Ecology BA Study

Geel Kop Grid Connection Infrastructure Project near Upington, Northern Cape Province

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Ecological Impact Assessment study on the potential impacts of the proposed Geel Kop Grid Connection Infrastructure near Upington in the Northern Cape Province.

Location:
Kai !Garib Local Municipality within the ZF Mgcawu District Municipality

for

Geel Kop Grid (Pty) Ltd
2020/171709/07

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Report version: 2nd draft

Details of specialist consultant

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EXECUTIVE SUMMARY

Geel Kop Grid (Pty) Ltd appointed Cape EAPrac as the Environmental Assessment Practitioners (EAP) to undertake the required Basic Assessment (BA) process for the proposed Geel Kop Grid Connection Infrastructure project. Dr David Hoare of David Hoare Consulting (Pty) Ltd was commissioned by Geel Kop Grid (Pty) Ltd to provide specialist biodiversity consulting services for the BA for the proposed Grid Connection Infrastructure. The consulting services comprise an assessment of potential impacts on the general ecology in the study area by the proposed project. The study excludes Avifauna, Aquatic Ecology and Invertebrates. This report provides details of the results of the ecology BA study, based on a desktop assessment of the study area, mapping from aerial imagery, and a detailed reconnaissance site visit of the footprint of the proposed project. The study area is located on various properties approximately 25km west of Upington along the N14 within in the Northern Cape Province.

The first section of the report provides an outline of the Terms of Reference for the study, Limitations, Asumptions and Uncertainties, a list of acronyms, abbreviations and a short glossary, and a table indicating compliance with Appendix 6 of the EIA Regulations. This is followed by an introduction to the project and a description of layout alternatives.

The following section provides an outline of the methodology used to undertake the ecology assessment. This includes the approach taken to assess the sensitivity of the site and a summary of the background information used to undertake the assessment. Background information includes electronic databases with species information, Red Data Lists, published field guides and National and Provincial legislation, specifically regulations with published lists of species and/or ecosystems.

The next section of the report provides details on legislation that applies to development of the site with respect to the ecological receiving environment. There are various acts that limit development or require permits before development can proceed. The most important of these are permits required in terms of protected species that could potentially occur on site, including the National Environmental Management: Biodiversity Act, the Northern Cape Nature Conservation Act and the National Forests Act.

The next section provides a description of the ecological receiving environment, including details on the location of the site, the regional vegetation patterns, local habitat patterns occurring on site, lists of plant and animal species of concern that are likely to occur there and a list of species that were observed on site during the site visit. Details of this section are summarised as follows:

1. The study area is situated in an area with relatively flat topography. Habitat on site is in a largely natural state and is in a rural environment. There is very little transformation or degradation on site.
2. There are three regional vegetation types occurring in the project study area, Bushmanland Arid Grassland, Kalahari Karroid Shrubland and Gordonia Duneveld. All three vegetation types are listed in the scientific literature as Least Threatened with less than 1% transformed overall and none are listed in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011).
3. There is a patch of habitat in the southern part of the proposed corridor and a more extensive section in the eastern parts of the corridor that are mapped as “Critical Biodiversity Area 2” (CBA2) in the Provincial Conservation Plan. There is also an area in the southern part of the proposed corridor mapped as “Ecological Support Area” (ESA), as well as a small patch in the eastern parts. The remaining parts of the corridor are mapped as “Other Natural Areas”. Natural vegetation in parts of the corridor therefore have high value for conservation of vegetation in the Province, according to the broadscale CBA maps.
4. The vegetation on site was found to be a karroid dwarf shrubland that resembles the description for Kalahari Karroid Shrubland, but with a trend of increasing diversity and structural variation with increased surface rockiness. A map of natural habitats of the study area was produced by mapping from aerial imagery and verifying in the field. Habitats on site were divided into various natural units, of which “Lowland Plains” is the most extensive. Other habitats found within the proposed corridor are “Rocky outcrops” and “Hills”, as well as “Drainage” and “Major drainage”, the latter associated with dry stream beds in which riparian vegetation is found. The corridor is also close to areas mapped as “Dunes”.

5. One Vulnerable plant species, *Aloidendron dichotomum*, and one Declining plant species, *Vachellia erioloba*, were found on site, the former occurring as odd individuals within the corridor.
6. There are no plant species protected according to the National Environmental Management: Biodiversity Act (Act No 10. Of 2004) (NEM:BA) that were found on site.
7. There are a number of plant species occurring on site that are protected according to the Northern Cape Nature Conservation Act (Act 9 of 2009). None of these are of conservation concern, but a permit is required from the Provincial authorities to destroy them. These are listed in the text in the body of this report.
8. There are two protected tree species that occur in the study area, *Vachellia erioloba* and *Boscia albitrunca*, neither of which were found within the parts of the corridor that were seen in the field. There is a possibility that individuals of either or both of these species could occur within the corridor.
9. A total of 64 mammal species have a geographical distribution that includes the general study area in which the site is found. Of the species currently listed as threatened or protected (see Appendix 5 for list of protected species), the following are considered to have a medium probability of occurring on site, based on habitat suitability: Leopard (Vulnerable), and Littledale's Whistling Rat (Near Threatened). Given the nature of the proposed project and the fact that many of the species of concern are relatively mobile, few threatened, near threatened or protected mammal species are likely to be significantly negatively impacted by activities on the site.
10. The site contains habitat that is possibly suitable for a small number of frog species, one of which is a protected species, the Giant Bullfrog. None were found on site following recent good rains.
11. A total of 74 reptile species have a geographical distribution that includes the general study area in which the site is found. No reptile species of conservation concern are likely to occur in the study area.
12. A sensitivity map of the site was produced that identifies areas of sensitivity that should be taken into account during activities on site. This includes watercourses and their associated riparian vegetation, locations of the Vulnerable plant species, *Aloidendron dichotomum*, and areas mapped as Critical Biodiversity Areas (CBA2).

The section of the report following the above identifies a number of potential impacts for the proposed project, including direct and indirect impacts for the construction, operation and decommissioning phases of the project, as well as cumulative impacts taken together with similar projects in the region. These are described and discussed. For each potential impact, some possible mitigation measures are provided for managing potential impacts related to this project.

The report concludes that there are some sensitivities on site related to natural habitat and to individual species, but that these can be minimised or avoided with the application of appropriate mitigation or management measures. There will be residual impacts, primarily on natural habitat, but the amount of habitat that will be lost to the project is insignificant compared to the area in hectares of the regional vegetation type that occurs on site and therefore the residual impacts are considered acceptable, on condition local sensitivities of biodiversity importance are avoided. On this basis it is recommended that the project be authorised.

The report includes a comprehensive list of Appendices containing lists of species and species of concern with a geographical distribution that includes the site as well as lists of species protected according to National legislation.

SPECIALISTS DECLARATION

I, David Hoare as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), hereby declare that I:

- act as the independent specialist in this application;
- perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- will comply with the Act, Regulations and all other applicable legislation;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- have no vested interest in the proposed activity proceeding;
- undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of specialist: 

Name of specialist: Dr D B Hoare

Date: 9 December 2020

TERMS OF REFERENCE

The study was to adhere to the following:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended.
- Consideration of the procedures for the assessment and minimum criteria for reporting on identified environmental themes (GNR320 of 20 March 2020)
- Adherence to all appropriate best practice guidelines, relevant legislation and authority requirements.
- Provide a thorough overview of all applicable legislation, guidelines.
- Identification of sensitive areas to be avoided (including providing shapefiles/kmls).
- Assessment of the significance of the proposed development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative.
    - Direct impacts: are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
    - Indirect impacts: of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.
    - Cumulative impacts: are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.
- Implications of specialist findings for the proposed development (e.g. permits, licenses etc).
- Specify if any further assessment will be required. Include an Impact Statement, concluding whether project can be authorised or not.
- Recommend mitigation measures in order to minimise the impact of the proposed development.

LIMITATIONS, ASSUMPTIONS & UNCERTAINTIES

The following assumptions, limitations, uncertainties are listed regarding the ecological assessment of the Geel Kop Grid Connection Infrastructure site:

- Compiling the list of species that could potentially occur on site is limited by the paucity of collection records for the area. The list of plant species that could potentially occur on site was therefore taken from a wider area and from literature sources that may include species that do not occur on site and may miss species that do occur on site. In order to compile a comprehensive site-specific list of the biota on site, studies would be required that would include different seasons, be undertaken over a number of years and include extensive sampling. Due to time constraints, this was not possible for this study.
- The timing of this site visit was within the summer flowering season and after relatively good rains. Many species of plants were flowering on site, although the late winter flowering period of bulbs was missed. The field survey was therefore considered to have taken place during the correct season and co-incides with the maximum emergence of perennial and dominant species.
- Rare and threatened plant and animal species are, by their nature, usually very difficult to locate and can be easily missed.
- The study excludes Avifauna, Aquatic Ecology and Invertebrates.

ACRONYMS

AIS	Alien and Invasive species
CBA	Critical Biodiversity Area
CBD	Convention on Biodiversity
CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
BA	Basic Assessment
ESA	Ecological Support Area
IUCN	International Union for the Conservation of Nature
I&APs	Interested and Affected Parties
GIS	Geographical Information System
NC	Northern Cape province
NEMA	National Environmental Management Act
NEM:BA	National Environmental Management: Biodiversity Act
NCNCA	Northern Cape Nature Conservation Act
NPAES	National Protected Area Expansion Strategy
ONA	Other Natural Areas
PA	Protected Area
REDZ	Renewable Energy Development Zone
SCC	Species of conservation concern
SEA	Strategic Environmental Assessment
SANBI	South African National Biodiversity Institute
ToPS	Threatened and Protected Species
ToR	Terms of Reference
WEF	Wind Energy Facility

ABBREVIATIONS

%	Percentage
MW	Megawatt
kV	Kilovolt
cm	Centimetres
m	Metres
km	Kilometres

GLOSSARY

Definitions	
Alternative	Alternatives can refer to any of the following but are not limited to: alternative sites for development, alternative projects for a particular site, alternative site layouts, alternative designs, alternative processes and alternative materials.
Category 1a Listed Invasive Species	Species listed by notice in terms of section 70(1)(a) of the act, as a species that must be combatted or eradicated. These species are contained in Notice 3 of the AIS list, which is referred to as the National List of Invasive Species. Landowners are obliged to take immediate steps to control Category 1a species.
Category 1b Listed Invasive Species	Species listed by notice in terms of section 70(1)(a) of the act, as species that must be controlled or 'contained'. These species are contained in Notice 3 of the AIS list, which is referred to as the National List of Invasive Species. However, where an Invasive Species Management Programme has been developed for a Category 1b species, then landowners are obliged to "control" the species in accordance with the requirements of that programme.
Category 2 Listed Invasive Species	Species which require a permit to carry out a restricted activity e.g. cultivation within an area specified in the Notice or an area specified in the permit, as the case may be. Category 2 includes plant species that have economic, recreational, aesthetic or other valued properties, notwithstanding their invasiveness. It is important to note that a Category 2 species that falls outside the demarcated area specified in the permit, becomes a Category 1b invasive species. Permit-holders must take all the necessary steps to prevent the escape and spread of the species.
Category 3 Listed Invasive Species	A species listed by notice in terms of section 70(1)(a) of the act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of the act, as specified in the notice. Category 3 species are less-transforming invasive species which are regulated by activity. The principal focus with these species is to ensure that they are not introduced, sold or transported. However, Category 3 plant species are automatically Category 1b species within riparian and wetland areas.
Connectivity	The spatial continuity of a habitat or land cover type across a landscape.
Corridor	A relatively narrow strip of a particular type that differs from the areas adjacent on both sides.
Edge	The portion of an ecosystem or cover type near its perimeter, and within which environmental conditions may differ from interior locations in the ecosystem.
Exempted Alien Species	An alien species that is not regulated in terms of this statutory framework - as defined in Notice 2 of the AIS List.
Fragmentation	The breaking up of a habitat or cover type into smaller, disconnected parcels, often associated with, but not equivalent to, habitat loss.
Prohibited Alien Species	An alien species listed by notice by the Minister, in respect of which a permit may not be issued as contemplated in section 67(1) of the act. These species are contained in Notice 4 of the AIS List, which is referred to as the List of Prohibited Alien Species.
Mitigate	The implementation of practical measures to reduce adverse impacts or enhance beneficial impacts of an action.
"No-Go" option	The "no-go" development alternative option assumes the site remains in its current state, i.e. there is no construction of a WEF and associated infrastructure in the proposed project area.
Patch	A surface area that differs from its surroundings in nature or appearance.
Rehabilitation	Less than full restoration of an ecosystem to its predisturbance condition.
Restoration	To return a site to an approximation of its condition before alteration.
Riparian	The land adjacent to a river or stream that is, at least periodically, influenced by flooding.
Runoff	Non-channelized surface water flow.

COMPLIANCE WITH APPENDIX 6 OF THE EIA REGULATIONS AND AMENDMENTS

Requirements of Appendix 6 – GN326 EIA Regulations of April 2017	Section of specialist report addressing requirement
1) A specialist report prepared in terms of these Regulations must contain— a. details of— i. the specialist who prepared the report; ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	See Page(ii) and Appendix 8
b. a declaration that the specialist is independent in a form as may be specified by the competent authority;	See Specailist Declaration (page viii)
c. an indication of the scope of, and the purpose for which, the report was prepared;	"Terms of Reference" in "Introduction" on page 10
A. an indication of the quality and age of base data used for the specialist report;	"Methodology" pages 12-22
B. a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	"Site conditions" on page 36, "Cumulative impacts" on page 68, "Habitat sensitivity" on page 55
d. the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	"Field surveys" on page 22
e. a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	"Methodology" pages 21-27
f. details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	"Habitat sensitivity" page 32 "Proposed infrastructure" page 41
g. an identification of any areas to be avoided, including buffers;	"Habitat sensitivity" page 55
h. a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	
i. a description of any assumptions made and any uncertainties or gaps in knowledge;	Page (xi)
j. a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	Page 36 onwards
k. any mitigation measures for inclusion in the EMPr;	Page 61 onwards
l. any conditions for inclusion in the environmental authorisation;	None proposed
m. any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Page 61 onwards
n. a reasoned opinion— i) as to whether the proposed activity, activities or portions thereof should be authorised; A. regarding the acceptability of the proposed activity or activities; and ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation	Page 90

	measures that should be included in the EMPr, and where applicable, the closure plan;	
o.	a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A – no consultation has been undertaken to date, but will be included in the DSR
p.	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A – no consultation has been undertaken to date, but will be included in the DSR
q.	any other information requested by the competent authority.	N/A
2)	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

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INTRODUCTION

Background

Geel Kop Grid (Pty) Ltd appointed Cape EAPrac as the Environmental Assessment Practitioners (EAP) to undertake the required Basic Assessment (BA) process for the proposed Geel Kop Grid Infrastructure project. Dr David Hoare of David Hoare Consulting (Pty) Ltd was commissioned by Geel Kop Grid (Pty) Ltd to provide specialist biodiversity consulting services for the BA for the proposed Grid Connection Infrastructure. The study area is located on the Remaining Extent of Geel Kop Farm No 456, Portion 5 and 14 of the Farm Bloemsmond No 455, the Remaining Extent of the Farm Dyasonsklip No 454, , the Remaining Extent of the Farm Tungsten Lodge No 638, Remaining Extent of Portion 35 of the Farm No 453 Mc Taggarts Camp, Remaining Extent (Portion 0) of the Farm No 636 and Portion 0, Holding No 1080 of the Olyvenhouts Drift Settlement Agricultural Holdings, approximately 25km west of Upington along the N14 within in the Northern Cape Province (Figure 1). The consulting services comprise an assessment of potential impacts on the general ecology in the study area by the proposed project. The study excludes Avifauna and Invertebrates.

