for construction purposes cannot be reversed. Any loss of individual trees will therefore be irreversible.

Extent: The impact will occur at the site of the proposed facility. It may affect single individuals of protected species.

Magnitude: The potential magnitude of this impact will be minor and will only affect two individuals of *Boscia albitrunca*.

Probability: There are two individuals of *Boscia albitrunca* on site, both of which occur on the banks of a drainage line. It is unknown what the exact footprint of the infrastructure will be, but it is highly probable that there will be protected trees affected. This is based on the fact that the solar energy facility requires large areas of land.

Potential significance: The significance of this impact could potentially be of low significance (see table below). However, a permit would need to be obtained for any protected trees that are affected, so a legal obligation remains to determine the possible presence of protected trees irrespective of the significance of the impact.

Mitigation measures: A permit is required for the removal or damage of protected trees.

Nature: Loss of individuals of protected trees		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (2)	Minor (2)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Medium (32)**	**Medium (32)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Not necessary	
Mitigation: (1) Obtain a permit for any protected trees that have to be destroyed in order to construct the plant.		
Cumulative impacts: Impacts due to alien invasions and damage to watercourses may possibly cause damage to habitat where protected trees could grow that may exacerbate this impact.		
Residual Impacts: None likely		

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

Impact 4: Impacts on threatened animals

Duration: The impact will be long-term due to the fact that disturbance on site is likely to lead to conditions in which the bird species of concern are less likely to return to the site or utilize it

in future. Disturbance from construction may cause some animals to move away, but they could return to remaining habitat after construction has been completed.

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

Magnitude: Assuming that all species of concern occur on site, the potential magnitude of this impact will be low on the species as a whole.

Probability: It is improbable that there will be impacts on populations of threatened species. This is based on the fact that none of the species of concern have been previously recorded in the grid in which the site is located or similar grids close to the Orange River. The site contains habitat which is considered to be potentially suitable, but is in close proximity to human activities, which will discourage many species from using the site.

Potential significance: The significance of this impact could potentially be of medium significance (see table below).

Mitigation measures: None.

Nature: Impacts on threatened animals		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Improbable (2)	Improbable (2)
Significance	**Low (18)**	**Low (18)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None		
Cumulative impacts: Loss of indigenous natural vegetation, alien invasions may all lead to additional impacts that will exacerbate this impact.		
Residual Impacts: None likely		

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

Impact 5: Impacts on watercourses and drainage areas

Duration: The impact will be permanent due to the fact that clearing of land for construction purposes cannot be reversed.

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

Magnitude: The potential magnitude of this impact will be moderate, but depends on the proportion of the landscape potentially affected and the specific locality of affected sites.

Probability: Due to the fact that drainage lines occur on site, some fairly significant in size, it is highly probable that there will be drainage lines affected. This is also based on the fact that solar energy facilities require large areas of land and there is little transformation of natural habitat on site.

Potential significance: The significance of this impact could potentially be of medium significance (see table below).

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. Cross watercourses close to existing disturbances. Cross watercourses perpendicularly, where possible, to minimize the construction footprint. Adequate culvert and/or bridge structures are required at crossings. No infrastructure should be placed within the bed of watercourses. Construction must not cause the width of the watercourse to be narrowed. Disturbed areas must be rehabilitated as soon as possible. A permit from the Department of Water Affairs (DWA) is required if there are expected to be any impacts on any wetlands or watercourses.

Nature: Damage to watercourses and drainage lines		
	Without mitigation	**With mitigation**
Extent	Local and surroundings (2)	Local and surroundings (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Medium (5)	Medium (5)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (48)**	**Medium (36)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Control stormwater and runoff water to avoid erosion impacts on watercourses. (2) Cross watercourses at or close to existing disturbances. (3) For any new construction, cross watercourses perpendicularly to minimise disturbance footprints (4) Rehabilitate any disturbed areas as quickly as possible (5) Adequate culvert and/or bridge structures are required to ensure that construction impacts do not permanently affect channel structure and morphology. (6) No structures should be permanently positioned within the bed of watercourses. (7) Construction of infrastructure must not cause the width of the watercourse to be narrowed or the general morphology to be altered. (8) Obtain a permit from DWA to impact on any wetland or water resource.		
Cumulative impacts: Soil erosion, alien invasions may all lead to additional impacts on watercourses that will exacerbate this impact.		
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.		

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

Impact 6: Establishment and spread of declared weeds and alien invader plants

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

Extent: The impact will occur at the site of the proposed facility, but could spread into neighbouring areas.

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

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

Potential significance: The significance of this impact could potentially be of medium significance (see table below).

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 that would take decades to remove. 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.

Nature: Establishment and spread of declared weeds and alien invader plants		
	Without mitigation	**With mitigation**
Extent	Site & surroundings (2)	Site & surroundings (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (5)	Low (3)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (18)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Keep disturbance of indigenous vegetation to a minimum (2) Rehabilitate disturbed areas as quickly as possible following completion of construcrtion activities in an area (3) Do not translocate soil stockpiles from areas with alien plants (4) Control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove (5) Establish an ongoing monitoring programme to detect and quantify any aliens that may become established		
Cumulative impacts: Soil erosion, habitat loss, damage to wetlands may all lead to additional impacts that will exacerbate this impact.		
Residual Impacts: Will probably be very low if control measures are effectively applied		

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

Powerline

The Taaiputs substation is less than a kilometer away towards the east of the site. It is estimated that no more than 1 kilometre of 22kV powerline would be required to service the project. The major potential impact of a powerline would be on flying animals. There would also be a small loss of habitat along the servitude and at the position of tower structures.

Impact 1: Impacts on indigenous natural vegetation (terrestrial)

Duration: The impact will be long-term. There will be a very small amount of clearing of vegetation for tower structures. Any other disturbance will be associated with construction traffic within the servitude, which should stabilize over the long-term.

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

Magnitude: The potential magnitude of this impact will be small due to the small area of vegetation likely to be affected relative to the overall extent of the vegetation type concerned.

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

Potential significance: The significance of this impact could potentially be of low significance (see table below).

Mitigation measures: Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the servitude of the powerline. Disturbed areas beyond the footprint of the infrastructure must be rehabilitated as quickly as possible.

Nature: Loss of habitat within indigenous natural vegetation		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	small (1)	small (1)
Probability	Highly probable (4)	probable (3)
Significance	**low (24)**	**low (18)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some extent	
Mitigation: (1) Avoid unnecessary impacts on natural vegetation surrounding infrastructure. Impacts should be contained, as much as possible, within the servitude of the infrastructure.		
Cumulative impacts: Soil erosion, alien invasions may lead to additional loss of habitat that will exacerbate this impact.		
Residual Impacts: Some loss of this vegetation type will occur, but this is insignificant relative to the total extent of the vegetation type.		

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

Impact 2: Impacts on threatened plants

Duration: The impact will be permanent due to the fact that clearing of vegetation for construction purposes cannot be reversed and any plants destroyed will be permanently lost.

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

Magnitude: The potential magnitude of this impact is likely to be low for the vulnerable species (*Aloe dichotoma* subsp. *dichotoma*). Two individuals of the species occurs on site. The overall impact is therefore likely to be on small numbers of individuals within a localized area.

Probability: It is unlikely that there could be impacts on populations of the Threatened species, *Aloe dichotoma* subsp. *dichotoma*. This is based on the fact that only two individuals of the species occur on site and the powerline towers can be positioned to avoid them.

Potential significance: The significance of this impact could potentially be of low significance (see table below).

Mitigation measures: Where possible, towers should be shifted slightly to avoid having to destroy plants.

Nature: Destruction/permanent loss of individuals of threatened plant species		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (2)
Probability	Improbable (2)	Highly improbable (1)
Significance	**Low (16)**	**Low (8)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Partially	
Mitigation: (1) Where possible, shift tower positions slightly to avoid having to destroy plants. If this is not possible, then: (2) Rescue any plants that will be affected and plant them in adjacent habitat where they will not be disturbed further.		
Cumulative impacts: Loss of habitat, soil erosion, alien invasions may all lead to additional impacts that will exacerbate this impact.		
Residual Impacts: None likely		

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

Impact 3: Impacts on protected tree species

Duration: The impact will be permanent due to the fact that clearing of trees for construction purposes cannot be reversed. Any loss of individual trees will therefore be irreversible.

Extent: The impact will occur at the site of the proposed facility. It may affect single individuals of protected species.

Magnitude: The potential magnitude of this impact will be minor and will only affect two individuals of *Boscia albitrunca*.

Probability: There are two individuals of *Boscia albitrunca* on site, both of which occur on the banks of a drainage line. It is unknown what the exact footprint of the infrastructure will be, but it is improbable that there will be protected trees affected. This is based on the fact that the powerline towers take up a very small area of space and are unlikely to be positioned directly on the banks of a drainage line.

Potential significance: The significance of this impact could potentially be of low significance (see table below). However, a permit would need to be obtained for any protected trees that are affected, so a legal obligation remains to determine the possible presence of protected trees irrespective of the significance of the impact.

Mitigation measures: A permit is required for the removal or damage of protected trees.

Nature: Loss of individuals of protected trees		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (2)	Minor (2)
Probability	Improbable (2)	Highly improbable (1)
Significance	**low (16)**	**low (8)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Not necessary	
Mitigation: (1) Ensure that powerline towers are situated a minimum of 20 m from any protected tree, OR (2) Obtain a permit for any protected trees that have to be destroyed in order to construct the powerline.		
Cumulative impacts: Impacts due to alien invasions and damage to watercourses may possibly cause damage to habitat where protected trees could grow that may exacerbate this impact.		
Residual Impacts: None likely		

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

Impact 4: Impacts on threatened animals

Duration: The most important threat to Ludwig's Bustard across it's range is collisions with overhead powerlines and telephone wires. The impact will therefore be long-term.

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

Magnitude: Assuming that both species of concern occur on site, the potential magnitude of this impact will be low on the two species as a whole.

Probability: It is improbable that there will be impacts on populations of threatened species. This is based on the fact that both species of concern have not been previously recorded in the grid in which the site is located or similar grids close to the Orange River. The field survey indicated that the site is not suitable for Ludwig's Bustard.

Potential significance: The significance of this impact could potentially be of low significance (see table below).

Mitigation measures: As a general measure, the powerline should be made visible to flying birds by attaching suitable visibility devices.

Nature: Impacts on threatened animals		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (3)
Probability	Improbable (2)	Highly improbable (1)
Significance	**Low (18)**	**Low (8)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible with effective rehabilitation	Reversible

Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) As a general measure, suitable measures must be taken to make the powerline more visible to flying birds.		
Cumulative impacts: Loss of indigenous natural vegetation, alien invasions may all lead to additional impacts that will exacerbate this impact.		
Residual Impacts: None likely		

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

Impact 5: Impacts on watercourses and drainage areas

Duration: The impact will be permanent due to the fact that clearing of land for construction purposes cannot be reversed.

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

Magnitude: The potential magnitude of this impact will be minor, but depends on the specific locality of affected sites.

Probability: Drainage lines occur on site, some fairly significant in size, but powerline towers occupy a very small relative area and the position can be adjusted with a fair degree of flexibility. It is therefore considered improbable that there will be drainage lines affected by construction of the proposed powerline.

Potential significance: The significance of this impact could potentially be of low significance (see table below).

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. Powerline towers must be placed a minimum of 50 m from drainage lines / watercourses. Disturbed areas must be rehabilitated as soon as possible. A permit from the Department of Water Affairs (DWA) is required if there are expected to be any impacts on any wetlands or watercourses.

Nature: Damage to watercourses and drainage lines		
	Without mitigation	**With mitigation**
Extent	Local and surroundings (2)	Local and surroundings (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (2)	Minor (1)
Probability	Improbable (2)	Highly improbable (1)
Significance	**Low (18)**	**Low (8)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	

Mitigation: (1) Control stormwater and runoff water to avoid erosion impacts on watercourses. (2) Powerline towers must be positioned a minimum of 50 m outside the outer boundary of any watercourse. (3) Rehabilitate any disturbed areas as quickly as possible (4) No structures should be permanently positioned within the bed of watercourses. (5) Obtain a permit from DWA to impact on any wetland or water resource.
Cumulative impacts: Soil erosion, alien invasions may all lead to additional impacts on watercourses that will exacerbate this impact.
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.

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

Impact 6: Establishment and spread of declared weeds and alien invader plants

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

Extent: The impact will occur at the site of the proposed powerline and servitude, but could spread into neighbouring areas.

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

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

Potential significance: The significance of this impact could potentially be of medium significance (see table below).

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 that would take decades to remove. 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.

Nature: Establishment and spread of declared weeds and alien invader plants		
	Without mitigation	**With mitigation**
Extent	Site & surroundings (2)	Site & surroundings (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (5)	Low (3)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (18)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Keep disturbance of indigenous vegetation to a minimum (2) Rehabilitate disturbed areas as quickly as possible following completion of construcrtion activities in an area (3) Do not translocate soil stockpiles from areas with alien plants		

(4) Control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove (5) Establish an ongoing monitoring programme to detect and quantify any aliens that may become established
Cumulative impacts: Soil erosion, habitat loss, damage to wetlands may all lead to additional impacts that will exacerbate this impact.
Residual Impacts: Will probably be very low if control measures are effectively applied

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

DISCUSSION AND CONCLUSIONS

There is one major vegetation type that occurs in the study area, namely Bushmanland Arid Grassland. This vegetation type is classified as Least Threatened and also has a wide distribution and extent. The site falls within an area classified in a Northern Cape Conservation Plan as being a corridor area. These are areas that are moderately to significantly disturbed, but still able to maintain basic functionality and are important terrestrial migration corridors in which basic ecological functionality needs to be maintained. The natural vegetation across most of the site is therefore not considered to have high conservation status, but that ecological functionality of the broader landscape may need to be taken into consideration in determining the desirability of development of the site. Recommended land management within corridor areas is to limit any further habitat loss or, where hard transformation is proposed, only to permit it with appropriate biodiversity offsets. The current site is situated between existing cultivated areas. It is therefore considered unlikely that development of the site will compromise ecological connectivity within this corridor area. Some loss of natural habitat will occur, but this will be insignificant in comparison to the total area of the vegetation type concerned or the width of the corridor area (10 km wide).

Most of the study area is in a natural condition. There is a small area of cultivation, two buildings and a gravel access road in the north-western part of the site. The north-eastern part of the site is also degraded to some extent due to earthworks of some nature. Except for the southern part of the site, the entire site is surrounded by cultivation and, in the northern part, is abutted by the national road. The site is therefore largely natural, but is surrounded almost completely by transformed habitat. There is also evidence that the site is regularly traversed by local farm workers moving between orchards on each side of the site, which has had an impact on the quality of the site and the value of the site for local flora and fauna.