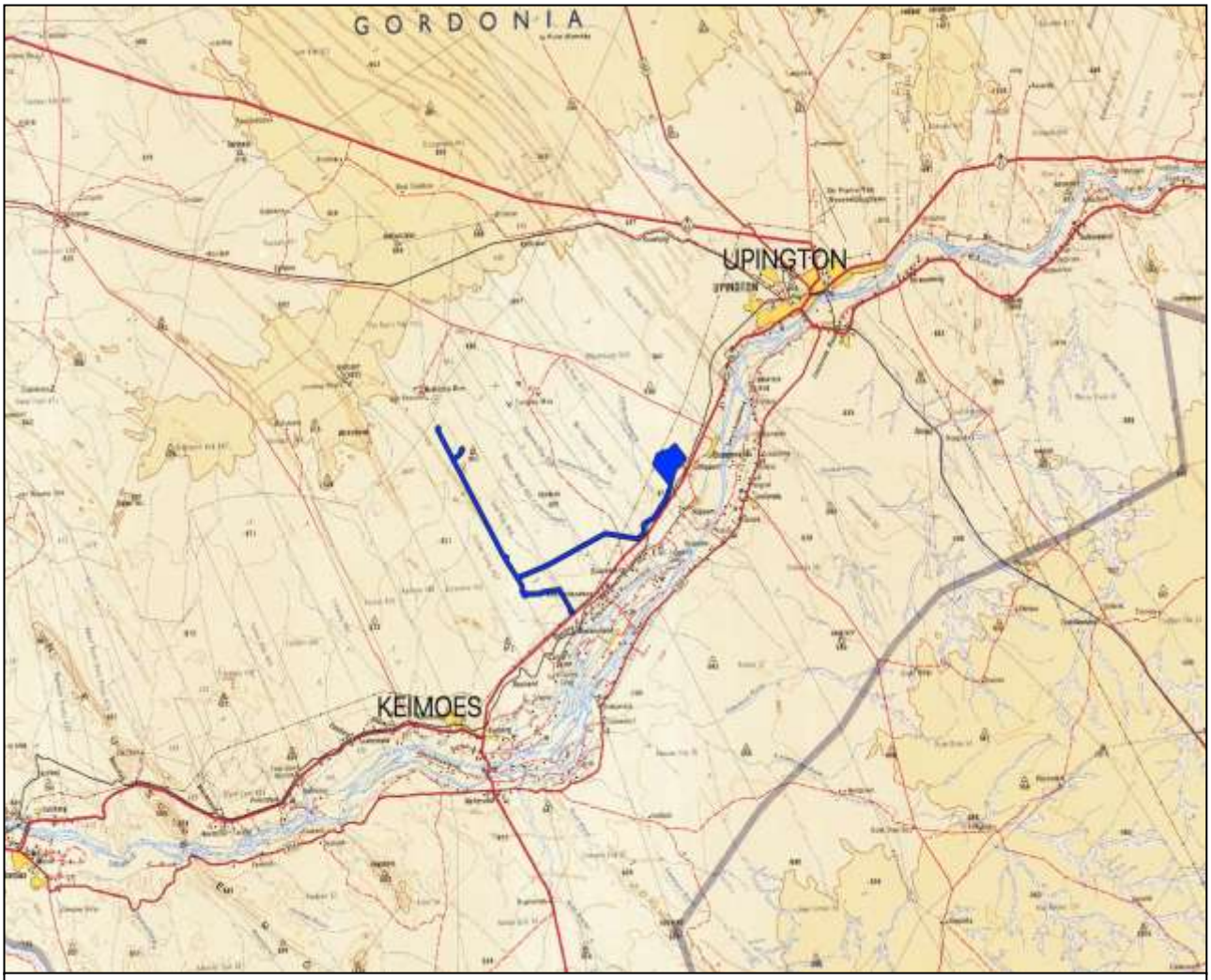

Figure 1: Location of proposed infrastructure (blue line).

The proposed facility is located within the Upington Renewable Energy Development Zone (REDZ 7), one of the eight REDZ formally gazetted in South Africa for development of solar and wind energy generation facilities. In line with the gazetted process for projects located within REDZ, a project would be subject to a Basic Assessment (BA) process instead of a full Environmental Impact Assessment (EIA) process in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA, 1998), EIA Regulations (NEMA, 2014; NEMA, 2017).

Project description

Geel Kop Grid (Pty) Ltd proposes the construction and operation of grid connection infrastructure for seven PV facilities near Upington in the Northern Cape Province. The grid connection infrastructure comprises the following (see proposed layout in Figure 2):

- Three switching stations:
  - GK Solar PV switching station;
  - Shrubland PV switching station; and
  - Karroid PV switching station.

- One collector switching station [Geel Kop collector switching station (Alt 1) or Bushmanland PV collector switching station (Alt 2)];
- Four single or double circuit 33kV or 132kV lines from the substations/ switching stations to the chosen collector switching station; and
- One double circuit 132kV power line from the chosen collector switching station to the Upington Main Transmission Substation (MTS).

Additional associated infrastructure will also be required for the grid connection solution, including access roads, feeder bays (inclusive of line bays, busbars, bussection and protection equipment), switching stations, a fibre and optical ground wire (OPGW) layout, insulation and assembly structures.

A grid connection corridor approximately 300m wide (widening at the MTS) and 34 km long is being assessed to allow for the optimisation of the grid connection and associated infrastructure to accommodate the identified environmental sensitivities. The grid connection infrastructure will be developed within the 300m wide grid connection corridor.

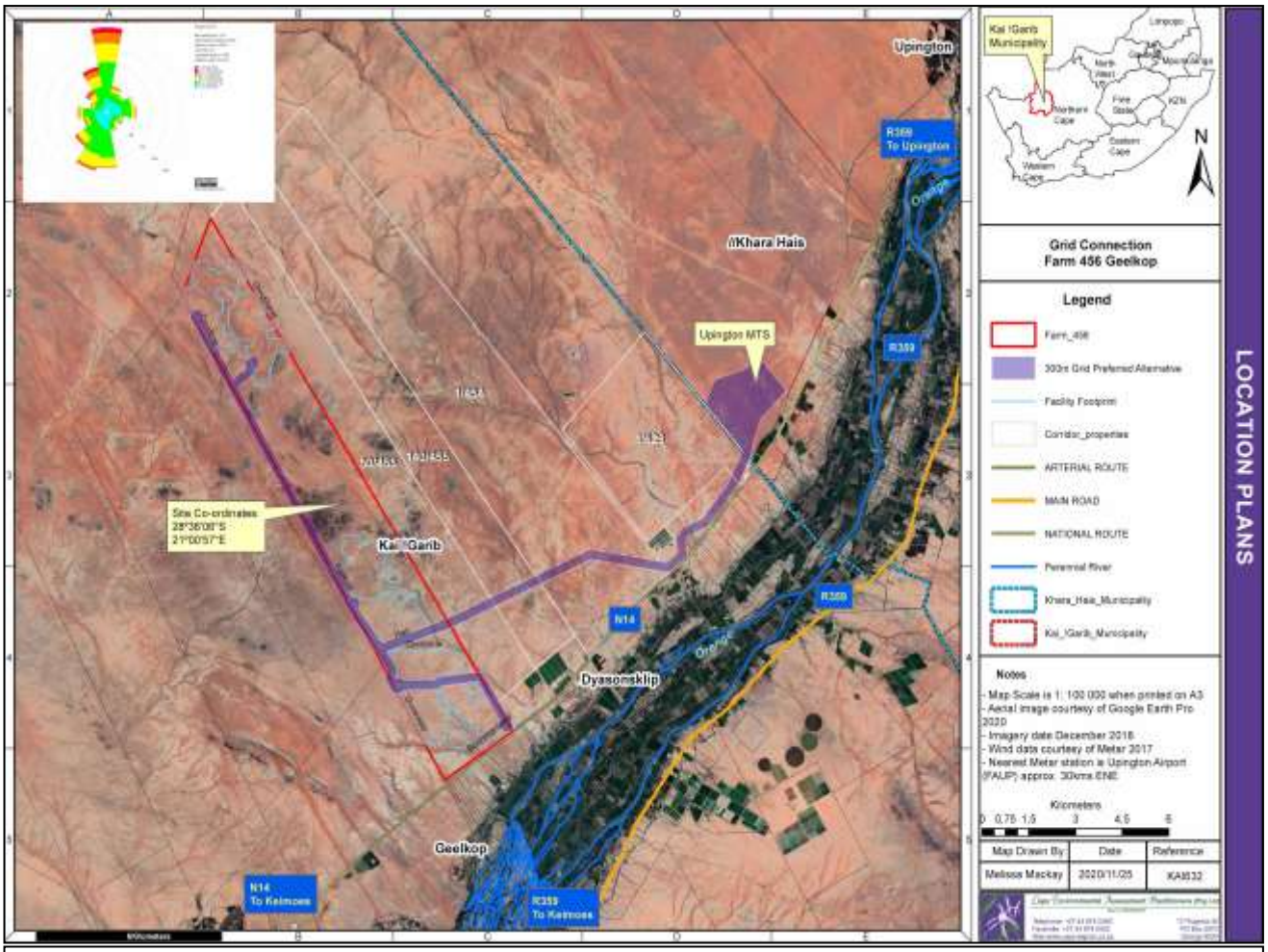

Figure 2: Proposed layout.

Location alternatives

There are two alternative routes to link the Geel Kop collector switching station to the Upington MTS:

- **Updated Alt 1 – Preferred:** a double circuit 132kV line from the Gordonia Solar PV/ Duneveld PV collector substation/ switching station to the Upington MTS, running parallel to the Eskom Aries-Upington 400kV 110m servitude for approximately 7.2km before turning towards and running along the N14 to the Upington MTS.

- **Alt 2:** a loop in loop out (LILO) from the Bushmanland PV collector substation/ switching station into the McTaggerts/Oasis 132kV powerline, and reconductored as a double circuit 132kV line back to the Upington MTS.

Technology alternatives

No technology alternatives were considered in this BA report.

Layout alternatives

The layout was determined from a Screening level assessment that identified sensitivities in the landscape. These were avoided for the current layout. No alternative layouts are therefore considered.

No-Go alternative

The no development alternative option assumes the site remains in its current state, i.e. there is no construction of a PV project and associated infrastructure in the proposed project area and the status quo would prevail.

APPROACH & METHODOLOGY

This report provides a BA level description of the site and assessment of the proposed project from and ecology perspective. The detailed methodology followed as well as the sources of data and information used as part of this assessment is described below.

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; and
3. threatened animal species.

Ecosystems

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

Processes

1. corridors;
2. mega-conservancy networks;
3. rivers and wetlands; and
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. National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998); and
2. National Environmental Management Biodiversity Act, 2004. (Act 10 0f 2004).

Approach

The study commenced as a desktop-study followed by a site-specific field study from the 26th – 28th February 2020. During the field survey, the entire footprint of the proposed project was traversed on foot.

Aerial imagery from Google Earth was used to identify and map habitats on site. Patterns identified from satellite imagery were verified on the ground. During the walk-through survey a checklist of plant species was compiled as well as an estimate of cover/abundance. From this vegetation survey, as well as ad hoc observations on site, a checklist of plant species occurring on site was compiled. Digital photographs were taken at locations where features of interest were observed.

Field surveys

The study area was visited and assessed to confirm patterns identified from the desktop assessment. One reconnaissance site visit was undertaken on 26th – 28th February 2020. The site visit was undertaken very soon after good rains and during the height of the growing season. Vegetation was in a good state, many plant species were flowering and / or could be identified, geophytic species were not dormant and habitats were generally in an ideal state to assess. This means that botanical diversity and species composition were relatively easy to assess, and any species of concervation concern (SCC) were likely to be visible.

Specific features of potential concern were investigated in the field, including the following:

- General vegetation status, i.e. whether the vegetation was natural, disturbed/secondary or transformed;
- Presence of habitats of conservation concern in terms of high biodiversity, presence of SCC, specific sensitivities, e.g. wetlands, and any other factors that would indicate an elevated biodiversity or functional value that could not be determined from the desktop assessment;
- Presence of protected trees; and
- Potential presence of SCC, including observation of individual plants found on site or habitats that are suitable for any of the species identified from the desktop assessment.

Key parts of the development site were visited during the reconnaissance site visit in such a way as to ensure all major variation was covered and that any unusual habitats or features were observed. A preliminary checklist of species occurring on site was collected during the reconnaissance survey (Appendix 3, highlighted in green). Plant names follow Germishuizen *et al*. (2005). The season of the survey was favourable, and it there is high confidence that many of species present on site were identifiable at the time of the survey. The survey was of adequate duration and intensity to characterise the flora of the development site as per the regulations.

The site was subject to a solar PV development application in 2011, for which the ecological study was undertaken by David Hoare Consulting. Field data from that survey was also used for the current assessment.

Species of conservation concern

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

Red List plant species

Determining the conservation status of a species is required to identify those species that are at greatest risk of extinction and, therefore, in most need of conservation action. South Africa has adopted the International Union for Conservation of Nature (IUCN) Red List Categories and Criteria to provide an objective, rigorous, scientifically founded system to identify Red List species. A published list of the Red List species of South African plants (Raimondo *et al*.,

2009) contains a list of all species that are considered to be at risk of extinction. This list is updated regularly to take new information into account, but these are not published in book/paper format. Updated assessments are provided on the SANBI website (http://redlist.sanbi.org/). According to the website of the Red List of Southern African Plants (http://redlist.sanbi.org/), *the conservation status of plants indicated on the Red List of South African Plants Online represents the status of the species within South Africa's borders. This means that when a species is not endemic to South Africa, only the portion of the species population occurring within South Africa has been assessed. The global conservation status, which is a result of the assessment of the entire global range of a species, can be found on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species: http://www.iucnredlist.org*. The South African assessment is used in this study.

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

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

Protected trees

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

Other protected species

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

- National Environmental Management: Biodiversity Act (Act No 10 of 2004); and
- Northern Cape Nature Conservation Act (Act No. 9 of 2009).

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

Red List animal species

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, Monadjem *et al*., 2010). The likelihood of any of them occurring was evaluated based on habitat preference and habitats available within the study area. 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.

Mammal threat status is according to Child et al. (2016), reptile threat status is according to Bates et al. 2014, and amphibian threat status is according to Minter et al. (2004).

Species probability of occurrence

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

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

Sources of information

Vegetation and plant species

- Broad vegetation types occurring on site were obtained from Mucina and Rutherford (2006), with updates according to the SANBI BGIS website (http://bgis.sanbi.org).
- The conservation status of the vegetation types were obtained from Mucina and Rutherford (2006) and the National List of Ecosystems that re Threatened and in need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004).
- The plant species checklist of species that could potentially occur on site was compiled from a plant species checklist extracted from the NewPosa database of the South African National biodiversity Institute (SANBI) for the quarter degree grids 2821CA.
- The IUCN Red List Category for plant species, as well as supplementary information on habitats and distribution, was obtained from the SANBI Threatened Species Programme (Red List of South African Plants, http://redlist.sanbi.org).

Fauna

- Lists of animal species that have a geographical range that includes the study area were obtained from literature sources (Bates et al., 2014 for reptiles, du Preez & Carruthers 2009 for frogs, Mills & Hes 1997 and Friedmann and Daly, 2004 for mammals). This was supplemented with information from the Animal Demography Unit website (adu.uct.ac.za) and literature searches for specific animals, where necessary.

Regional plans

- Information from the National Protected Areas Expansion Strategy (NPAES) was consulted for possible inclusion of the site into a protected area in future (available on http://bgis.sanbi.org).).
- The Northern Cape Biodiversity Area Maps were consulted for inclusion of the site into a Critical Biodiversity Area or Ecological Support Area (biodiversityadvisor.sanbi.org).

Habitat sensitivity

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

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

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

Table 1: Explanation of sensitivity ratings.

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
VERY HIGH	Indigenous natural areas that are highly positive for any of the following: • presence of threatened species (Critically Endangered, Endangered, Vulnerable) and/or habitat critical for the survival of populations of threatened species. • High conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk). • Protected habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act) And may also be positive for the following: • High intrinsic biodiversity value (high species richness and/or turnover, unique ecosystems) • High value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value) • Low ability to respond to disturbance (low resilience, dominant species very old).	• CBA 1 areas. • Remaining areas of vegetation type listed in Draft Ecosystem List of NEM:BA as Critically Endangered, Endangered or Vulnerable. • Protected forest patches. • Confirmed presence of populations of threatened species.
HIGH	Indigenous natural areas that are positive for any of the following: • High intrinsic biodiversity value (moderate/high species richness and/or turnover). • presence of habitat highly suitable for threatened species (Critically Endangered, Endangered, Vulnerable species). • Moderate ability to respond to disturbance (moderate resilience, dominant species of intermediate age). • Moderate conservation status (moderate proportion remaining intact, moderately fragmented, habitat for species that are at risk). • Moderate to high value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food	• CBA 2 "critical biodiversity areas". • Habitat where a threatened species could potentially occur (habitat is suitable, but no confirmed records). • Confirmed habitat for species of lower threat status (near threatened, rare). • Habitat containing individuals of extreme age.

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
	production, raw materials, genetic resources, cultural value). And may also be positive for the following: • Protected habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)	• Habitat with low ability to recover from disturbance. • Habitat with exceptionally high diversity (richness or turnover). • Habitat with unique species composition and narrow distribution. • Ecosystem providing high value ecosystem goods and services.
MEDIUM-HIGH	Indigenous natural areas that are positive for one or two of the factors listed above, but not a combination of factors.	• CBA 2 "corridor areas". • Habitat with high diversity (richness or turnover). • Habitat where a species of lower threat status (e.g. (near threatened, rare) could potentially occur (habitat is suitable, but no confirmed records).
MEDIUM	Other indigenous natural areas in which factors listed above are of no particular concern. May also include natural buffers around ecologically sensitive areas and natural links or corridors in which natural habitat is still ecologically functional.	• Natural habitat with no specific sensitivities.
MEDIUM-LOW	Degraded or disturbed indigenous natural vegetation.	• Highly degraded areas or highly disturbed areas in which the original species composition has been lost.
LOW	No natural habitat remaining.	• Transformed areas.

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

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

Impact assessment methodology

The Impact Assessment Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

Determination of Significance of Impacts
Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 2.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Impact Rating System
Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed.

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

Table 2: Description of impact assessment terms

NATURE		
A brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).

3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative Impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).

3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity. The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

Table 3: Impact table format.

IMPACT TABLE FORMAT	
Environmental parameter	A brief description of the environmental aspect likely to be affected by the proposed activity e.g. Surface water
Issue/Impact/Environmental Effect/Nature	A brief description of the nature of the impact that is likely to affect the environmental aspect as a result of the proposed activity e.g. alteration of aquatic biota The environmental impact that is likely to positively or negatively affect the environment as a result of the proposed activity e.g. oil spill in surface water
Extent	
Probability	A brief description indicating the chances of the impact occurring
Reversibility	A brief description of the ability of the environmental components recovery after a disturbance as a result of the proposed activity
Irreplaceable loss of resources	A brief description of the degree in which irreplaceable resources are likely to be lost
Duration	A brief description of the amount of time the proposed activity is likely to take to its completion

Cumulative effect	A brief description of whether the impact will be exacerbated as a result of the proposed activity	
Intensity/magnitude	A brief description of whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily	
Significance rating	A brief description of the importance of an impact which in turn dictates the level of mitigation required	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	4	1
Probability	4	1
Reversibility	4	1
Irreplaceable loss	4	1
Duration	4	1
Cumulative effect	4	1
Intensity/magnitude	4	1
Significance rating	-96 (high negative)	-6 (low negative)
Mitigation measures	Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. Describe how the mitigation measures have reduced/enhanced the impact with relevance to the impact criteria used in analyzing the significance. These measures will be detailed in the EMPR.	

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.

Convention on Biodiversity (CBD)

South Africa became a signatory to the United Nations Convention on Biological Diversity (CBD) in 1993, which was ratified in 1995. The CBD requires signatory states to implement objectives of the Convention, which are the conservation of biodiversity; the sustainable use of biological resources and the fair and equitable sharing of benefits arising from the use of genetic resources. According to Article 14 (a) of the CBD, each Contracting Party, as far as possible and as appropriate, must introduce appropriate procedures, such as environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biological diversity, to avoid or minimize these effects and, where appropriate, to allow for public participation in such procedures.

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

NEMA is the framework environmental management legislation, enacted as part of the government's mandate to ensure every person's constitutional right to an environment that is not harmful to his or her health or wellbeing. It is administered by DEA but several functions have been delegated to the provincial environment departments. One of the purposes of NEMA is to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment. The Act further aims to provide for institutions that will promote cooperative governance and procedures for coordinating environmental functions exercised by organs of state and to provide for the administration and enforcement of other environmental management laws.

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."

This report considers the Environmental Impact Assessment (EIA) Regulations of 2014 (NEMA, 2014) as amended in 2017 (NEMA, 2017), under the National Environmental Management Act, (Act No. 107 of 1998). According to these Regulations under Listing Notice 1 (GRN No. 327), Listing Notice 2 (GRN No 325) and Listing Notice 3 (GRN No 324), the activities listed are identified as activities that may require Environmental Authorisation prior to commencement of that activity and to identify competent authorities in terms of sections 24(2) and 24D of the Act.

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

As the principal national act regulating biodiversity protection, NEM:BA, which is administered by DEA, is concerned with the management and conservation of biological diversity, as well as the use of indigenous biological resources in a sustainable manner. The term biodiversity according to the Convention on Biodiversity (CBD) refers to the variability among living organisms from all sources including, inter alia terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity in genes, species and ecosystems.

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".

Alien and Invasive Species

Chapter 5 of NEM:BA relates to species and organisms posing a potential threat to biodiversity. The Act defines alien species and provides lists of invasive species in regulations. The Alien and Invasive Species (AIS) Regulations, in terms of Section 97(1) of NEM:BA, was published in Government Notice R598 in Government Gazette 37885 in 2014 (NEM:BA, 2014). The Alien and Invasive Species (AIS) lists were subsequently published in Government Notice R 864 of 29 July 2016 (NEM:BA, 2016).

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.

The National Environmental Management: Biodiversity Act (NEMBA) regulates all invasive organisms in South Africa, including a wide range of fauna and flora. Chapter 5 of the Act relates to species and organisms posing a potential threat to biodiversity. The purpose of Chapter 5 is:

a) to prevent the unauthorized introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur;
b) to manage and control alien species and invasive species to prevent or minimize harm to the environment and to biodiversity in particular;
c) to eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats;

According to Section 65 of the Act, "Restricted activities involving alien species":

1) A person may not carry out a restricted activity involving a specimen of an alien species without a permit issued in terms of Chapter 7. Restricted activities include the following:
    a. Importing into the Republic, including introducing from the sea, any specimen of a listed invasive species.
    b. Having in possession or exercising physical control over any specimen of a listed invasive species.
    c. Growing, breeding or in any other way propagating any specimen of a listed invasive species, or causing it to multiply.
    d. Conveying, moving or otherwise translocating any specimen of a listed invasive species.
    e. Selling or otherwise trading in, buying, receiving, giving, donating or accepting as a gift, or in any other way acquiring or disposing of any specimen of a listed invasive species.
    f. Spreading or allowing the spread of any specimen of a listed invasive species.
    g. Releasing any specimen of a listed invasive species.
    h. Additional activities that apply to aquatic species.

2) A permit referred to in subsection (1) may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out.
3)

An "**alien species**" is defined in the Act as:

a) a species that is not an indigenous species; or
b) an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by means of migration or dispersal without human intervention.

According to Section 71 of the Act, "Restricted activities involving listed invasive species":

1) A person may not carry out a restricted activity involving a specimen of a listed invasive species without a permit issued in terms of Chapter 7.
2) A permit referred to in subsection (1) may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out.

An "**invasive species**" is defined in the Act as any species whose establishment and spread outside of its natural distribution range:

a) threaten ecosystems, habitats or other species or have demonstrable potential to threaten ecosystems, habitats or other species; and
b) may result in economic or environmental harm or harm to human health.

A "**listed invasive species**" is defined in the Act as any invasive species listed in terms of section 70(1).

According to Section 73 of the Act, "Duty of care relating to listed invasive species":

2) A person who is the owner of land on which a listed invasive species occurs must-
    a) notify any relevant competent authority, in writing, of the listed invasive species occurring on that land;
    b) take steps to control and eradicate the listed invasive species and to prevent it from spreading; and
    c) take all the required steps to prevent or minimize harm to biodiversity.

According to Section 75 of the Act, "Control and eradication of listed invasive species":

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

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

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

The EIA Regulations (2014, as amended) include three lists of activities that require environmental authorisation:

- Listing Notice 1: activities that require a basic assessment (GNR. 327 of 2014, as amended),
- Listing Notice 2: activities that require a full environmental impact assessment report (EIR) (GNR. 325 of 2014, as amended),
- Listing Notice 3: activities that require a basic assessment in specific identified geographical areas only (GNR. 324 of 2014, as amended).

The proposed WEF is located partially within the Komsberg Renewable Energy Development Zone (REDZ 2), one of the eight REDZ formally gazetted[1] in South Africa indicating the procedure to be followed in applying for environmental authorisation (EA) for large scale solar and wind energy generation facilities. Considering that a portion of the proposed facility is located outside of the Komsberg REDZ, the Rondekop WEF will be subject to a full Environmental Impact Assessment (EIA) process in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA) as amended and EIA Regulations, 2014 (as amended).

The full list of trigger activities has been included in the application form and will be assessed and discussed in the Ecology Impact Assessment Report.

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).

Government Notice No. 40733 of 2017: Draft National Biodiversity Offset Policy
Published under the National Environmental Management Act (Act No. 107 of 1998). The aim of the Policy is to ensure that significant residual impacts of developments are remedied as required by NEMA, thereby ensuring sustainable development as required by section 24 of the Constitution of the Republic of South Africa, 1996. This policy should be taken into consideration with every development application that still has significant residual impact after the Mitigation Sequence has been followed. The mitigation sequence entails the consecutive application of avoiding or preventing loss, then at minimizing or mitigating what cannot be avoided, rehabilitating where possible and, as a last resort, offsetting the residual impact. The Policy specifies that one impact that has come across consistently as unmitigatable is the rapid and consistent transformation of certain ecosystems and vegetation types, leading to the loss of ecosystems and extinction of species. The Policy specifically targets ecosystems where the ability to reach protected area targets is lost or close to being lost. However, the Policy states that "*[w]here ecosystems remain largely untransformed, intact and functional, an offset would not be required for developments that lead to transformation, provided they have not been identified as a biodiversity priority*". Biodivesity offsets should be considered to remedy residual negative impacts on biodiversity of 'medium' to 'high' significance. Residual impacts of 'very high' significance are a fatal flaw for development and residual biodiversity impacts of 'low' significance would usually not require offsets. The Policy indicates that impacts should preferably be avoided in protected areas, CBAs, verified wetland and river features and areas earmarked for protected area expansion.

National Forests Act (Act no 84 of 1998)

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

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

National Water Act (Act 36 of 1998)

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

- River or spring;
- A natural channel in which water flows regularly or intermittently;

[1] Formally gazetted on 16 February 2018 (government notice 114).

- 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.

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

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

Northern Cape Nature Conservation Act, No. 9 of 2009

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

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

The Act provides lists of protected species for the Province. According to Northern Cape Nature Conservation officials, a permit is required for the removal of any species on this list.

Other Acts

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

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

DESCRIPTION OF STUDY AREA

Location

The project is located 25 km south-west of Upington, in the Northern Cape Province, South Africa (Figure 3). The proposed facility is located within the Kai !Garib Local Municipality, which falls within the ZF Mgcawu District Municipality. The N14 road from Upington to Keimoes passes to the south of the site. A jeep-track off of this road leads directly onto site.

The site is in the quarter degree grid 2821CA, between 28°37'25" S and 28°38'41 S latitude, and between 21°01'45 E and 21°03'17 E longitude.

The proposed facility is located within the Upington Renewable Energy Development Zone (REDZ 7), one of the eight REDZ formally gazetted in South Africa for development of solar and wind energy generation facilities

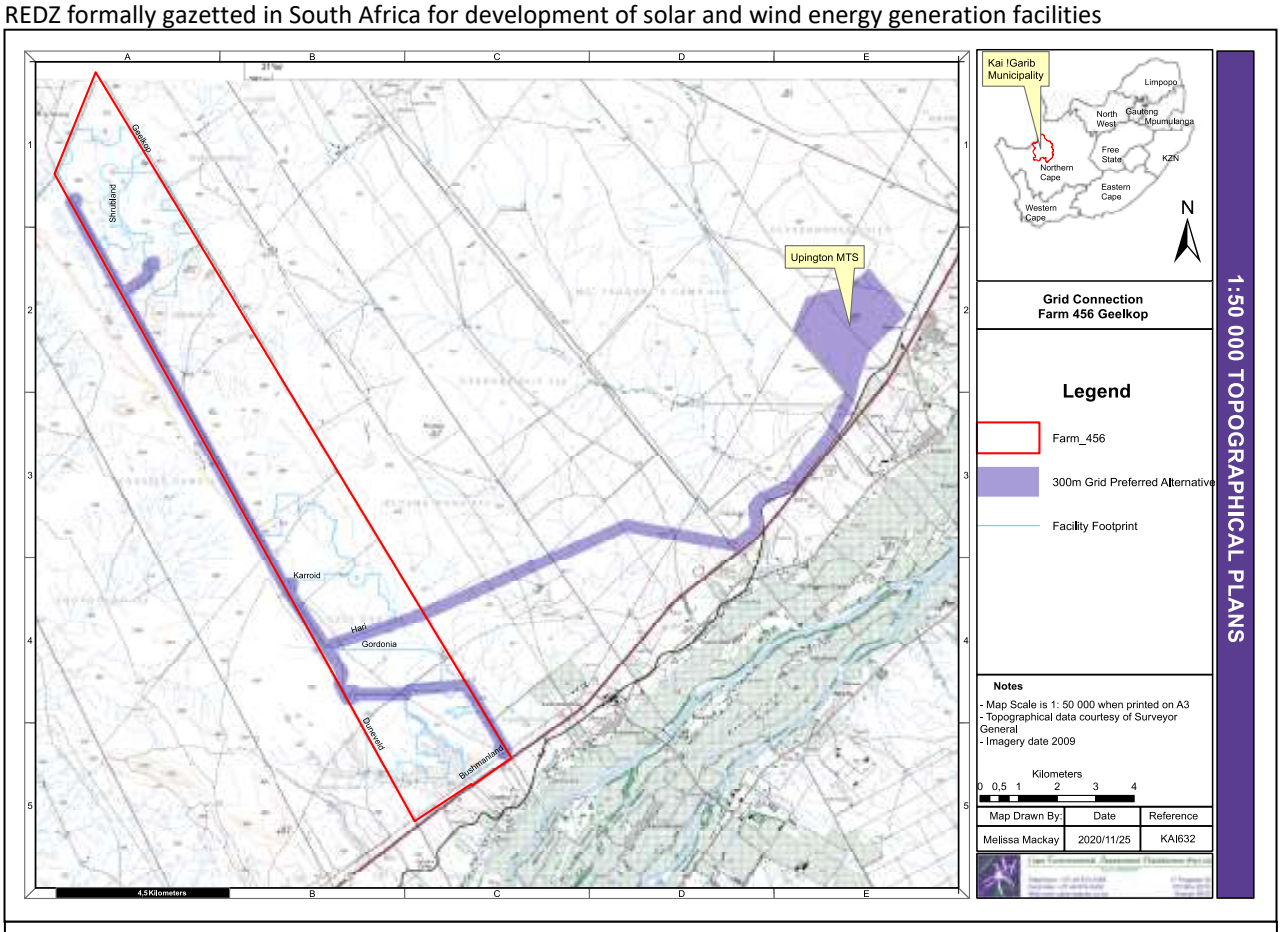

Figure 3: Location of the corridor south-west of Upington.