Other factors that may lead to parts of the study area having elevated ecological sensitivity are the presence of dry watercourses on site and the potential presence of various plant and animal species of conservation concern. Watercourses represent particularly vital natural corridors as they function both as wildlife habitat, providing resources needed for survival, reproduction and movement, and as biological corridors, providing for movement between habitat patches. Wetlands (including watercourses) are protected under national legislation (National Water Act). Any impacts on these areas would require a permit from the National Department of Water Affairs.

There are four protected tree species that occur in the general area that includes the site. Only one of these occur on site, two individuals of *Boscia albitrunca*, both of which occur in close proximity to drainage lines. The geographical co-ordinates of these two individuals are as follows: Specimen 1: South 28.76528 East 20.58435, Specimen 2 South 28.77674 East 20.58849.

There is one threatened plant species that occurs on site, the Vulnerable species, *Aloe dichotoma* subsp. *dichotoma* (kokerboom). Two individuals of this species were found on site, both in the southern part of the site near to the existing powerline. The geographical co-ordinates of these two individuals are as follows: Specimen 1: South 28.77424 East 20.58481, Specimen 2 South 28.77428 East 20.58858.

There are a small number of animal species protected according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) that have a geographical distribution that includes the site and that may occur on site. These are the Honey Badger and the Cape Fox. These two species are unlikely to be affected by development of the site. No signs of them

were found on site, but, if they occur there, they are mobile species that are likely to move away during construction of the facility.

There are two bird species of potential conservation concern that were considered to potentially make use of habitats on site, either for foraging or breeding. These are Ludwig's Bustard (listed globally as Endangered) and the Kori Bustard (listed globally as Least Concern and nationally as Vulnerable). After a field assessment of the site, it was considered unlikely that Ludwig's Bustard would occur there. This is based on the fact that there is a regular presence of humans on site and in the surrounding orchards. Field experience of Ludwig's Bustard is that it avoids humans and flies away when it detects them, even from far away. In addition, the vegetation on site is very sparse and offers little cover for individual birds. It is therefore considered unlikely that the site constitutes important habitat for this species and that it is unlikely that any of these birds would be found regularly on site. For similar reasons, the Kori Bustard is also not likely to be found on site. It is therefore considered improbable that there will be impacts on populations of these two threatened species.

A risk assessment was undertaken which identified six main potential negative impacts on the ecological receiving environment. The significance of these impacts was assessed and it was determined that some of these impacts are likely to be significant (see Table 5 for a summary of the significance of impacts). The potential impacts of greatest significance are on a threatened plant (the Vulnerable *Aloe dichotoma*), protected trees (*Boscia albitrunca*) and watercourses and due to the potential spread of alien invasive plants.

Table 5: Summary of the significance of impacts for different infrastructure components before and after mitigation.

	Solar array, roads and buildings		**Overhead powerline**	
Impact on:	Without mitigation	With mitigation	Without mitigation	With mitigation
1. Natural vegetation	low (28)	low (21)	low (24)	low (18)
2. threatened plants	medium (40)	medium (35)	low (16)	low (8)
3. protected trees	medium (32)	medium (32)	low (16)	low (8)
4. threatened animals	low (18)	low (18)	low (18)	low (8)
5. watercourses	medium (48)	medium (36)	low (18)	low (8)
6. alien plants	medium (33)	low (18)	medium (33)	low (18)

*Significance: <30 = low, 30–60 = medium, >60 = high.

Recommendations

The following recommendations are made to reduce impacts or provide additional information that can lead to reduction or control of impacts:

- A permit (water-use license) is required to impact on any watercourse. Watercourses should be avoided, where possible, and measures taken to reduce impacts where it is not possible to avoid watercourses.
- If possible, infrastructure should be positioned in such a way as to prevent damage to threatened trees and protected trees. The geographical co-ordinates of four potentially affected individuals are provided in this report. If not, a permit is required for the removal of the protected trees (*Boscia albitrunca*) and authorisation for damage to individuals of the threatened tree species (*Aloe dichotoma*).

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.

OBJECTIVE: Control loss of/disruption to indigenous vegetation	
Project component/s	Any infrastructure or activity that will result in disturbance to natural areas
Potential Impact	Loss of indigenous natural vegetation due to construction activities
Activity/risk source	Construction
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/servitude of the infrastructure (2) Limit unnecessary impacts on surrounding natural vegetation, e.g. driving around in the veld, use access roads only (3) Where possible, situate infrastructure within or close to existing disturbance	Construction team, management (environmental officer)	Construction

Performance Indicator	Minimum loss of natural vegetation outside ofthe exact footprint of the proposed project
Monitoring	• Before construction, demarcate footprint of proposed infrastructure and construction area and ensure that construction impacts are contained within this area.

OBJECTIVE: Protect individuals of threatened tree (*Aloe dichotoma*)	
Project component/s	Any infrastructure that may affect threatened species
Potential Impact	Loss of single individual of threatened tree, *Aloe dichotoma* subsp. *dichotoma* (quiver tree).
Activity/risk source	Construction
Mitigation: Target/Objective	Target: no damage to threatened trees Time period: construction

Mitigation: Action/control	Responsibility	Timeframe
(1) No construction activities must take place within 50 m of the potentially affected trees. The individual trees are located at geographical co-ordinate South 28.77424 East 20.58481 and South 28.77428 East 20.58858. (2) Position infrastructure so that individual trees are not affected. (3) Educate personnel on the conservation value of the species and the need to prevent disturbance to any individuals. (4) Where possible, shift infrastructure position to avoid having to destroy plants. (5) If plants are to be destroyed (in the case that no other options are available) then a permit is required (National Environmental Management: Biodiversity Act). In such a case, measures must be taken to translocate individuals into adjacent natural areas where they will not be disturbed further.	Construction team, management (environmental officer)	Construction

Performance Indicator	No loss of threatened trees
Monitoring	• Survival of and no damage to potentially affected individuals.

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

Mitigation: Action/control	Responsibility	Timeframe
(1) Where possible, position infrastructure so that individuals of protected trees are not affected. The individual trees are located at geographical co-ordinate South 28.76528 East 20.58435 and South 28.77674 East 20.58849. (2) If it is not possible to avoid destroying trees, a permit is required from Dept. of Forestry for removal of trees or damage to trees. The permit requires the identity, number, size and condition of each tree that will be affected.	Environmental management team, management (environmental officer)	Construction

Performance Indicator	No loss of trees OR permit for affected trees
Monitoring	• None required

OBJECTIVE: Limit damage to watercourses

Project component/s	Any infrastructure or activity that will result in disturbance to watercourses
Potential Impact	Damage to watercourses 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 unnecessary damage to watercourses within project area Time period: construction, operation

Mitigation: Action/control	Responsibility	Timeframe
(1) For any new construction, cross watercourses perpendicularly to minimise disturbance footprints (2) Rehabilitate any disturbed areas as quickly as possible (3) Control stormwater and runoff water (4) Obtain a permit from DWA to impact on any wetland or water resource. (5) Control stormwater and runoff water to avoid erosion impacts on watercourses. (6) Cross watercourses at or close to existing disturbances. (7) Adequate culvert and/or bridge structures are required to ensure that construction impacts do not permanently affect channel structure and morphology. (8) No structures should be permanently positioned within the bed of watercourses. (9) Powerline towers must be positioned a minimum of 50 m outside the outer boundary of any watercourse. (10) Construction of infrastructure must not cause the width of the watercourse to be narrowed or the general morphology to be altered. (11) Obtain a permit from DWA to impact on any wetland or water resource.	Construction team, management, environmental control officer	Construction, Operation