Site conditions

The entire site is largely in a natural state, with the exception of existing vehicle tracks asnd other powerline infrastructure. The vegetation is used primarily for livestock grazing and is affected to some degree by this useage, but not to the extent that any obvious degradation was noted on site. No stands of alien plants were seen anywhere during the field survey, although scattered individual plants were seen. The vegetation and habitats on site appear to be largely in a natural state and reflecting what would be expected according to the natural relationship between the physical

environment and the vegetation. This natural pattern extends beyond the site in all directions and gives the general area a sense of being relatively unspoilt, remote and natural. The implication of this is that any development will cause damage to natural habitats and will affect the natural status of the area.

Topography and drainage

The study site is situated just to the north of the Orange River. The topography of this area is relatively gentle and slopes in a southerly direction towards the Orange River. The elevation on site varies from 786 to 821 m above sea level. There are some low rocky outcrops north of the site, but these are not affected by the current project.

The site is drained by several non-perennial (dry) drainage lines, most of which drain eventually towards the south and into the Orange River.

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.

Broad vegetation patterns

There are three regional vegetation types converging in the study area, namely Bushmanland Arid Grassland, Kalahari Karroid Shrubland and Gordonia Duneveld (Figure 4). There are likely to be floristic and vegetation structural influences from any of these three vegetation types at any location on site, depending on local ecological conditions. The vegetation types that occur on site and nearby areas are briefly described below.

Bushmanland Arid Grassland (NKb3)

Distribution

Northern Cape Province: Spanning about one degree of latitude from around Aggeneys in the west to Prieska in the east. The southern border of the unit is formed by edges of the Bushmanland Basin while in the northwest this vegetation unit borders on desert vegetation (northwest of Aggeneys and Pofadder). The northern border (in the vicinity of Upington) and the eastern border (between Upington and Prieska) are formed with often intermingling units of Lower Gariep Broken Veld, Kalahari Karroid Shrubland and Gordonia Duneveld. Most of the western border is formed by the edge of the Namaqualand hills. Altitude varies mostly from 600–1 200 m.

Vegetation & Landscape Features

Extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses (*Stipagrostis* species) giving this vegetation type the character of semidesert 'steppe'. In places low shrubs of *Salsola* change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected.

Geology & Soils

A third of the area is covered by recent (Quaternary) alluvium and calcrete. Superficial deposits of the Kalahari Group are also present in the east. The extensive Palaeozoic diamictites of the Dwyka Group also outcrop in the area as do gneisses and metasediments of Mokolian age. The soils of most of the area are red-yellow apedal soils, freely drained, with a high base status and <300 mm deep, with about one fifth of the area deeper than 300 mm, typical of Ag and Ae land types.

Climate

Rainfall largely in late summer/early autumn (major peak) and very variable from year to year. MAP ranges from about 70 mm in the west to 200 mm in the east. Mean maximum and minimum monthly temperatures for Kenhardt are 40.6°C

and –3.7°C for January and July respectively. Corresponding values for Pofadder are 38.3°C and –0.6°C. Frost incidence ranges from around 10 frost days per year in the northwest to about 35 days in the east. Whirl winds (dust devils) are common on hot summer days.

Important Taxa

Graminoids	*Aristida adscensionis* (d), *A. congesta* (d), *Enneapogon desvauxii* (d), *Eragrostis nindensis* (d), *Schmidtia kalahariensis* (d), *Stipagrostis ciliata* (d), *S. obtusa* (d), *Cenchrus ciliaris*, *Enneapogon scaber*, *Eragrostis annulata*[E], *E. porosa*[E], *E. procumbens*, *Panicum lanipes*[E], *Setaria verticillata*[E], *Sporobolus nervosus*, *Stipagrostis brevifolia*[W], *S. uniplumis*, *Tragus berteronianus*, *T. racemosus*[E].
Small trees	*Acacia mellifera* subsp. *detinens*[E], *Boscia foetida* subsp. *foetida*
Tall Shrubs	*Lycium cinereum* (d), *Rhigozum trichotomum* (d), *Cadaba aphylla*, *Parkinsonia africana*
Low shrubs	*Aptosimum spinescens* (d), *Hermannia spinosa* (d), *Pentzia spinescens* (d), *Aizoon asbestinum*[E], *A. schellenbergii*[E], *Aptosimum elongatum*, *A. lineare*[E], *A. marlothii*[E], *Barleria rigida*, *Berkheya annectens*, *Blepharis mitrata*, *Eriocephalus ambiguus*, *E. spinescens*, *Limeum aethiopicum*, *Lophiocarpus polystachyus*, *Monechma incanum*, *M. spartioides*, *Pentzia pinnatisecta*, *Phaeoptilum spinosum*[E], *Polygala seminuda*, *Pteronia leucoclada*, *P. mucronata*, *P. sordida*, *Rosenia humilis*, *Senecio niveus*, *Sericocoma avolans*, *Solanum capense*, *Talinum arnotii*[E], *Tetragonia arbuscula*, *Zygophyllum microphyllum*
Succulent shrubs	*Kleinia longiflora*, *Lycium bosciifolium*, *Salsola tuberculata*, *S. glabrescens*
Herbs	*Acanthopsis hoffmannseggiana*, *Aizoon canariense*, *Amaranthus praetermissus*, *Barleria lichtensteiniana*[E], *Chamaesyce inaequilatera*, *Dicoma capensis*, *Indigastrum argyraeum*, *Lotononis platycarpa*, *Sesamum capense*, *Tribulus pterophorus*, *T. terrestris*, *Vahlia capensis*

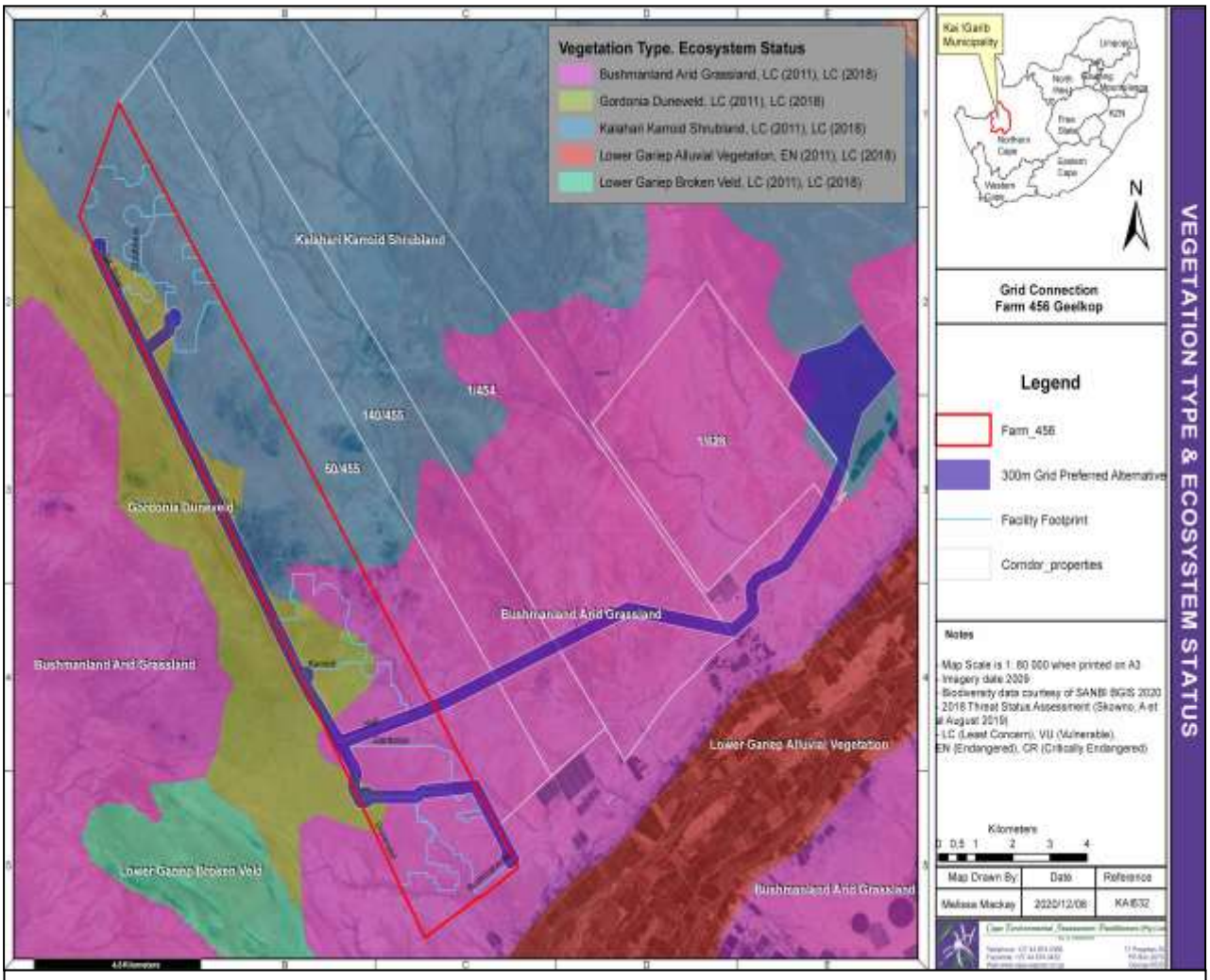

Figure 4: Broad vegetation types of the study area.

Succulent herbs	*Gisekia pharnacioides*[E], *Psilocaulon coriarium*, *Trianthema parvifolia*
Geophytic Herbs	*Moraea venenata*

Biogeographically Important Taxa

Succulent Herb	*Tridentea dwequensis*

Endemic Taxa

Succulent Shrubs	*Dinteranthus pole-evansii*, *Larryleachia dinteri*, *L. marlothii*, *Ruschia kenhardtensis*
Herbs	*Lotononis oligocephala*, *Nemesia maxii*

Kalahari Karroid Shrubland (NKb5)

Distribution

Northern Cape Province: Typically forming belts alternating with belts of Gordonia Duneveld on plains northwest of Upington through Lutzputs and Noenieput to the Rietfontein/Mier area in the north. Other patches occur around Kakamas and north of Groblershoop. The unit is also found in the neighbouring Namibia. Altitude varies mostly from

700–1 100 m.

Vegetation & Landscape Features

Low karroid shrubland on flat, gravel plains. Karoo-related elements (shrubs) meet here with northern floristic elements, indicating a transition to the Kalahari region and sandy soils.

Geology & Soils

Cenozoic Kalahari Group sands and small patches also on calcrete outcrops and screes on scarps of intermittent rivers (mekgacha). In places Dwyka Group tillites outcrop. The soils are deep (>300 mm), red-yellow, apedal, freely drained, with a high base status, typical of Ae land type.

Climate

MAP ranges from about 100–200 mm and most rain falls in late summer and early autumn. Winters are particularly dry, with lowest winter relative humidity compared to other Nama-Karoo types. Mean maximum and minimum monthly temperatures in Upington are 39.5°C and –4.2°C for January and July, respectively. Solar radiation is high and in winter is higher than in any other vegetation type of the Nama-Karoo.

Important Taxa

Graminoids	*Aristida adscensionis* (d), *Enneapogon desvauxii* (d), *E. scaber* (d), *Stipagrostis obtusa* (d), *Aristida congesta*, *Enneapogon cenchroides*, *Eragrostis annulata*, *E. homomalla*, *E. porosa*, *Schmidtia kalahariensis*, *Stipagrostis anomala*, *S. ciliata*, *S. hochstetteriana*, *S. uniplumis*, *Tragus berteronianus*, *T. racemosu*.
Small trees	*Acacia mellifera* subsp. *detinens* (d), *Parkinsonia africana* (d), *Boscia foetida* subsp. *foetida*
Tall Shrubs	*Rhigozum trichotomum* (d).
Epiphytic Semiparasitic Shrub	*Tapinanthus oleifolius*
Low shrubs	*Hermannia spinosa* (d), *Limeum aethiopicum* (d), *Phaeoptilum spinosum* (d), *Aizoon schellenbergii*, *Aptosimum albomarginatum*, *A. lineare*, *A. marlothii*, *A. spinescens*, *Barleria rigida*, *Hermannia modesta*, *Indigofera heterotricha*, *Leucosphaera bainesii*, *Monechma genistifolium* subsp. *genistifolium*, *Phyllanthus maderaspatensis*, *Polygala seminuda*, *Ptycholobium biflorum* subsp. *biflorum*, *Sericocoma avolans*, *Solanum capense*, *Tephrosia dregeana*
Herbs	*Dicoma capensis* (d), *Chamaesyce inaequilatera* (d), *Amaranthus praetermissus*, *Barleria lichtensteiniana*, *Chamaesyce glanduligera*. *Chascanum garipense*, *Cleome angustifolia* subsp. *diandra*, *Cucumis africanus*, *Geigeria ornativa*, *Hermannia abrotanoides*, *Indigastrum argyraeum*, *Indigofera alternans*, *I. auricoma*, *Kohautia cynanchica*, *Limeum argute-carinatum*, *Mollugo cerviana*, *Monsonia umbellata*, *Sesamum capense*, *Tribulus cristatus*, *T. pterophorus*, *T. terrestris*
Succulent herbs	*Gisekia africana*, *G. pharnacioides*, *Trianthema parvifolia*.

Biogeographically Important Taxa

Graminoid	*Dinebra retroflexa*

Gordonia Duneveld (SVkd1)

Distribution

Northern Cape Province: Areas with dunes comprising the largest part of the South African side of the Kgalagadi Transfrontier Park. South of the Molopo River border with Botswana (west of Van Zylsrus), interleaving with NKb 5 Kalahari Karroid Shrubland in the west (south of Rietfontein to the Orange River area) and in the south (around Upington and north of Groblershoop). Also occurs as a number of loose dune cordons south of the Orange River near Keimoes and between Upington and Putsonderwater. Eastern boundary is found at the longitude of Pearson's Hunt, but with outliers near Niekerkshoop in the southeast and Floradora in the northeast. Altitude 800–1 200 m.

Vegetation & Landscape Features

Parallel dunes about 3–8 m above the plains. Open shrubland with ridges of grassland dominated by *Stipagrostis amabilis* on the dune crests and *Acacia haematoxylon* on the dune slopes, also with *A. mellifera* on lower slopes and *Rhigozum trichotomum* in the interdune straaten.

Geology & Soils

Aeolian sand underlain by superficial silcretes and calcretes of the Cenozoic Kalahari Group. Fixed parallel sand dunes, with Af land type almost exclusively.

Climate

Summer and autumn rainfall with very dry winters. MAP about 120–260 mm. Frost fairly frequent to frequent in winter. Mean monthly maximum and minimum temperatures for Vrouenspan 41.5°C and –4.0°C for December and July, respectively.

Important Taxa

Graminoids	*Schmidtia kalahariensis* (d), *Brachiaria glomerata*, *Bulbostylis hispidula*, *Centropodia glauca*, *Eragrostis lehmanniana*, *Stipagrostis ciliata*, *S. obtusa*, *S. uniplumis*.
Small trees	*Acacia mellifera* subsp. *detinens* (d).
Tall Shrubs	*Grewia flava* (d), *Rhigozum trichotomum* (d).
Succulent Shrub	*Lycium bosciifolium*, *L. pumilum*, *Talinum caffrum*
Low shrubs	*Aptosimum albomarginatum*, *Monechma incanum*, *Requienia sphaerosperma*
Herbs	*Hermbstaedtia fleckii* (d), *Acanthosicyos naudinianus*, *Hermannia tomentosa*, *Limeum arenicolum*, *L. argute-carinatum*, *Oxygonum dregeanum* subsp. *canescens* var. *canescens*, *Sericorema remotiflora*, *Sesamum triphyllum*, *Tribulus zeyheri*

Biogeographically Important Taxa

Graminoid	*Stipagrostis amabilis* (d), *Anthephora argentea*, *Megaloprotachne albescens*
Tall shrub	*Acacia haematoxylon* (d).
Herbs	*Helichrysum arenicola*, *Kohautia ramosissima*, *Neuradopsis austro-africana*.

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 4 below, 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).

Determining ecosystem status (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

Table 4: Conservation status of different vegetation types occurring in the study area.

Vegetation Type	Target (%)	Conserved (%)	Transformed (%)	Conservation status	
				Driver *et al*. 2005; Mucina *et al*., 2006	National Ecosystem List (NEM:BA)
Bushmanland Arid Grassland	21	0.4	0.6	Least threatened	Not listed
Kalahari Karroid Shrubland	21	0.1	0.8	Least threatened	Not listed
Gordonia Duneveld	16	14	0.2	Least threatened	Not listed

According to scientific literature (Driver *et al*., 2005; Mucina *et al*., 2006), as shown in Table 3, all three vegetation types are listed as Least Threatened.

The National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists national vegetation types that are afforded protection on the basis of rates of transformation. The thresholds for listing in this legislation are higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature.

None of the vegetation types are listed in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011).

Biodiversity Conservation Plans

The Northern Cape Critical Biodiversity Area (CBA) Map (Figure 5) was published in 2016 (Holness & Oosthuysen 2016) and "updates, revises and replaces all older systematic biodiversity plans and associated products for the province". This includes the Namakwa District Biodiversity Sector Plan (Desmet & Marsh 2008), from which the Northern Cape CBA Map derived identified CBA1 and CBA2 areas (and added additional CBA1 and CBA2 areas). This is important, since the rationale for defining the recent (2016) CBA areas is derived from the earlier (2008) product. CBA1 and CBA2 areas in the 2016 map include the following areas:

1. Important Bird Areas;
2. SKEP expert identified areas;
3. Threatened species locations;
4. Features from previous conservation plans (including CBA1 and CBA2 areas from the Namakwa District Biodiversity Sector Plan);
5. Areas supporting climate change resilience, e.g. areas of high diversity, topographic diversity, strong biophysical gradients, climate refugia, including kloofs, south-facing slopes and river corridors;
6. Conservation Plans from adjacent provinces; and
7. Landscape structural elements, e.g. rocky outcrops, koppies, dolerite dykes, boulder fields, woody vegetation on outwash plains.

The Northern Cape CBA map classifies the natural vegetation of the province according to conservation value in decreasing value, as follows:

1. Protected
2. Critical Biodiversity Area One (Irreplaceable Areas) (RED)
3. Critical Biodiversity Area Two (Important Areas) (ORANGE)
4. Ecological Support Area (GREEN)
5. Other Natural Area (YELLOW)

This shows features within the grid corridor within four of these classes, as follows:

1. Critical Biodiversity Areas: The southernmost and eastern parts of the corridor are within a CBA2 area. There are patches of CBA1 within the floodplain of the Orange River to the south of the site, but these do not occur within the grid corridor.
2. Ecological Support Areas: There are two small parts of the grid corridor within ECAs.
3. Other Natural Areas: Most of the grid corridor is indicated as being in a natural state.

The presence of CBA areas 2 in the southern and eastern parts of the study area indicate that these areas are considered important for biodiversity conservation. Additionally, the ESAs throughout most of the corridor indicate that the area has importance in a wider ecological context for supporting biodiversity patterns. CBA2 areas in the Northern Cape are assigned on the basis of one of the following five categories:

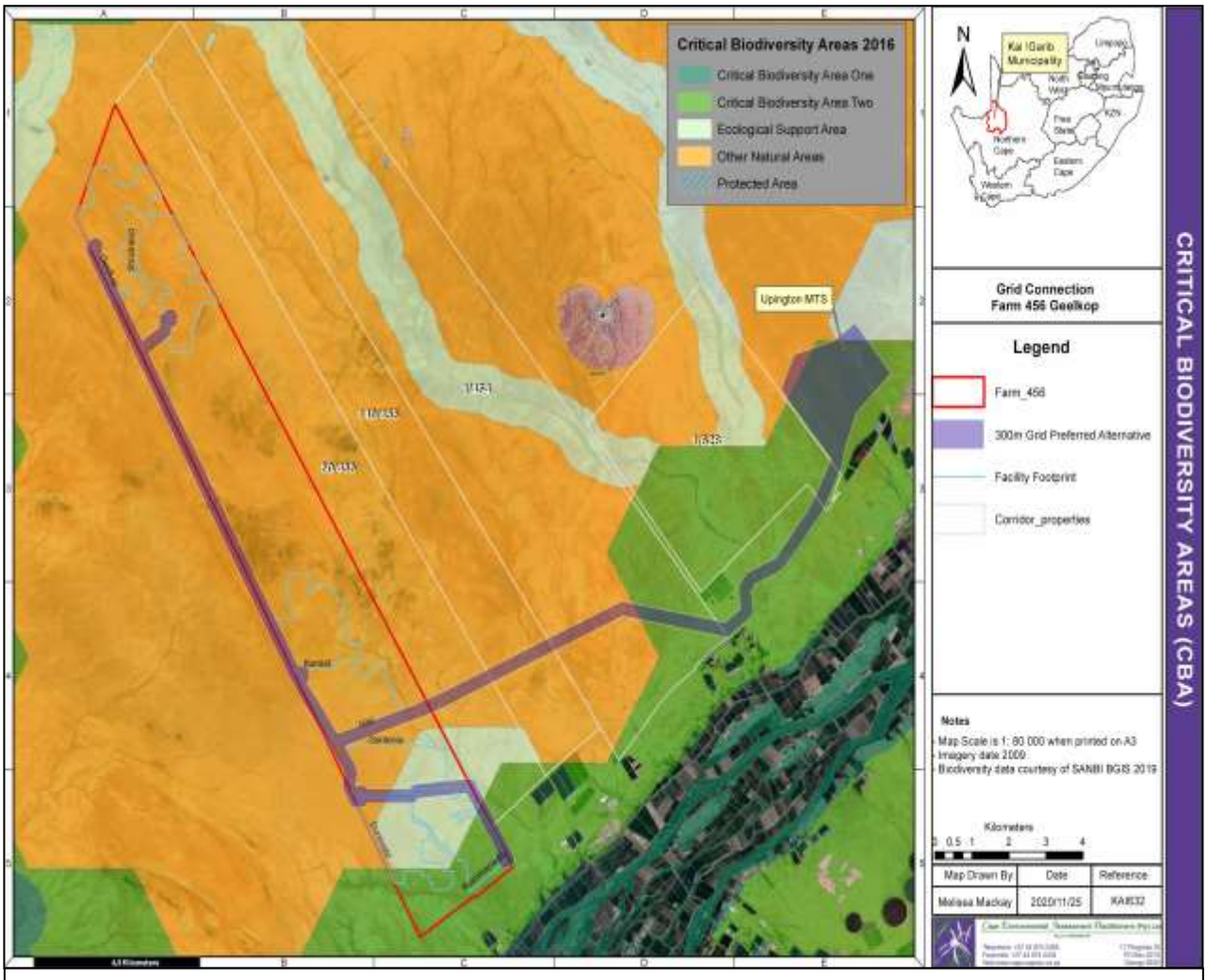

Figure 5: Northern Cape CBA map for the study area.

1. PA Domains & Buffers
2. SKEP Expert Areas
3. Namakwa CBA 2s
4. PUs <65% irreplaceability
5. NFEPA Wetland Clusters

The following is of pertinence to the site under investigation:

1. Protected Areas (PA Domains & Buffers): The closest protected area to the site is the Augrabies Falls National Park, over 50 km away, therefore PA Domains & Buffers do not apply. Note that there are also no areas close to the site that are within National Park Area Expansion Strategy focus areas.
2. SKEP Expert Areas: The site is outside of the SKEP planning domain area, therefore SKEP expert areas do not apply.
3. Namakwa CBA2s: The site is outside the Namakwa District, therefore Namakwa CBAs do not apply.
4. PU irreplaceability: Irreplaceability of Planning Units is based on a variety of factors, for example, conservation targets for vegetation types, habitat for threatened species, rare habitats in the Province, and threatened ecosystem processes. For those specific locations, processes or targets listed in the Technical Report (Holness & Oosthuysen 2016), none are applicable to the current general area.
5. NFEPA Wetland Clusters: The site falls within a NFEPA Wetland Cluster. It is associated with the Orange River and, according to "Atlas of Freshwater Ecosystem Priority Areas in South Africa", WRC Report No TT500/11", the site is within an area designated as "Fish Support Area and associated sub-quaternary catchment" with the river at this location designated as "Fish Sanctuary: other threatened" (as opposed to "Fish Sanctuary: critically endangered & endangered". The site is within a FEPA Sub-quaternary Catchment.

An interpretation of the above information is (1) that the CBA is moderately irreplaceable, and (2) the function of the sub-quaternary catchment requires protection.

In addition, a regional view of the CBA2 area on site shows the following:

1. The CBA2 areas in the study area are part of a broader CBA2 network associated with the Orange River across its entire length through the Northern Cape. The CBA2 areas in the study area are therefore a very small part of a much larger network. The intention therefore appears to be to preserve representative areas of various ecosystems, as well as preserve aquatic functioning of key ecosystems.
2. The Planning Units are hexagons with an individual area of 1600 ha, which provides little local resolution. On-site observation indicates that there is little difference between the CBA2 areas on site and other areas on site that are outside the CBA2 area. It should therefore be possible to preserve similar habitat nearby with the same overall outcome, even with some loss of habitat on site.

The most important objective in considering the CBA2 areas in the study area is to ensure that aqutic function in the landscape is not compromised. Steps to achieve this objective would be to protect main drainage lines from development, manage runoff and overland flow, avoid invasion by alien invasive plants, and avoid damage to aquatic patterns and processes.

Proposed protected areas

According to the National Parks Area Expansion Strategy (NPAES), there are no areas within the study area that have been identified as priority areas for inclusion in future protected areas. The study area is therefore **outside the NPAES focus area**. There are many areas outside of the study site, to the north, south, east and west that are included as being part of future protected areas, but not within or adjacent to the site itself.

Red List plant species of the study area

Lists of plant species previously recorded in the study area were obtained from the South African National Biodiversity Institute (SANBI) website (http://newposa.sanbi.org/). 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 occurs in the study area, *Aloidendron dichotomum*. According to IUCN Ver. 3.1 (IUCN, 2001) this species is listed as Vulnerable. A total of 5 individuals were found on site within the footprint of proposed infrastructure or in close proximity to the boundary of these areas.

There are also two species listed as Near threatened (*Dinteranthus wilmotianus* and *Hoodia officinalis* subsp. *officinalis*) and two species listed as Declining (*Vachellia erioloba* and *Hoodia gordonii*) that could occur on site (see Table 4 for explanation of categories). A number of individuals of *Vachellia erioloba* were found on site. The other species were not found on site.

Table 5: Explanation of IUCN Version 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

In summary, one Vulnerable plant species, *Aloidendron dichotomum*, and one Declining plant species, *Vachellia erioloba*, were found on site.

Protected plants (National Environmental Management: Biodiversity Act)

Plant species protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) are listed in Appendix 6. None of the species on this list were found on site, although several have a geographical distribution that includes the site.

Protected plants (Northern Cape Nature Conservation Act)

Plant species protected under the Northern Cape Nature Conservation Act, 2009 (Act 9 of 2009) are listed in Appendix 5. One species on this list, *Hoodia gordonii*, is also protected according to the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) and has been discussed above. A number of species were found on site that are protected according to the Northern Cape Nature Conservation Act, 2009 (Act 9 of 2009). From the reconnaissance survey, this includes the following: *Aloidendron dichotomum* (Asphodolaceae), *Aloe claviflora* (Asphodolaceae), *Aloe gariepensis* (Asphodolaceae), *Avonia albissima* (Anacampserotaceae), *Boscia foetida*, *Boscia albitrunca* (protected Provincially as well as according to the National Forests Act), *Mesembryanthemum sp.* (Aizoaceae), *Ruschia* sp. (Aizoaceae), *Euphorbia braunsii*, and *Nerine laticoma* (Amaryllidaceae). Despite not being threatened, any impacts on these species will require a permit from the relevant authorities. There is a possibility that additional protected species occur on site that were not detected during the field survey. Note that many of these species are widespread and not of any conservation concern, but protected due to the fact that the Northern Cape Nature Conservation Act, 2009 (Act 9 of 2009) protects entire families of flowering plants irrespective of whether some members are rare or common. The implication is that a comprehensive list of species occurring within the footprint of the proposed infrastructure is required and a permit application submitted for any of those listed as protected.

Protected trees

Tree species protected under the National Forest Act are listed in Appendix 2. Those that have a geographical distribution that includes the study area are *Vachellia erioloba* (Camel Thorn, Kameeldoring), *Vachellia haematoxylon* (Grey Camel Thorn, Vaalkameeldoring), *Boscia albitrunca* (Shepherd's Tree / Witgatboom / !Xhi) and *Euclea pseudebenus (*Ebony Tree, Ebbeboom).

The tree *Vachellia erioloba* occurs in dry woodland along watercourses in arid areas where underground water is present as well as on deep Kalahari sands. A number of individuals of this species were found in the study area within proximity to the proposed grid corridor. They were associated with drainage areas / watercourses.

Vachellia 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. A small number of individuals of this species were found in the study area, all within very close proximity to drainage lines, but none were found within those parts of the footprint of the grid corridor that was examined.

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 into Namibia. No individuals have been sighted close to Keimoes, but specimens have been recorded in the grid south and west of Kakamas. No individuals were recorded on site.

In summary, two species of protected trees were found on site, namely *Vachellia erioloba* and *Boscia albitrunca*. None of the individuals of these species were within the footprint of the proposed grid corridor, although small individuals could possibly have been missed in the field.

Vertebrate animal species of the study area

Vertebrate species (mammals, reptiles, amphibians) with a geographical distribution that includes the study area are listed in Appendix 4. All threatened (Critically Endangered, Endangered or Vulnerable) or near threatened vertebrate animals that could occur in the study area and have habitat preference that includes habitats available in the study area, are discussed further below.

Mammals

There are 64 mammal species that have a geographical distribution that includes the study area, of which six (6) are listed in a conservation category of some level (see Appendix 3), as follows: Black Rhinoceros (CR), Hartmann's Mountain Zebra (EN), Cape Clawless Otter (NT), Leopard (VU), Dent's Horseshoe Bat (NT), and Littledale's Whistling Rat (NT). This is a relatively moderate diversity of mammals compared to other parts of South Africa. Based on the natural state of the study area and surrounding areas, it is considered likely that many of these species could occur on site, especially the smaller species, such as various rodents, insectivores and small predators. Listed species with a geographical range that includes the site are discussed in more detail below to evaluate the potential for them to ocur on site.