Performance Indicator	No impacts on water quality, water quantity, wetland vegetation, natural status of watercourses outside of footprint of infrastructure
Monitoring	• Habitat loss in watercourses should be monitored before and after construction • The environmental manager should be responsible for driving this process • Reporting frequency depends on legal compliance framework

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

Mitigation: Action/control	Responsibility	Timeframe
(1) Avoid creating conditions in which alien plants may become established: a. Keep disturbance of indigenous vegetation to a minimum b. Rehabilitate disturbed areas as quickly as possible c. Do not import soil from areas with alien plants (2) Establish an 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	• Ongoing monitoring of area by environmental control officer during construction • Ongoing monitoring of area by environmental manager during operation • Annual audit of project area and immediate surroundings by qualified botanist. If no species are detected, then this can be stated. If any alien invasive species are detected then the distribution of these should be mapped (GPS co-ordinates of plants or concentrations of plants), number of individuals (whole site or per unit area), age and/or size classes of plants and aerial cover of plants. The results should be interpreted in terms of the risk posed to sensitive habitats within and surrounding the project area. The environmental manager should be responsible for driving this process. Reporting frequency depends on legal compliance framework

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

Sources: South African National Biodiversity Institute in Pretoria.

Family	Taxon	Status	Habitat	Likelihood of occurrence on site
FABACEAE	Acacia erioloba	Declining	Savanna, semi-desert and desert areas, deep sandy soils and along drainage lines in very arid areas, sometimes in rocky outcrops.	HIGH
ASPHODALACEAE	Aloe dichotoma subsp. dichotoma	VU	North-facing rocky slopes (particularly dolomite) in the south of its range.	MEDIUM
FABACEAE	Bauhinia bowkeri	NT	Mzimvubu to Kei River, Eastern Cape and KwaZulu-Natal. Specimen in grid is in cultivation or wrongly identified.	ZERO
FABACEAE	Caesalpinia bracteata	VU	This species is only known from below the Augrabies Falls near the Orange River and Klein Pella on granite. Blouputs Karroid Thornveld.	LOW, nearest locality is 40 km away
AMARYLLIDACEAE	Crinum bulbispermum	Declining	Scattered from the Northern Cape on the banks of the Orange River eastwards through the Free State, Lesotho to Mpumalanga and KwaZulu-Natal. Recorded in the drainage basins of the Orange and Vaal Rivers practically throughout their lengths, and also in the catchment areas of the Pongola and the Tugela Rivers. Near rivers, streams, seasonal pans and in damp depressions.	LOW
MESEMBRYANTHEMACEAE	Dinteranthus wilmotianus	NT	Orange river basin, from Augrabies to Eendoorn area near Warmbad in southern Namibia. Alluvial gravel soils.	MEDIUM
APOCYNACEAE	Hoodia gordonii	Declining	Wide variety of arid habitats	HIGH
APOCYNACEAE	Hoodia officinalis subsp. officinalis	NT	Namibia, Northern Cape and just enters the western part of the Free State at Jacobsdal. Almost always found growing inside bushes in flattish or gently sloping areas, often associated with patches of driedoring (*Rhigozum trichotomum*)	HIGH

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

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

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

Acacia erioloba, Acacia haematoxylon, Boscia albitrunca, Euclea pseudebenus have a geographical distribution that coincides with the study area.

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

Family	Species
ACANTHACEAE	Acanthopsis disperma Nees
ACANTHACEAE	Barleria lichtensteiniana Nees
ACANTHACEAE	Barleria rigida Nees
ACANTHACEAE	Monechma divaricatum (Nees) C.B.Clarke
ACANTHACEAE	Monechma genistifolium (Engl.) C.B.Clarke subsp. australe (P.G.Mey.) Munday
ACANTHACEAE	Monechma spartioides (T.Anderson) C.B.Clarke
AIZOACEAE	Aizoon burchellii N.E.Br.
AIZOACEAE	Galenia africana L.
AIZOACEAE	Galenia sarcophylla Fenzl
AIZOACEAE	Tetragonia reduplicata Welw. ex Oliv.
AMARYLLIDACEAE	Nerine gaberonensis Bremek. & Oberm.
APOCYNACEAE	Cryptolepis decidua (Planch. ex Benth.) N.E.Br.
APOCYNACEAE	Hoodia officinalis (N.E.Br.) Plowes subsp. officinalis
APOCYNACEAE	Microloma incanum Decne.
APOCYNACEAE	Microloma sagittatum (L.) R.Br.
APOCYNACEAE	Pergularia daemia (Forssk.) Chiov. subsp. garipensis (E.Mey.) Goyder
ASPARAGACEAE	Asparagus pearsonii Kies
ASPHODELACEAE	Aloe claviflora Burch.
ASPHODELACEAE	Aloe gariepensis Pillans
ASPHODELACEAE	Trachyandra divaricata (Jacq.) Kunth
ASPHODELACEAE	Aloe dichotoma Masson
ASPHODELACEAE	Aloe gariepensis Pillans
ASTERACEAE	Amellus epaleaceus O.Hoffm.
ASTERACEAE	Amellus strigosus (Thunb.) Less. subsp. strigosus
ASTERACEAE	Amellus tridactylus DC. subsp. arenarius (S.Moore) Rommel
ASTERACEAE	Arctotis campanulata DC.
ASTERACEAE	Berkheya chamaepeuce (S.Moore) Roessler
ASTERACEAE	Berkheya spinosissima (Thunb.) Willd. subsp. spinosissima
ASTERACEAE	Dicoma capensis Less.
ASTERACEAE	Dimorphotheca sinuata DC.
ASTERACEAE	Eriocephalus ambiguus (DC.) M.A.N.Müll.
ASTERACEAE	Felicia clavipilosa Grau subsp. clavipilosa
ASTERACEAE	Foveolina dichotoma (DC.) Källersjö
ASTERACEAE	Gazania lichtensteinii Less.
ASTERACEAE	Geigeria filifolia Mattf.
ASTERACEAE	Gorteria corymbosa DC.
ASTERACEAE	Helichrysum argyrosphaerum DC.
ASTERACEAE	Helichrysum gariepinum DC.
ASTERACEAE	Helichrysum herniarioides DC.
ASTERACEAE	Helichrysum micropoides DC.
ASTERACEAE	Helichrysum zeyheri Less.

ASTERACEAE	Ifloga molluginoides (DC.) Hilliard
ASTERACEAE	Nidorella resedifolia DC. subsp. resedifolia
ASTERACEAE	Oncosiphon piluliferum (L.f.) Källersjö
ASTERACEAE	Osteospermum armatum Norl.
ASTERACEAE	Pentzia argentea Hutch.
ASTERACEAE	Pentzia pinnatisecta Hutch.
ASTERACEAE	Pteronia leucoclada Turcz.
ASTERACEAE	Pteronia mucronata DC.
ASTERACEAE	Senecio laxus DC.
ASTERACEAE	Senecio niveus (Thunb.) Willd.
ASTERACEAE	Tripteris microcarpa Harv. subsp. microcarpa
ASTERACEAE	Arctotis leiocarpa Harv.
ASTERACEAE	Felicia namaquana (Harv.) Merxm.
ASTERACEAE	Foveolina dichotoma (DC.) Källersjö
ASTERACEAE	Kleinia longiflora DC.
ASTERACEAE	Nolletia arenosa O.Hoffm.
ASTERACEAE	Senecio niveus (Thunb.) Willd.
BORAGINACEAE	Codon royenii L.
BORAGINACEAE	Trichodesma africanum (L.) Lehm.
BRASSICACEAE	Coronopus integrifolius (DC.) Spreng.
BRASSICACEAE	Heliophila deserticola Schltr. var. deserticola
BRASSICACEAE	Heliophila trifurca Burch. ex DC.
BRASSICACEAE	Heliophila deserticola Schltr. var. deserticola
BURSERACEAE	Commiphora gracilifrondosa Dinter ex J.J.A.van der Walt
CAMPANULACEAE	Wahlenbergia androsacea A.DC.
CAPPARACEAE	Boscia foetida Schinz subsp. foetida
CAPPARACEAE	Cleome angustifolia Forssk. subsp. diandra (Burch.) Kers
CAPPARACEAE	Cleome gynandra L.
CARYOPHYLLACEAE	Pollichia campestris Aiton
CELASTRACEAE	Gymnosporia linearis (L.f.) Loes. subsp. lanceolata (E.Mey. ex Sond.) M.Jordaan
CHENOPODIACEAE	Chenopodium hederiforme (Murr) Aellen var. dentatum Aellen
CHENOPODIACEAE	Salsola aphylla L.f.
CHENOPODIACEAE	Salsola barbata Aellen
CHENOPODIACEAE	Salsola kali L.
CHENOPODIACEAE	Salsola tuberculata (Moq.) Fenzl
CHENOPODIACEAE	Suaeda fruticosa (L.) Forssk.
COLCHICACEAE	Ornithoglossum undulatum Sweet
CONVOLVULACEAE	Ipomoea oenotheroides (L.f.) Raf. ex Hallier f.
CRASSULACEAE	Crassula muscosa L. var. muscosa
CRASSULACEAE	Crassula sericea Schönland var. sericea
CRASSULACEAE	Tylecodon rubrovenosus (Dinter) Toelken
CUCURBITACEAE	Cucumis africanus L.f.
EBENACEAE	Euclea pseudebenus E.Mey. ex A.DC.
EUPHORBIACEAE	Euphorbia avasmontana Dinter var. avasmontana

EUPHORBIACEAE	Euphorbia glanduligera Pax
EUPHORBIACEAE	Euphorbia gregaria Marloth
EUPHORBIACEAE	Euphorbia gummifera Boiss.
EUPHORBIACEAE	Euphorbia rudis N.E.Br.
EUPHORBIACEAE	Euphorbia spinea N.E.Br.
FABACEAE	Acacia erioloba E.Mey.
FABACEAE	Acacia mellifera (Vahl) Benth. subsp. detinens (Burch.) Brenan
FABACEAE	Aspalathus hirta E.Mey. subsp. hirta
FABACEAE	Calobota spinescens (Harv.) Boatwr. & B.-E.van Wyk
FABACEAE	Crotalaria virgultalis Burch. ex DC.
FABACEAE	Cullen tomentosum (Thunb.) J.W.Grimes
FABACEAE	Indigastrum argyroides (E.Mey.) Schrire
FABACEAE	Indigofera heterotricha DC.
FABACEAE	Indigofera pechuelii Kuntze
FABACEAE	Lotononis falcata (E.Mey.) Benth.
FABACEAE	Lotononis marlothii Engl.
FABACEAE	Lotononis rabenaviana Dinter & Harms
FABACEAE	Melolobium candicans (E.Mey.) Eckl. & Zeyh.
FABACEAE	Parkinsonia africana Sond.
FABACEAE	Pomaria lactea (Schinz) B.B.Simpson & G.P.Lewis
FABACEAE	Schotia afra (L.) Thunb. var. angustifolia (E.Mey.) Harv.
FABACEAE	Sutherlandia microphylla Burch. ex DC.
FABACEAE	Tephrosia dregeana E.Mey. var. dregeana
FABACEAE	Bauhinia bowkeri Harv.
FABACEAE	Indigofera pechuelii Kuntze
FABACEAE	Lotononis platycarpa (Viv.) Pic.Serm.
FABACEAE	Lotononis rabenaviana Dinter & Harms
HYACINTHACEAE	Drimia fasciata (B.Nord.) J.C.Manning & Goldblatt
HYACINTHACEAE	Ornithogalum deltoideum Baker
HYACINTHACEAE	Albuca collina Baker
HYACINTHACEAE	Dipcadi gracillimum Baker
IRIDACEAE	Babiana curviscapa G.J.Lewis
IRIDACEAE	Gladiolus saccatus (Klatt) Goldblatt & M.P.de Vos
IRIDACEAE	Lapeirousia plicata (Jacq.) Diels subsp. plicata
IRIDACEAE	Romulea obscura Klatt var. subtestacea M.P.de Vos
LAMIACEAE	Ocimum americanum L. var. americanum
LAMIACEAE	Salvia garipensis E.Mey. ex Benth.
LOASACEAE	Kissenia capensis Endl.
LORANTHACEAE	Tapinanthus oleifolius (J.C.Wendl.) Danser
MALVACEAE	Abutilon dinteri Ulbr.
MALVACEAE	Abutilon pycnodon Hochr.
MALVACEAE	Hermannia minutiflora Engl.
MALVACEAE	Hermannia modesta (Ehrenb.) Mast.
MALVACEAE	Hermannia spinosa E.Mey. ex Harv.

MALVACEAE	Hermannia stricta (E.Mey. ex Turcz.) Harv.
MALVACEAE	Hibiscus elliottiae Harv.
MALVACEAE	Hibiscus engleri K.Schum.
MALVACEAE	Radyera urens (L.f.) Bullock
MALVACEAE	Grewia flava DC.
MALVACEAE	Hermannia comosa Burch. ex DC.
MALVACEAE	Hermannia stricta (E.Mey. ex Turcz.) Harv.
MELIACEAE	Nymania capensis (Thunb.) Lindb.
MELIACEAE	Nymania capensis (Thunb.) Lindb.
MESEMBRYANTHEMACEAE	Dinteranthus wilmotianus L.Bolus
MESEMBRYANTHEMACEAE	Lithops julii (Dinter & Schwantes) N.E.Br. subsp. fulleri (N.E.Br.) B.Fearn
MESEMBRYANTHEMACEAE	Mesembryanthemum guerichianum Pax
MESEMBRYANTHEMACEAE	Phyllobolus lignescens (L.Bolus) Gerbaulet
MESEMBRYANTHEMACEAE	Prenia tetragona (Thunb.) Gerbaulet
MESEMBRYANTHEMACEAE	Psilocaulon subnodosum (A.Berger) N.E.Br.
MOLLUGINACEAE	Hypertelis salsoloides (Burch.) Adamson var. salsoloides
MOLLUGINACEAE	Limeum aethiopicum Burm.f. var. aethiopicum
MOLLUGINACEAE	Limeum dinteri G.Schellenb.
MOLLUGINACEAE	Limeum fenestratum (Fenzl) Heimerl var. fenestratum
MOLLUGINACEAE	Limeum dinteri G.Schellenb.
MONTINIACEAE	Montinia caryophyllacea Thunb.
MORACEAE	Ficus cordata Thunb. subsp. cordata
NEURADACEAE	Grielum sinuatum Licht. ex Burch.
PEDALIACEAE	Rogeria longiflora (Royen) J.Gay ex DC.
PHYLLANTHACEAE	Phyllanthus parvulus Sond. var. garipensis (E.Mey. ex Drège) Radcl.-Sm.
PHYLLANTHACEAE	Phyllanthus parvulus Sond. var. parvulus
PLUMBAGINACEAE	Dyerophytum africanum (Lam.) Kuntze
POACEAE	Anthephora pubescens Nees
POACEAE	Aristida adscensionis L.
POACEAE	Aristida congesta Roem. & Schult. subsp. congesta
POACEAE	Aristida engleri Mez var. engleri
POACEAE	Brachiaria glomerata (Hack.) A.Camus
POACEAE	Cenchrus ciliaris L.
POACEAE	Dichanthium annulatum (Forssk.) Stapf var. papillosum (A.Rich.) de Wet & Harlan
POACEAE	Echinochloa stagnina (Retz.) P.Beauv.
POACEAE	Enneapogon cenchroides (Licht. ex Roem. & Schult.) C.E.Hubb.
POACEAE	Enneapogon desvauxii P.Beauv.
POACEAE	Enneapogon scaber Lehm.
POACEAE	Eragrostis annulata Rendle ex Scott-Elliot
POACEAE	Eragrostis nindensis Ficalho & Hiern
POACEAE	Eragrostis porosa Nees
POACEAE	Leucophrys mesocoma (Nees) Rendle
POACEAE	Melinis repens (Willd.) Zizka subsp. repens
POACEAE	Odyssea paucinervis (Nees) Stapf