Black Rhinoceros

The Black Rhinoceros (*Diceros bicornis bicornis*), listed as Critically Endangered, has a geographical distribution that includes the study area. The species is confined to formal conservation areas as well as a few individuals held on private land. **Although the habitat on site is suitable for this species, it does not occur there and would not be found there unless deliberately introduced.**

Hartmann's Mountain Zebra

Hartmann's Mountain Zebra (*Equus zebra hartmannae*), listed as Endangered in South Africa and Vulnerable regionally, is found in Namibia, southern Angola and the north-west parts of the Northern Cape. Ii inhabits rugges, broken mountainous and escarpment areas up to 2000 m in elevation where there is a diversity of grasses and a perennial water source. It has not been recorded in the grid in which the site is found or any nearby grids. The habitat on site is only marginally suited to this species. There is therefore a low likelihood of it being found on site. **The proposed development is therefore highly unlikely to have any negative effect on the species.**

Cape Clawless Otter

The Cape Clawless Otter (*Aonyx capensis*), listed as Least Concern in South Africa and Near Threatened regionally, is widely but patchily distributed throughout South Africa, and is also the most widely found otter in Africa. It is aquatic and seldom found far from permanent water, which needs to be fresh. They may be found in seasonal rivers in the Karoo, provided suitable-sized pools persist. The site is within the known distribution of this species but there are no historical records for the grid in which the site is found or any nearby grids. There is no suitable habitat for this species on site. **It is therefore considered highly unlikely that it occurs on site.**

Leopard

The Leopard (*Panthera pardus*), listed as Vulnerable, has a wide habitat tolerance, but with a preference for densely wooded areas and rocky areas. In montane and rocky areas of the Western and Northern Cape, they prey on dassies and klipspringers. They have large home ranges, but do not migrate easily, males having ranges of about 100 km^2 and females 20 km^2. It has been recorded in the grid in which the site is located, as well as nearby grids. There is a medium to high probability of this species occurring on site, in which case it would be at very low densities. **The proposed project could displace individuals but is unlikely to have a significant effect on overall population densities.**

Den't Horseshoe Bat

Dent's Horseshoe Bat (*Rhinolophus dentei*), listed as Near Threatened, is widely but patchily distributed in west and southern Africa. In southern Africa it is found in Namibia, western Botswana and northern parts of South Africa. The global distribution includes the study area, but known sitings in South Africa are restricted to the Ghaap Plateau (between Olifantshoek and Vryburg, down towards Kimberley and De Aar). It is associated with arid savannah habitats where suitable roosting sites occur, which restricts it to broken country with rocky outcrops or suitable caves. Colonies are largely dependent on caves, caverns, crevices in rocky outcrops, abandoned mines and similar habitats. It is were to occur on site, which is not very likely, it would probably only be found in the rocky outcrops to the north of the

current site. **It is considered possible but unlikely that it could occur on site and individuals could be affected by activities on site.**

Littledale's Whistling Rat
Littledale's Whistling Rat (*Parotomys littledalei*), listed as Near Threatened, has a narrow distribution in the driest parts of southern Africa, from the western regions of South Africa north into Namibia and mostly along a narrow strip of desert. It has been recorded in the grid in which the site is located as well as two surrounding grids and some nearby grids. It is found in Desert and Karoo on sandy or gravel open plains. It tends to excavate burrow beneath a shrub, but will also contruct stick nest at the base of a shrub. It is herbivorous, favouring leaves of Zygophullum and Mesembryanthemaceae. **It is considered possible and likely for it to occur in the study area and the proposed development could therefore affect this species**.

Of the species currently listed as threatened (see Appendix 5 for list of protected species), those listed in Table 6 are considered to have a low - medium probability of occurring on site and being potentially negatively affected by proposed activities on site.

Table 6: Mammal species of conservation concern with a likelihood of occurring on site.

Scientific name	Common name	Status	Likelihood of occurrence
Panthera pardus	Leopard	Vulnerable, protected	High
Parotomys littledalei	Littledale's Whistling Rat	Near Threatened	High
Rhinolophus denti	Dent's Horseshoe Bat	Near Threatened	Medium
Aonyx capensis	Cape Clawless Otter	Near Threatened, protected	Low
Diceros bicornis bicornis	Black Rhinoceros	Critically Endangered, protected	Zero
Equus zebra hartmannae	Hartmann's Mountain Zebra	Endangered, protected	Zero

Reptiles
A total of 62 reptile species have a geographical distribution that includes the general study area in which the site is found (Alexander & Marais 2007, Bates et al. 2014, Branch 1988, Marais 2004, Tolley & Burger 2007). This is a fairly high potential diversity compared to average diversity in other parts of the country. Of the reptile species that could potentially occur in the study area, none are listed in a threat category.

There are therefore no reptile species of conservation concern that could potentially occur in the study area and that may therefore be affected by the proposed project, shown in Table 7.

Table 7: Reptile species of conservation concern with a likelihood of occurring on site.

Scientific name	Common name	Status	Likel;ihood of occurrence
None	None	N/A	N/A

Amphibians
A total of only 9 frog species have a geographical distribution that includes the general study area in which the site is found (Du Preez & Carruthers 2009). Some of these species are only marginally present in the study area due to the fact that their distribution range ends close to the study area. Of the frog species that could potentially occur in the study area, none are listed in a threat category. Note that the Giant Bullfrog was previously listed as Near Threatened, but it is currently assessed as Least Concern, although still listed in legislation as protected.

It is concluded that the site contains habitat that is suitable for various frog species, although **no species of conservation concern are likely to occur in the study area**.

Table 8: Amphibian species of conservation concern with a likelihood of occurring on site.

Scientific name	Common name	Status	Likelihood of occurrence
None	None	N/A	N/A

Protected animals

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 6, marked with the letter "N". This includes the following species: White Rhinoceros (does not occur on site), Black Rhinoceros (does not occur on site), Hrtmann's Mountain Zebra (unlikely to occur on site), Cape Clawless Otter (unlikely to occur on site), Leopard, Cape Fox, and Giant Bullfrog .

Due to habitat and forage requirements, and the fact that some species are restricted to game farms and/or conservation areas, only the Leopard, Cape Fox, and Giant Bullfrog have any likelihood of occurring on site. Two of these species are mobile animals (Leopard and Cape Fox) that are likely to move away in the event of any activities on site disturbing them. However, the Giant Bullfrog, if it occurs on site, may be dependent on a small patch of habitat within their range to exist there. They could therefore be affected by the proposed development of the project.

Habitats on site

A map of habitats within the study area is provided in Figure 6. This shows the habitats for the site in relationship to the entire farm, Remainder of Geel Kop No. 456 as well as the proposed grid connection corridor. Transformed areas where no vegetation occurs were insignificant in area and were not mapped. This included roads, farm buildings and similar existing disturbances. The broad natural habitat units within the study area are as follows:

1. Plains vegetation (dwarf karroid shrubland);
2. Dune ridges:
3. Rocky outcrops (high rock cover areas);
4. Hills vegetation (more diverse karoo with high rock cover); and
5. Depressions (temporary pans);
6. Drainage lines;
7. Dry stream beds and associated riparian vegetation.

The following habitats occur within the area under consideration for this application:

1. Plains vegetation (dwarf karroid shrubland);
2. Dune ridges;
3. Drainage lines;
4. Dry stream beds and associated riparian vegetation;
5. Depressions (temporary pans).

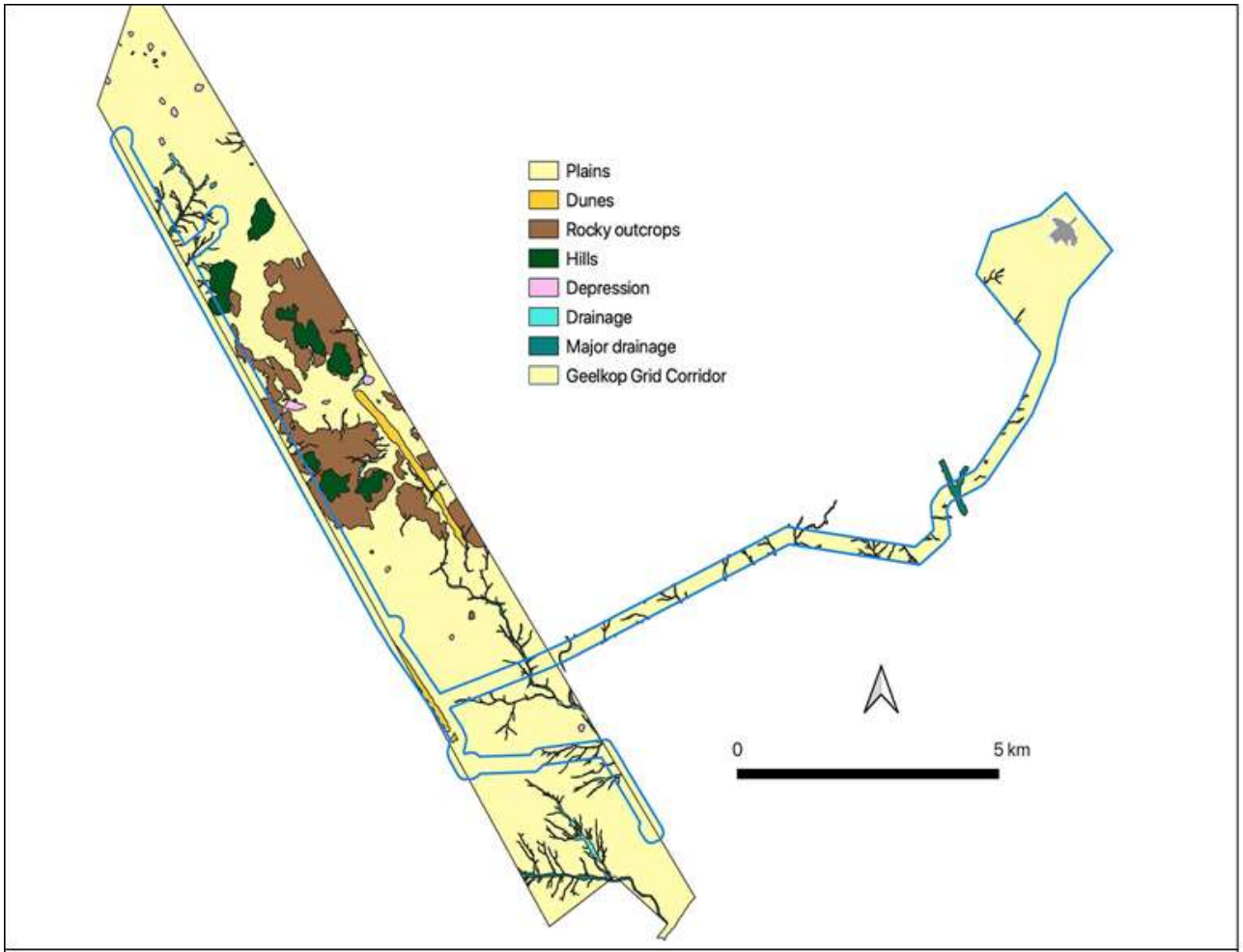

Figure 6: Habitats of the study area.

Plains vegetation

The general study area is characterised by a low karroid dwarf shrubland, typical of one of the two regional vegetation types that converge here, **Kalahari Karroid Shrubland**, which is described as "Low karroid shrubland on flat, gravel plains." (Mucina & Rutherford 2006). A typical view of this vegetation is shown in Figure 7.

The general floristic character of this vegetation on site is fairly uniform across wide areas, often dominated by the same suite of species, including *Rhigosum trichototum*, *Caroxylon calluna, Justicia australis, Galenia africana, Limeum aethiopicum, Tribulus pterophorus, Indigofera alternans, Enneapogon cenchroides, Tragus berteronianus, Senegalia mellifera, Blepharis mitrata, Aptosimum spinescens, Aptosimum procumbens, Roepera lichtensteiniana, Stiparostis uniplumis* and *Eriocephalus sp.*. However, any local variation in topography can lead to localized increase in richness associated with a more diverse species composition. Localised rock outcrops add habitat diversity.

Figure 7: View showing karroid dwarf vegetation on plains.

Drainage lines and iparian vegetation

There is a network of dry stream beds throughout the lower-lying areas of the study area, with smaller streams eventually joining together to form larger systems further downstream. In the hilly areas these start as dry drainage lines, but these are not mapped as part of this unit since they reflect the characteritstics of the surrounding vegetation rather than that of being a unique habitat. Where the dry streams occur as a unique habitat, they consist of a sandy or rocky bed, often unvegetatated or sparsely vegetated, bordered by a line of shrubs or small trees. The smaller drainage areas are only recognizable by the increased density of more woody shrubs, such as *Rhigozum obovatum*, *Asparagus suaveolens* and *Lycium cinereum*, as well as *Senegalia mellifera*. As they increase in size, they tend to develop a channel of sand (Figure 8).

As the stream beds get larger, the riparian fringe becomes more pronounced, often containing some large trees of *Vachellia erioloba*, as shown in Figure 9. There is a continuum from the smallest streams to the larger "rivers". Other species typical of these areas are *Senegalia mellifera*, *Asparagus suaveolens*, *Lycium cinereum*, *Boscia foetida*, and *Rhigosum trichotomum*.

The habitat contains a combination of bare rock and deeper sands, so it is able to support a flora that is adapted to these substrate conditions, in addition to the sporadic flooding and scouring that takes place in these habitats as a result of rare large rainfall events. The thorn trees (and other shrubs) occur here because they are able to root deeply to access underground water, a source that is not available to other terrestrial habitats. Although not necessarily floristically sensitive, the habitat that is derived under these ecological conditions is critically important for fauna, providing food and shelter as well as corridors for undetected movement. In times of drought, riparian areas may offer

Figure 8: Vegetation in minor drainage lines.

the only slightly green vegetation as a source of food. The deeper sands are important for burrowing animals and the shrubs and low trees offer shelter and browse.

Riparian habitats are disproportionately important in terms of the proportion of the area that they occupy in the landscape – they probably occupy 5-10% of the landscape in total, but provide a unique and important habitat for both flora and fauna. The plant species occurring within these habitats are not necessarily rare in a global sense, but degradation of this interconnected system can cause floristic loss and change in areas far removed from any impact. Maintenace of regional vegetation patterns therefore is dependent on maintaining the health and functionality of this component of the landscape. For this reason, and for the utilitarian importance to fauna, the riparian vegetation is considered to be ecologically sensitive.

Figure 9: Typical habitat in dry stream beds.

Rocky hills

There are a number of low hills in the northern half of the Remaining Extent of Geel Kop Farm No 456. The proposed corridor runs along the western side of these hills, at their base. The hills have high rock cover, including boulder fields, rock sheets, stony areas, and areas of shallow soil. There is also a mixture of relatively steep slopes and more gently sloping areas. The vegetation in these hills was generally quite bare compared to the surrounding plains (see Figure 10), but included many plant species that do not occur on the plains, including the following that were restricted to the hills: *Digitaria argyrograpta*, *Dicoma capensis*, *Cleome angustifolia*, *Jamesbrittenia megadenia*, *Cryptolepis decidua*, *Panicum coloratum*, *Solanum tomentosum*, *Rogeria longiflora* and *Chascanum garipense*. The hills were the prime habitat for the Vulnerable plant species, *Aloidendron dichotomum*, of which up to 100 individuals may occur on site within these hills. The hills are also the most likely habitat for encountering the protected tree species, *Boscia albitrunca*.

Figure 10: Vegetation of rocky hills.