POACEAE	Oropetium capense Stapf
POACEAE	Panicum arbusculum Mez
POACEAE	Schmidtia kalahariensis Stent
POACEAE	Setaria appendiculata (Hack.) Stapf
POACEAE	Sorghum bicolor (L.) Moench subsp. arundinaceum (Desv.) de Wet & Harlan
POACEAE	Sporobolus coromandelianus (Retz.) Kunth
POACEAE	Stipagrostis namaquensis (Nees) De Winter
POACEAE	Stipagrostis obtusa (Delile) Nees
POACEAE	Stipagrostis uniplumis (Licht.) De Winter var. uniplumis
POACEAE	Tragus berteronianus Schult.
POACEAE	Tricholaena capensis (Licht. ex Roem. & Schult.) Nees subsp. capensis
POACEAE	Triraphis ramosissima Hack.
POACEAE	Cenchrus ciliaris L.
POACEAE	Enneapogon scaber Lehm.
POACEAE	Eragrostis caesia Stapf
POACEAE	Panicum arbusculum Mez
POACEAE	Setaria appendiculata (Hack.) Stapf
POACEAE	Stipagrostis uniplumis (Licht.) De Winter var. uniplumis
POLYGALACEAE	Polygala leptophylla Burch. var. armata (Chodat) Paiva
POLYGALACEAE	Polygala leptophylla Burch. var. leptophylla
PORTULACACEAE	Anacampseros filamentosa (Haw.) Sims subsp. namaquensis (H.Pearson & Stephens) G.D.Rowley
PORTULACACEAE	Ceraria namaquensis (Sond.) H.Pearson & Stephens
RHAMNACEAE	Ziziphus mucronata Willd. subsp. mucronata
RUBIACEAE	Kohautia caespitosa Schnizl. subsp. brachyloba (Sond.) D.Mantell
RUBIACEAE	Kohautia cynanchica DC.
RUTACEAE	Thamnosma africana Engl.
SANTALACEAE	Thesium lineatum L.f.
SAPINDACEAE	Pappea capensis Eckl. & Zeyh.
SCROPHULARIACEAE	Antherothamnus pearsonii N.E.Br.
SCROPHULARIACEAE	Aptosimum lineare Marloth & Engl. var. lineare
SCROPHULARIACEAE	Aptosimum procumbens (Lehm.) Steud.
SCROPHULARIACEAE	Aptosimum spinescens (Thunb.) F.E.Weber
SCROPHULARIACEAE	Diascia engleri Diels
SCROPHULARIACEAE	Diclis petiolaris Benth.
SCROPHULARIACEAE	Freylinia lanceolata (L.f.) G.Don
SCROPHULARIACEAE	Jamesbrittenia aridicola Hilliard
SCROPHULARIACEAE	Jamesbrittenia canescens (Benth.) Hilliard var. canescens
SCROPHULARIACEAE	Jamesbrittenia integerrima (Benth.) Hilliard
SCROPHULARIACEAE	Limosella longiflora Kuntze
SCROPHULARIACEAE	Nemesia maxii Hiern
SCROPHULARIACEAE	Peliostomum leucorrhizum E.Mey. ex Benth.
SCROPHULARIACEAE	Zaluzianskya diandra Diels
SCROPHULARIACEAE	Diascia engleri Diels
SCROPHULARIACEAE	Peliostomum leucorrhizum E.Mey. ex Benth.

SINOPTERIDACEAE	Cheilanthes deltoidea Kunze
SOLANACEAE	Lycium bosciifolium Schinz
SOLANACEAE	Lycium pumilum Dammer
SOLANACEAE	Nicotiana glauca Graham
SOLANACEAE	Solanum burchellii Dunal
SOLANACEAE	Solanum namaquense Dammer
TAMARICACEAE	Tamarix usneoides E.Mey. ex Bunge
TECOPHILAEACEAE	Cyanella lutea L.f.
URTICACEAE	Forsskaolea candida L.f.
VERBENACEAE	Chascanum garipense E.Mey.
VERBENACEAE	Chascanum garipense E.Mey.
ZYGOPHYLLACEAE	Tribulus cristatus C.Presl
ZYGOPHYLLACEAE	Zygophyllum dregeanum Sond.
ZYGOPHYLLACEAE	Zygophyllum microcarpum Licht. ex Cham. & Schltdl.
ZYGOPHYLLACEAE	Zygophyllum retrofractum Thunb.
ZYGOPHYLLACEAE	Zygophyllum simplex L.
ZYGOPHYLLACEAE	Zygophyllum microcarpum Licht. ex Cham. & Schltdl.

Appendix 4: Threatened vertebrate species with a geographical distribution that includes the current study area.

MAMMALS

Common name	Taxon	Habitat[1]	National status	Global status[2]	Likelihood of occurrence
Black rhinoceros	*Diceros bicornis bicornis*	Wide variety of habitats, but currently only occurs in game reserves.	CR	CR	**NONE**, only occurs in game reserves
Hartmann's mountain zebra	*Equus zebra hartmannae*	Rocky barren areas, ecotones between mountains and plains / flats, grazer	EN	VU	**LOW,** historical record from nearby grid, edge of geographical distribution, habitat is not suitable.
Honey badger	*Mellivora capensis*	Wide variety of habitats. Probably only in natural habitats.	NT	LC	**HIGH**, overall geographical distribution includes this area, habitat is suitable.
Darling's horseshoe bat	*Rhinolophus darlingii*	Savanna, rossting in caves and sub-terranean habitats	NT	LC	**LOW**, recorded in nearby grid, on edge of distribution; suitable probably does not occur on site.
Dent's horseshoe bat	*Rhinolophus denti*	Savanna, nama-Karoo, succulent Karoo, distribution follows rivers. Caves and subterranean habitats. Aerial insectivore.	NT	LC	**MEDIUM**, within distribution; suitable habitat may occur nearby in Orange River valley.
Littledale's whistling rat	*Parotomys littledalei*	Desert, Karoo. Sandy or gravel open plains. Tends to excavate burrow beneath a shrub, but will also contruct stick nest at the base of a shrub. Herbivorous, favouring leaves of *Zygophullum* and Mesembryanthemaceae.	NT	LC	**HIGH**, site is in core of distribution range. Habitat suitable on site.
Dassie Rat	*Petromus typicus*	Rocky barren areas on rocky outcrops and koppies. Flat rock crevices. Eats soft vegetable matter, including leaves of shrubs and flowers of many Asteraceae.	NT	LC	**LOW**, site is in core of distribution range, but no suitable habitat on site.