Dune ridges

There is a low dune ridge running up the western side of the property (Remainder of Geel Kop No. 456). This is in close proximity to the western side of the proposed location of the PV area for the current project, but not directly affected. The habitat consists of relatively mobile, partially vegetated dunes consisting of characteristic orange sand. The dunes are linear structures that are aligned according to the prevailing wind directions, in this case in a north-west to south-east direction. The vegetation consists of a mixture of grasses, woody shrubs, scattered trees and various herbaceous species (Figure 11). Species observed on this ridge on the property include the grasses *Centropodia glauca*, and *Schmidtia kalahariensis*, the shrubs, *Senegalia mellifera*, *Lycium* species, *Rhigozum trichotomum*, *Cadaba aphylla*, *Boscia foetida*, and Asp*aragus suaveolens*, and the herbaceous species, *Indigofera alternans*, *Tribulus pterophorus*, *Giseckia africana*, *Limeum aethiopicum*, and *Ledebouria apertiflora*. There are often one or two small *Vachellia erioloba* trees dotted within this area.

Figure 11: View along dune ridge in study area.

Habitat sensitivity

To determine sensitivity on site, local and regional factors were taken into account. There are some habitats on site that have been described as sensitive in their own right, irrespective of regional assessments. This includes primarily the dry stream beds and associated riparian zones. Rocky outcrops and steep slopes are more sensitive than surrounding areas, mainly due to higher floristic diversity and the likelihood of plant species with low local abundance occurring there. They are also the most likely habitat for the threatened *Aloidendron dichotomum*.

At a regional level, the Critical Biodiversity Area (CBA) map for Northern Cape indicates the southern and eastern portions of the site as being important for conservation, but the reason behind the specific location of CBAs is not provided in relevant literature. It is assumed that there is a band of vegetation adjacent to the Orange River that is treated as a buffer for the CBA1 area designated for the river and its floodplain. The remaining parts of the study area are indicated as being Ecological Support Areas (ESAs).

In terms of other species of concern, including both plants and animals, the low hills on the property (to the north of the current site) are the locations where conservation of habitat would benefit species of concern based on the exisitng data available. All mammal species of concern and all protected plant species described previously could occur on any part of the site, whether in the mountains or on the lowlands, but they are all more likely to occur within the hills (with the exception of species occurring specifically within drainage lines).

A summary of sensitivities that occur on site and that may be vulnerable to damage from the proposed project are as follows:

1. Dry stream beds, including the associated riparian habitats and adjacent floodplains;
2. CBA areas;
3. Locations of threatened plants (*Aloidendron dichotomum*).

Based on this desktop information, a map of habitat sensitivity on site is provided in Figure 12. This shows main habitat sensitivity classes on site, namely HIGH for CBA2 areas and riparian habitats, and MEDIUM for plains vegetation. In the absence of the CBA areas, the affected habitats would have the sensitivity value of the adjacent equivalent habitat. Local areas classified as having VERY HIGH sensitivity are the locations of *Aloidendron dichotomum* on site, as well as a 50 m buffer around each one.

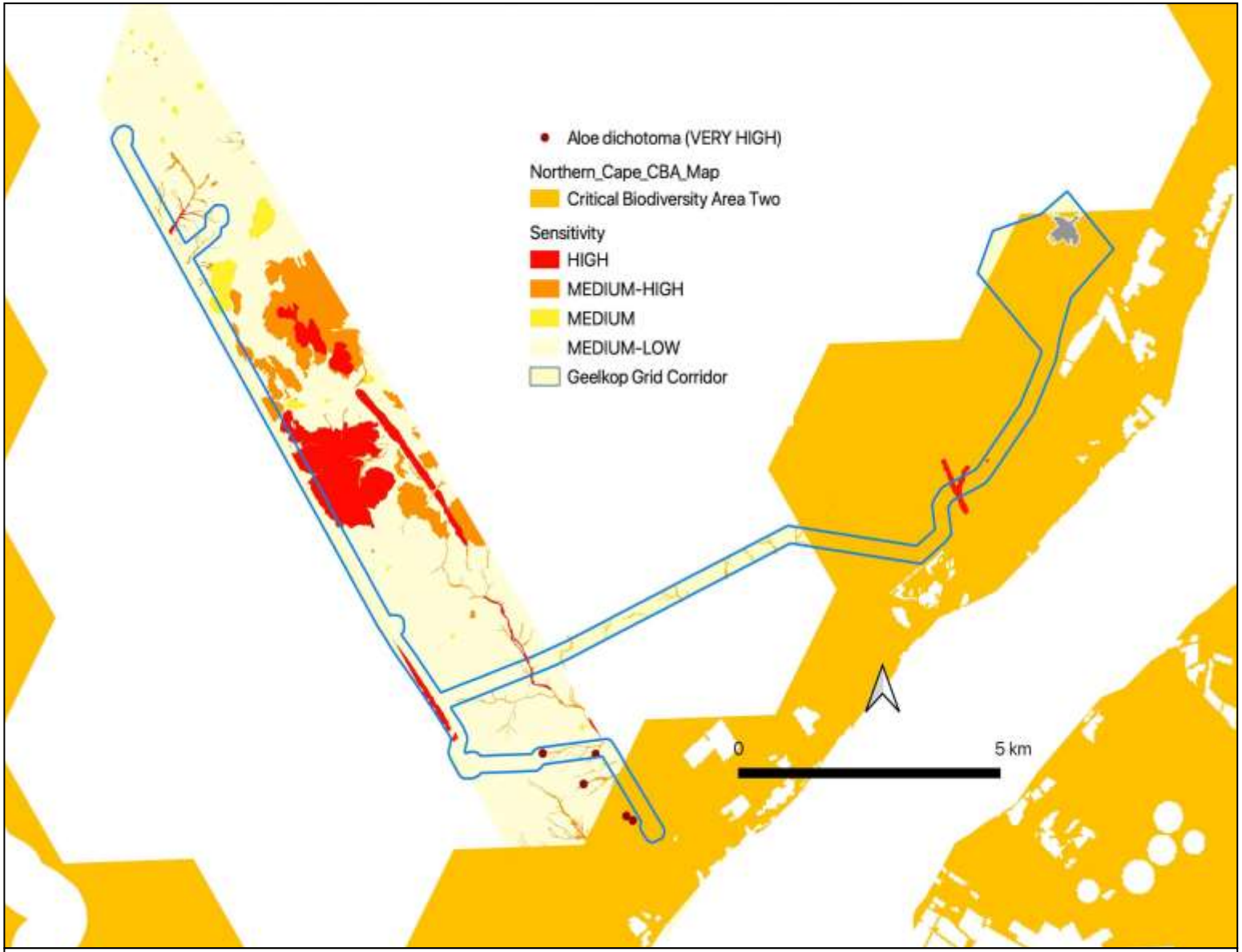

Figure 12: Habitat sensitivity of the study area.

DESCRIPTION OF POTENTIAL IMPACTS

Potential issues relevant to 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 grassland 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.

Potential sensitive receptors in the general study area

A summary of the potential ecological issues for the study area is as follows (issues assessed by other specialists, e.g. on birds and on wetland and hydrological function, are not included here):

- Presence of natural vegetation on site, some of which has high conservation value due to being within Critical Biodiversity Areas (CBA2). All-natural vegetation on site is vulnerable to disturbance, especially direct habitat loss and habitat fragmentation.
- Presence of dry stream beds and associated riparian vegetation on site, assessed as being sensitive to impacts associated with development as well as being important habitat for various plant and animal species.
- Presence of protected plant species, namely *Vachellia erioloba* and *Boscia albitrunca*, protected according to the National Forests Act (Act 84 of 1998).
- Presence of a plant species of conservation concern, namely *Aloidendron dichotomum*, listed as Vulnerable.
- Presence of various plant species protected according to the Northern Cape Nature Conservation Act (Act 9 of 2009). The identity of such species requires detailed floristic surveys within the footprint of the proposed project.
- Potential presence of various mammal species of concern, including Leopard and Cape Fox, protected according to the National Environmental Management: Biodiversity Act (Act 10 of 2004). In addition, the Leopard is listed as Vulnerable.
- Potential invasion of natural habitats by alien invasive plants, thus causing additional impacts on biodiversity features.

Construction Phase Impacts

Direct impacts

Direct impacts include the following:

1. Loss and/or fragmentation of indigenous natural vegetation due to clearing;
2. Loss of individuals of plant species of conservation concern and/or protected plants;
3. Loss of faunal habitat and refugia;
4. Direct mortality of fauna due to machinery, construction and increased traffic;
5. Displacement and/or disturbance of fauna due to increased activity and noise levels;
6. Effects on physiological functioning of vegetation due to dust deposition;
7. Increased poaching and/or illegal collecting due to increased access to the area.

Indirect impacts

Indirect impacts during the construction phase include the following:

1. Establishment and spread of alien invasive plants due to the clearing and disturbance of indigenous vegetation;
2. Changes to behavioural patterns of animals, including possible migration away or towards the project area;
3. Increased runoff and erosion due to clearing of vegetation, construction of hard surfaces and compaction of surfaces, leading to changes in downslope areas.

Operational Phase Impacts

Direct impacts

Ongoing direct impacts will include the following:

1. Continued disturbance to natural habitats due to general operational activities and maintenance;
2. Direct mortality of fauna through traffic, illegal collecting, poaching and collisions and/or entanglement with infrastructure;

Indirect impacts

These will include the following:

1. Continued establishment and spread of alien invasive plant species due to the presence of migration corridors and disturbance vectors;
2. Continued runoff and erosion due to the presence of hard surfaces that change the infiltration and runoff properties of the landscape;
3. Changes to behavioural patterns of animals, including possible migration away or towards the project area;
4. Positive potential impact on climate change due to generation of electricity without the need for coal mining or burning of coal, currently the main form of power generation in South Africa.

Decommissioning Phase Impacts

Direct impacts

These will include the following:

1. Loss and disturbance of natural vegetation due to the removal of infrastructure and need for working sites;
2. Direct mortality of fauna due to machinery, construction and increased traffic;
3. Displacement and/or disturbance of fauna due to increased activity and noise levels;
4. Effects on physiological functioning of vegetation due to dust deposition;

Indirect impacts

These will occur due to renewed disturbance due to decommissioning activities, as follows:

1. Continued establishment and spread of alien invasive plant species due to the presence of migration corridors and disturbance vectors;
2. Continued runoff and erosion due to the presence of hard surfaces that change the infiltration and runoff properties of the landscape;

3. Changes to behavioural patterns of animals, including possible migration away or towards the project area;

Cumulative impacts

The projects listed in Table 9 have been identified within a 30 km radius of the current project (shown in Figure 13 below) and are included in the Cumulative Impact Assessment. There are 27 projects listed that cover a fairly broad area, mostly to the east and north-east of the current project.

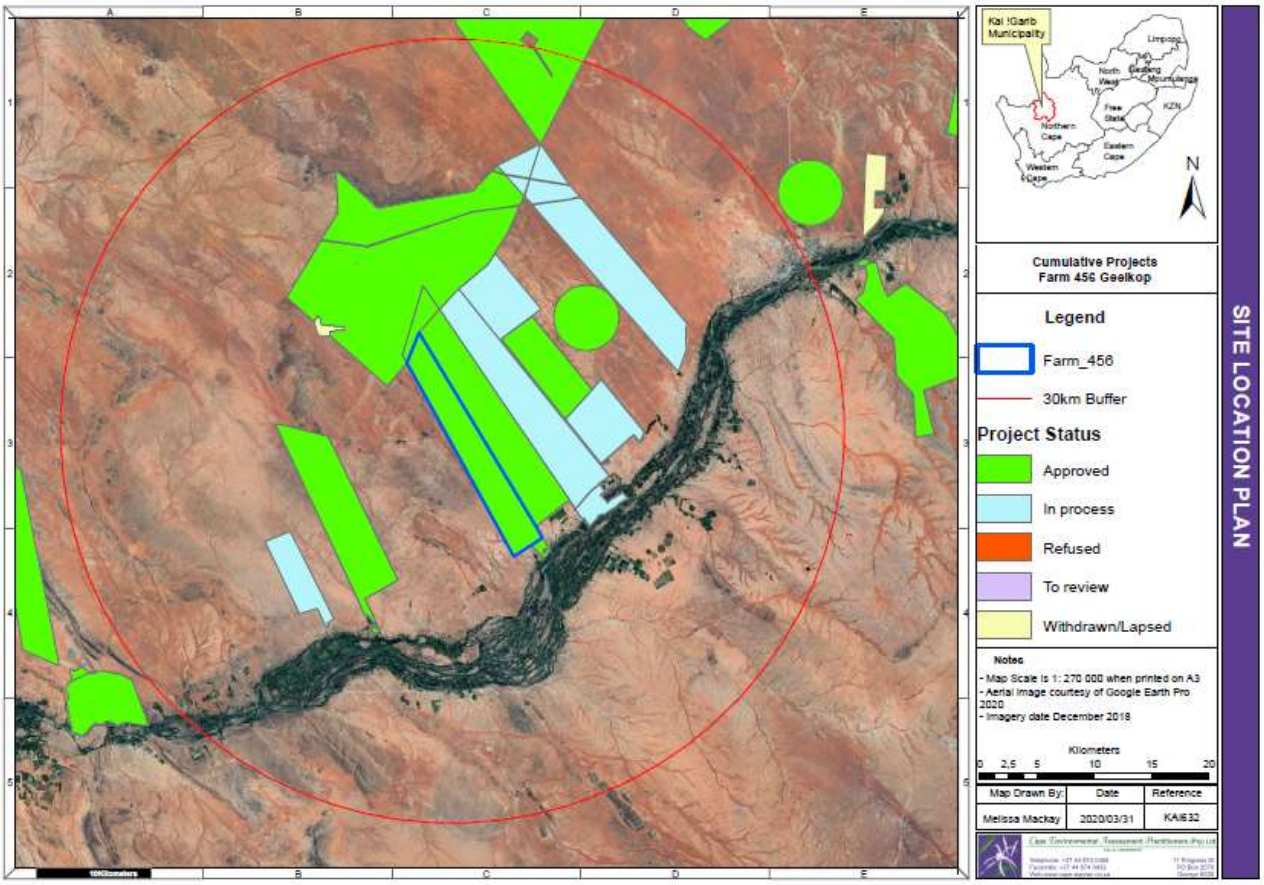

Table 9: Projects within a 30 km radius of the Duneveld PV project.

PROJECT	PROPERTY	STATUS
Khi Solar 1 (CSP)	Portion 3 of the Farm McTaggarts Camp 453	Operational
Upington CSP tower 2 and 3 (CSP)	Portion 3 of the Farm McTaggarts Camp 453	Authorised
Rooipunt Solar Park (PV)	Remainder farm Rooipunt 617	Authorised
Sasol CSP Phase 1 and 2 (CSP)	Portions 443 and 450 of 450 van roois vley	Authorised
Sirius Solar One (PV)	Remainder of Farm Tungsten Lodge	Operational
Sirius Solar 2 (PV)	Remainder of Farm Tungsten Lodge	Authorised
Sirius Solar 3 (PV)	Remainder of Farm Tungsten Lodge	EIA in Process
Sirius Solar 4 (PV)	Remainder of Farm Tungsten Lodge	EIA in Process
S-Kol (PV)	Farm Geelkop 456	Authorised
Ofir ZX (PV)	Remainder of Farm 616	Authorised
Sonneberg PV Facility	Portion 11 of 474	Authorised
Dyasonsklip 1	Farm Dyasonsklip 454	Operational

Dyasonsklip 2	Farm Dyasonsklip 454	Operational
Dyasonsklip 3	Farm Dyasonsklip 454	Authorised
Dyasonsklip SEF 1	Farm Dyasonsklip 454	Authorised
AEP Bloemsmond Solar 1	Portion 5 and 14 of Bloemsmond 455	Authorised
AEP Bloemsmond Solar 2	Portion 5 and 14 of Bloemsmond 455	Authorised
Bloemsmond 3	Portion 5 and 14 of Bloemsmond 455	Authorised
Bloemsmond 4	Portion 5 and 14 of Bloemsmond 455	Authorised
Bloemsmond 5	Portion 5 and 14 of Bloemsmond 455	Authorised
Bushmanland PV	RE Geelkop 456	Authorised
Duneveld PV	RE Geelkop 456	Authorised
Hari PV	RE Geelkop 456	Authorised
Gordonia PV	RE Geelkop 456	Authorised
Shrubland PV	RE Geelkop 456	Authorised
Karroid PV	RE Geelkop 456	Authorised
GK PV	RE Geelkop 456	Authorised

It has been estimated that habitat transformation related to these projects will be 920 ha for operational projects, 3220 ha for authorized projects and 2760 ha for projects that are currently in the process of undertaking EIAs. If all of these proceed, the total loss of habitat will be 6900 ha. This is a small area in relation to the total area of the two main vegetation types that will be affected, namely Bushmanland Arid Grassland (4547896 ha) and Kalahari Karroid Shrubland (3677171 ha), although this will admittedly be concentrated in a way that will lead to about 20-25% of the landscape within 30 km of the current project being lost to development.