[1]Distribution and national status according to Friedmann & Daly 2004.

[2]Global status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 29 April 2011.

AMPHIBIANS

Common name	Species	Habitat	Status	Likelihood of occurrence
Giant Bullfrog	*Pyxicephalus adspersus*	Widely distributed in southern Africa, mainly at higher elevations. Inhabits a variety of vegetation types where it breeds in seasonal, shallow, grassy pans in flat, open areas; also utilises non-permanent	NT[1] LC[2] Protected (NEMBA)	**LOW**, within known distribution range, suitable habitat unlikely to occur on

		vleis and shallow water on margins of waterholes and dams. Prefer sandy substrates although they sometimes inhabit clay soils.		site.

[1]Status according to Minter et al. 2004.

[2]Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 29 April 2011.

REPTILES

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

[3]Distribution according to Marais 2004.

[4]Status according to Alexander & Marais 2007.

BIRDS

Common name	Species	Habitat	Status	Importance of site for species	
				Breeding	Foraging
Chestnutbanded plover	*Charadrius pallidus*	Saline lagoons, saline and brackish pans, saltworks; occasionally estuaries and sandy lagoons. Uncommon resident in study area.	NT	ZERO	ZERO
Black Stork	*Ciconia nigra*	Feeds in or around marshes, dams, rivers and estuaries; breeds in mountainous regions. Uncommon resident in study area.	NT Protected (NEMBA)	LOW	LOW
Black harrier	*Circus maurus*	Grassveld, karoo scrub, mountain fynbos, cultivated lands, subalpine vegetation, semidesert.	VU	LOW	LOW
Marabou Stork	*Leptoptilos crumeniferus*	Open to semi-arid woodland, bushveld, fishing villages, rubbish tips, lake shores. Uncommon resident in study area.	NT	ZERO	LOW
Martial Eagle	*Polemaetus bellicosus*	The Martial Eagle is widespread but uncommon throughout South Africa and neighbouring countries. It tolerates a wide range of vegetation types, being found in open grassland, scrub, Karoo and woodland. It relies on large trees (and electricity pylons) to provide nest sites. It is found typically in flat country and is rarer in mountains and forests. One of the main reason it is declining is because of persecution on private land. This species has been recorded from the study area and many surrounding areas. Common resident in study area.	VU[1] NT[2] Protected (NEMBA)	ZERO	LOW
Kori Bustard	*Ardeotis kori*	Semi-arid regions, within the 100 - 600 mm rainfall isohyet. Also occurs throughout dryer west, particularly in the Nama-Karoo. Open plains of karoo, highveld	VU[1] LC[2] Protected (NEMBA)	LOW	MEDIUM

		grassland, Kalahari sandveld, arid scrub, Namib Desert, lightly wooded savanna, bushveld. Diet consists of insects, reptiles, rodents and vegetable matter. Breeding peaks from October to January. In the semi-arid western parts of South Africa, favours tree-lined watercourses. Common to very common resident in study area.			
Ludwig's Bustard	*Neotis ludwigii*	This is a near-endemic to southern Africa, with its range centred on the Nama Karoo and Succulent Karoo biomes. It occurs in western grasslands of the Eastern Cape, but supposedly as a nonbreeding visitor. The most important threat to this species is collisions with overhead powerlines and telephone wires. It inhabits the open plains of the semi-arid Karoo and especially in areas where extensive sheep farming is prevalent. Uncommon to common resident in study area. Site is not considered suitable for this species	VU[1] EN[2] Protected (NEMBA)	LOW	LOW
Secretarybird	*Sagittarius serpentarius*	Widespread across South Africa, occurring in savanna and open grassland from coastal regions to high altitudes, but avoids thick bush and forest. Sensitive to disturbance and high human population numbers - higher numbers usually found in conservation areas. Uncommon resident in study area.	NT[1] LC[2]	LOW	MEDIUM
Lanner Falcon	*Falco biarmicus*	Widespread species, occurring in Afrotropics, Middle East and western Palearctic. Common resident in study area.	NT	LOW	LOW
Lesser kestrel	*Falco naumanni*	Open grassveld, mainly on highveld, usually near towns or farms. Uncommon non-breeding migrant in study area.	VU Protected (NEMBA)	ZERO	LOW
Peregrine Falcon	*Falco peregrinus*	Cliffs, mountains, steep gorges; may hunt over open grassland, farmland and forests; rarely enters cities to hunt pigeons. Uncommon resident or non-breeding migrant in study area.	NT Protected (NEMBA)	ZERO	LOW
Sclater's Lark	*Spizocorys sclateri*	Endemic to South Africa and southern Namibia. Confined to Nama Karoo, concentrated in the Northern Cape. Uncommon resident	NT[1] NT[2]	LOW	MEDIUM

		in study area.			
Lesser flamingo	*Phoeniconaias minor*	Shallow saline and alkaline wetlands, such as saltpans and coastal lagoons. Uncommon resident in study area.	NT	NONE	NONE
Greater flamingo	*Phoenicopterus ruber*	Estuaries and other wetlands along the west coast, endorheic pans on the Highveld. Uncommon resident in study area.	NT	NONE	NONE

[1]Distribution according to Barnes 2000.

[2]Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 29 April 2011.

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 Western Cape Nature Conservation Laws Amendment Act of 2000 (Act 3 of 2000) marked with "P"
3. Species protected according to the National Environmental Management: Biodiversity Act of 2004 (Act 10 of 2000) marked with "N"

Mammals:

[P]Springbok
[NP]White rhinoceros
[NP]Black rhinoceros
[NP]Hartmann's mountain zebra
[P]Giraffe
Klipspringer
[P]Gemsbok
[P]Steenbok
[P]Common duiker
Rock hyrax
[NP]Cape clawless otter
[P]Water mongoose
Black-backed jackal
Caracal
[P]Yellow mongoose
[P]African wild cat
[P]Small grey mongoose
[P]Slender mongoose
[P]Small-spotted genet
[P]Striped polecat
[NP]Honey badger
[P]Bat-eared fox
[NP]Leopard
[P]Aardwolf
[P]Suricate
[NP]Cape fox
[P]Cape serotine bat
[P]Egyptian slit-faced bat
[P]Darling's horseshoe bat
[P]Dent's Horseshoe Bat
[P]Flat-headed free-tail bat
[P]Egyptian free-tailed bat
[P]Reddish-grey musk shrew
[P]Lesser red musk shrew
[P]Cape/Desert hare
[P]Scrub/Savannah hare
Vervet monkey
Chacma baboon
[P]Namaqua rock mouse
[P]Short-tailed gerbil
[P]Hairy-footed gerbil
[P]Bush-tailed hairy-footed gerbil
[P]Spectacled dormouse
[P]Porcupine
[P]Large-eared mouse
[P]Multimammate mouse
[P]Brant's whistling rat
[P]Littledale's whistling rat
[P]Springhare
[P]Dassie rat
[P]Pygmy rock mouse
[P]Striped mouse
[P]Pouched mouse
[P]Bushveld gerbil
[P]Cape ground squirrel
[P]Smith's rock elephant-shrew
[P]Round-eared elephant shrew
[P]Aardvark

Reptiles:

[P]Common flap-necked chameleon
[P]Namaqua chameleon
Puff adder
Horned adder
Cape cobra
Black spitting cobra
Coral snake / coral shield cobra
Dwarf beaked snake
Karoo whip snake
Kalahari sand snake
Beetz's tiger snake
Brown house snake
[P]Mole snake
Common wolf snake
Common egg-eater
Delalande's beaked blind snake
Schinz's beaked blind snake
[P]Anchieta's agama
[P]Ground agama
[P]Rock monitor
[P]Water monitor
[P]Western sandveld lizard
[P]Namaqua sand lizard
[P]Spotted sand lizard
[P]Western sand lizard

[P]Dusky spade-snouted worm lizard
[P]Cape skink
[P]Karoo girdled lizard
Giant ground gecko
Bibron's tubercled gecko
Kalahari ground gecko
Cape gecko
Rough gecko
Marico gecko
Common barking gecko
[P]Leopard tortoise
[P]Karoo tent tortoise

Amphibians
Guttural toad
Western olive toad
Karoo toad
Common platanna
Boettger's caco
Common river frog
[N]Giant bullfrog
Tremolo sand frog
Tandy's sand frog

Birds:
[P]African Black Duck
[P]African Fish Eagle
[P]African Hoopoe
[P]African Marsh Warbler
[P]African Pied Wagtail
[P]African Rail
[P]Alpine Swift
[P]Anteating Chat
[P]Ashy Tit
[P]Barn Owl
[P]Black Crake
[P]Black Crow
[P]Black Eagle
[P]Black Harrier
[P]Black Kite
[NP]Black Stork
[P]Blackbreasted Snake Eagle
[P]Blackchested Prinia
[P]Blackcrowned Night Heron
[P]Blackeared Finchlark
[P]Blackheaded Canary
[P]Blackheaded Heron
[P]Blackshouldered Kite
[P]Blacksmith Plover
[P]Blackthroated Canary
[P]Blackwinged Stilt
[P]Bokmakierie
[P]Booted Eagle
[P]Bradfield's Lark
[P]Bradfield's Swift
[P]Brownthroated Martin
[P]Brubru
[P]Burchell's Courser
[P]Cape Bunting
[P]Cape Francolin
[P]Cape Penduline Tit
[P]Cape Reed Warbler
[P]Cape Robin
[P]Cape Shoveller
[P]Cape Sparrow
[P]Cape Teal
[P]Cape Turtle Dove
[P]Cape Wagtail
[P]Cape Weaver
[P]Capped Wheatear
[P]Cardinal Woodpecker
[P]Cattle Egret
[P]Chat Flycatcher
[P]Chestnutbanded Plover
[P]Cinnamonbreasted Warbler
[P]Common Moorhen
[P]Common Quail
[P]Common Sandpiper
[P]Common Waxbill
[P]Crimsonbreasted Shrike
[P]Crowned Plover
[P]Curlew Sandpiper
[P]Dabchick
[P]Damara Canary
[P]Darter
[P]Desert Cisticola
[P]Diederik Cuckoo
[P]Doublebanded Courser
[P]Dusky Sunbird
[P]Eastern Clapper Lark
[P]Egyptian Goose
[P]Eurasian Bee-eater
[P]Eurasian Nightjar
[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]Freckled Nightjar
[P]Gabar Goshawk
[P]Garden Warbler

[P]Giant Kingfisher
[P]Glossy Starling
[P]Goldentailed Woodpecker
[P]Goliath Heron
[P]Grassveld Pipit
[P]Greater Flamingo
[P]Greater Kestrel
[P]Greater Striped Swallow
[P]Greenshank
[P]Grey Heron
[P]Greybacked Cisticola
[P]Greybacked Finchlark
[P]Greyheaded Gull
[P]Gymnogene
[P]Hadeda Ibis
[P]Hamerkop
[P]Helmeted Guineafowl
[P]House Sparrow
[P]Jackal Buzzard
[P]Jacobin Cuckoo
[P]Kalahari Robin
[P]Karoo Chat
[P]Karoo Korhaan
[P]Karoo Longbilled Lark
[P]Karoo Robin
[P]Karoo Thrush
[NP]Kori Bustard
[P]Lanner Falcon
[P]Larklike Bunting
[P]Laughing Dove
[P]Layard's Titbabbler
[P]Lesser Doublecollared Sunbird
[P]Lesser Flamingo
[P]Lesser Grey Shrike
[P]Lesser Honeyguide
[NP]Lesser Kestrel
[P]Levaillant's Cisticola
[P]Little Bittern
[P]Little Egret
[P]Little Stint
[P]Little Swift
[P]Longbilled Crombec
[PN]Ludwig's Bustard
[P]Maccoa Duck
[P]Malachite Kingfisher
[P]Marabou Stork
[P]Marsh Sandpiper
[NP]Martial Eagle
[P]Masked Weaver
[P]Mountain Chat
[P]Namaqua Dove
[P]Namaqua Sandgrouse
[P]Namaqua Warbler
[P]Orange River White-eye
[P]Ostrich
[P]Pale Chanting Goshawk
[P]Palewinged Starling
[P]Palm Swift
[P]Pearlbreasted Swallow
[NP]Peregrine Falcon
[P]Pied Avocet
[P]Pied Barbet
Pied Crow
[P]Pied Kingfisher
[P]Pinkbilled Lark
[P]Pintailed Whydah
[P]Pririt Batis
[P]Purple Gallinule
[P]Pygmy Falcon
[P]Red Bishop
[P]Redbacked Shrike
[P]Redbilled Firefinch
Redbilled Quelea
[P]Redbilled Teal
[P]Redcapped Lark
[P]Redeyed Bulbul
[P]Redeyed Dove
[P]Redfaced Mousebird
[P]Redheaded Finch
[P]Redknobbed Coot
[P]Rednecked Falcon
[P]Reed Cormorant
[P]Rock Kestrel
[P]Rock Martin
[P]Rock Pigeon
[P]Rosyfaced Lovebird
[P]Ruff
[P]Rufouscheeked Nightjar
[P]Rufouseared Warbler
[P]Sacred Ibis
[P]Sand Martin
[P]Sanderling
[P]Scalyfeathered Finch
[P]Scimitarbilled Woodhoopoe
[P]Sclater's Lark
[P]Secretarybird
[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]Spikeheeled Lark
[P]Spotted Dikkop
[P]Spotted Eagle Owl

[P]Spotted Flycatcher
[P]Spurwinged Goose
[P]Stark's Lark
[P]Steppe Buzzard
[P]Swallowtailed Bee-eater
[P]Threebanded Plover
[P]Titbabbler
[P]Tractrac Chat
[P]Wattled Starling
[P]Whimbrel
[P]Whiskered Tern
[P]White Stork
[P]Whitebacked Mousebird
[P]Whitebreasted Cormorant
[P]Whitebrowed Sparrowweaver
[P]Whitefaced Owl
[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]Yellowbellied Eremomela
[P]Yellowbilled Duck
[P]Yellowbilled Egret
[P]Yellowbilled Kite