There are various cumulative impacts that may occur as a result of the combined impact of a number of similar projects in the area, as follows:

1. Loss and/or fragmentation of indigenous natural vegetation due to clearing;
2. Loss of individuals of plant species of conservation concern and/or protected plants;
3. Changes to ecological processes at a landscape level;
4. Mortality, displacement and/or disturbance of fauna;
5. General increase in the spread and invasion of new habitats by alien invasive plant species;
6. Reduction in the opportunity to undertake or plan conservation, including effects on CBAs and ESAs, as well as on the opportunity to conserve any part of the landscape;
7. Loss of the wilderness character of the area;
8. Positive cumulative impact on climate change.

ASSESSMENT OF SIGNIFICANCE OF ECOLOGICAL IMPACTS

Construction Phase Impacts

Impact 1: Loss and/or fragmentation of indigenous natural vegetation due to clearing
The regional vegetation type in the broad study area is a combination of Bushmanland Arid Grassland, Kalahari Karroid Shrubland and Gordonia Duneveld, classified in the scientific literature as Least Threatened (Mucina *et al*., 2008) and not listed in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011). Any areas of natural habitat within this regional vegetation type are therefore considered to have moderate conservation value. The southern and eastern portions of the site is included in a Critical Biodiversity Area (CBA2) for the Northern Cape and considered to have moderately high conservation value.

Vegetation on site is within a very arid region and consists of slow-growing dwarf shrubs and ephemeral herbs, some of which are partially succulent. These species are slow to grow and individuals are probably much older than they appear from their size. Disturbed areas are not likely to recover to any natural state and clearing must therefore be kept to an absolute minimum to avoid habitat degradation issues.

Habitat loss refers to physical disturbance of habitats through clearing, grading and other permanent to semi-permanent loss or degradation. Loss of habitat on site could lead to loss of biodiversity as well as habitat important for the survival of populations of various species. Habitat fragmentation will occur primarily through the construction of roads. Edge effects related to roads are difficuklt to quantify or predict, but anything within 50 m of a road is almost certain to be affected by the changed physical conditions.

All infrastructure components associated with the various PV projects to be serviced by the proposed grid infrastructure will require some level of clearing of vegetation prior to construction. However, the proposed grid infrastructure will cause the least loss of vegetation relative to the other components. The substations will also require vegetation clearing, but this will be much smaller areas in comparison to the other components. For all infrastructure components, loss of habitat will occur, but this will be relatively insignificant in comparison to the total area of the vegetation types concerned.

Table 10: Impact table for Impact 1: Loss and/or fragmentation of indigenous natural vegetation.

Loss and/or fragmentation of indigenous natural vegetation	
Environmental parameter	Indigenous natural vegetation
Issue/Impact/Environmental Effect/Nature	Loss, degradation or fragmentation of vegetation.
Extent	The impact will affect natural vegetation on site.
Probability	If the project is authorized then the impact will definitely happen.
Reversibility	Irreversible in human timeframes, since construction of roads and other hard surfaces completely remove vegetation and modify the substrate upon which it grows. Secondary vegetation in disturbed areas will probably never resemble the original vegetation found on site.
Irreplaceable loss of resources	Significant loss of resources will occur within the footprint of the proposed infrastructure since vegetation clearing is required prior to installation of infrastructure.
Duration	The impact will be permanent (mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient)
Cumulative effect	Medium cumulative impact. Added to existing impacts on natural habitat from activities in the general region as well as the nearby similar

	RE projects, the current project will cause additional loss of vegetation, the cumulative effect of which will be medium.
Intensity/magnitude	High. The functional integrity of vegetation on site will be compromised to some degree (especially in the sense that the quality, integrity and functionality of CBA areas will be affected, which can be limited to some extent by implementation of mitigation measures.
Significance rating	Medium negative impact expected.

	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	4 (Definite)	4 (Definite)
Reversibility	4 (Irreversible)	4 (Irreversible)
Irreplaceable loss	2 (Marginal loss of resources)	2 (Marginal loss of resources)
Duration	4 (Permanent)	4 (Permanent)
Cumulative effect	3 (Medium)	3 (Medium)
Intensity/magnitude	2 (Medium)	2 (Medium)
Significance rating	**-36 (medium negative)**	**-36 (medium negative)**
Mitigation measures	It is not possible to completely avoid impacts on indigenous vegetation for this project. The following mitigation measures would help to limit impacts: 1. Restrict impact to development footprint only and limit disturbance spreading into surrounding areas. 2. As far as possible, locate infrastructure within areas that have been previously disturbed or in areas with lower sensitivity scores. 3. Avoid sensitive features and habitats when locating infrastructure. 4. Cross streams and other linear features at right angles, where possible, and also near their end-points or where there are natural breaks in the feature. 5. Construct adequate structures at points where roads cross watercourses, either proper stabilized dips in the road or culverts that do not limit the width of natural channels or the natural hydrological function. 6. No mass clearing of vegetation for the PV arrays should be allowed. Vegetation to be brush cut and only in exceptional circumstances completely cleared. 7. Compile a Rehabilitation Plan. 8. Compile an Alien Plant Management Plan, including monitoring, to ensure minimal impacts on surrounding areas. 9. Where possible, access roads should be located along existing farm, access and district roads. 10. Access to sensitive areas outside of development footprint should not be permitted during construction. 11. Undertake monitoring to evaluate whether further measures would be required to manage impacts.	

Impact 2: Impacts on listed or protected plant species

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 within which metapopulation dynamics occur (dispersal, recruitment, pollination, etc.).

There is one species listed as Vulnerable, *Aloidendron dichotomum*, five of which occur in or near the proposed infrastructure.

There is one species protected according to the National Forests Act, *Vachellia erioloba*, two of which were found on site during the field survey. No additional individuals were found on site during the field survey.

There are a number of species protected according to the Northern Cape Nature Conservation Act that were recorded on site during the walk-through survey. None of these are threatened species, but are protected according to Provincial legislation.

Table 11: Impact table for impact 2: Loss of individuals of protected plants.

Loss of individuals of protected plants		
Environmental parameter	Protected plants, as per NEM:BA or NCNCA or listed plants	
Issue/Impact/Environmental Effect/Nature	Loss of individuals occurring within the footprint of construction.	
Extent	The impact will affect local populations or individuals of the affected species.	
Probability	Based on the list of species that are protected or listed, the impact is certain to happen.	
Reversibility	Partly reversible. Where necessary, individuals can be rescued or else cultivated to replace lost specimens.	
Irreplaceable loss of resources	Marginal loss of resources could occur. The species that are likely to occur on site are likely to be relatively common throughout their range and they have very wide geographical ranges.	
Duration	The impact will be medium-term.	
Cumulative effect	Low cumulative impact. Cumulative effects will not be significant.	
Intensity/magnitude	Low. Loss of some individuals will be insignificant compared to the number that probably occur in nearby natural areas.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	2 (Possible)
Reversibility	4 (Irreversible)	4 (Irreversible)
Irreplaceable loss	2 (Marginal loss of resources)	1 (No loss of resources)
Duration	4 (Permanent	2 (Medium-term)
Cumulative effect	2 (Low)	1 (Negligible)
Intensity/magnitude	2 (Medium	1 (Low)
Significance rating	**-32 (medium negative)**	**-12 (low negative)**
Mitigation measures	A number of protected species were found on site. The following mitigation measures would help to avoid and limit impacts: **1. It is a legal requirement to obtain permits for specimens that will be lost.** 2. A detailed pre-construction walk-through survey will be required during a favourable season to locate any additional individuals of protected plants. This survey must cover the footprint of all approved infrastructure, including internal access roads. 3. If possible, plants should be conserved *in situ*, along with an appropriate buffer zone around them. Consideration should be given to shifting infrastructure to avoid such plants, especially the Vulnerable *Aloidendron dichotomum*. If this is not possible, then the following measures may be implemented: a. Plants lost to the development can be rescued and planted in appropriate places in rehabilitation	

	areas. This will reduce the irreplaceable loss of resources as well as the cumulative effect. b. A Plant Rescue Plan must be compiled to be approved by the appropriate authorities.

Impact 3: Loss of faunal habitat and refugia

Construction activities will lead to direct loss of habitat favourable for various faunal species, including sites where mobile fauna would obtain refuge and sedentary fauna would have permanent homes. This could potentially affect all animal species occurring on site, although threatened and protected species are of greater concern. There are two animal species of particular concern for this project, namely the Leopard (Vulnerable) and Littledale's Whistling Rat (Near Threatened), neither of which were seen on site, although they have been assessed as having a probability of occurring there. There are also other more mobile species that are protected by legislation, including the Cape Fox.

Table 12: Impact table for Impact 3: Loss of faunal habitat and refugia.

Loss of faunal habitat and refugia		
Environmental parameter	Fauna of conservation concern (Leopard, Littledale's Whistling Rat)	
Issue/Impact/Environmental Effect/Nature	Displacement of individuals.	
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	No or low loss of resources will occur.	
Duration	The impact will be short-term (construction phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Low. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	3 (Probable)
Reversibility	3 (Barely reversible)	3 (Barely reversible)
Irreplaceable loss	2 (Marginal)	2 (Marginal)
Duration	4 (Permanent)	4 (Permanent)
Cumulative effect	2 (Low)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Medium)
Significance rating	**-30 (medium negative)**	**-15 (low negative)**
Mitigation measures	1. Restrict impact to development footprint only and limit disturbance spreading into surrounding areas. 2. Limit clearing of natural habitat designated as sensitive, especially rocky outcrops, cliffs and riparian habitats. 3. All mitigation measures that apply to "Loss and/or fragmentation of indigenous natural vegetation" also apply here.	

Impact 4: Direct mortality of fauna due to machinery, construction and increased traffic

There is a possibility that animals will be killed by machinery during construction, especially sedentary or relatively sedentary species, and those that move too slowly to move out of the path of construction. This will inevitably lead to mortality of individuals of such animals. There is also a possibility of collisions with vehicles due to increased traffic along roads and within the project area. Faunal mortalities may also be caused by electric fences, ingestion of waste material and/or accidental ensnarement.

Table 13: Impact table for Impact 4: Mortality of fauna.

Mortality of individuals of fauna due to machinery, construction or increased traffic		
Environmental parameter	Fauna	
Issue/Impact/Environmental Effect/Nature	Loss of individuals.	
Extent	The impact will affect individuals on site.	
Probability	The impact will probably happen to some extent.	
Reversibility	Completely reversible. Impact is reversible with mitigation measures.	
Irreplaceable loss of resources	Marginal loss of resources will occur.	
Duration	The impact will be short-term (during construction phase only).	
Cumulative effect	Negligible cumulative impact.	
Intensity/magnitude	Low. Barely perceptible impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable))	2 (Possible))
Reversibility	1 (Completely reversible)	1 (Completely reversible)
Irreplaceable loss	2 (Marginal)	2 (Marginal)
Duration	1 (Short-term)	1 (Short-term)
Cumulative effect	1 (Negligible)	1 (Negligible)
Intensity/magnitude	1 (Low)	1 (Low)
Significance rating	**-9 (low negative)**	**-8 (low negative)**
Mitigation measures	The following mitigation measures would help to avoid or limit impacts: 1. Access to sensitive areas outside of development footprint should not be permitted during construction. 2. Speed limits should be set for all roads on site, as well as access roads to the site. Strict enforcement of speed limits should occur – install speed control measures, such as speed humps, if necessary. 3. Night driving should be strictly limited and, where absolutely required, lower speed limits should apply for night driving. 4. Pre-construction walk-through on construction front must be undertaken to move any individual animals, such as tortoises, prior to construction. 5. No dogs or other pets should be allowed on site. 6. Personnel on site should undergo environmental induction training, including the need to abide by speed limits, the increased risk of collisions with wild animals on roads in rural areas. 7. If electric fences are to be constructed, these should be erected according to the standars of Nature Conservation authorities. 8. Proper waste management must be implemented, ensuring no toxic or dangerous substances are accessible to wildlife. This should also apply to stockpiles of new and used materials to ensure that they do not become a hazard.	

Impact 5: Displacement of mobile terrestrial fauna

Construction activities, loss of habitat, noise, dust and general activity associated with the construction phase of the project are likely to cause all mobile species to move away from the site. Mobile species of conservation concern that could potentially be affected by the proposed project are as follows:

1. Leopard,
2. Cape Fox.

These are mobile terrestrial species with a large home range and the ability to travel long distances in short periods of time. Individuals may be locally displaced, but this will have little effect on the overall range of the species nor is it expected that any overall impacts will result from local displacement.

Table 14: Impact table for Impact 5: Displacement of terrestrial fauna.

Displacement of individuals of mobile terrestrial fauna		
Environmental parameter	Mobile fauna of conservation concern (Honey Badger, Black-footed Cat, Leopard, Cape Fox and Grey Rhebok)	
Issue/Impact/Environmental Effect/Nature	Displacement of individuals.	
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	No or low loss of resources will occur.	
Duration	The impact will be short-term (construction phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Low. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	1 (None)	1 (None)
Duration	1 (Short-term)	1 (Short-term)
Cumulative effect	1 (Low)	1 (Low)
Intensity/magnitude	1 (Low)	1 (Low)
Significance rating	**-8 (low negative)**	**-8 (low negative)**
Mitigation measures	1. Restrict impact to development footprint only and limit disturbance spreading into surrounding areas. 2. Access to sensitive areas outside of development footprint should not be permitted during construction. 3. No speeding on access roads – install speed control measures, such as speed humps, if necessary 4. No hunting of protected species. 5. Personnel to be educated about protection status of species, including distinguishing features to be able to identify protected species. 6. Report any sitings to conservation authorities.	

Impact 6: Increased poaching and/or illegal collecting due to increased access to the area

The site is in a relatively remote area with moderately low access to the public. More importantly, access to mountainous areas is limited due to it being on private land. There is therefore a relatively low risk of opportunistic or targeted poaching of plants or animals. The construction of roads into the project area and the increased amount of traffic from outside areas will increase the opportunity for poaching or illegal collecting.

From a botanical perspective, there are a number of plants in succulent or geophyte groups that are attractive to collectors. There are also animals, such as lizards and tortoises that may be attractive to collectors or vulnerable to opportunistic collection. Many of these groups are protected under national and/or provincial legislation, but this does not necessarily prevent ill-informed or determined collectors.

Poaching of animals or plants for meat or medicinal purposes is a separate risk that is also more likely to occur where physical access is created.

Table 15: Impact table for Impact 6: Increased poaching and illegal collecting.

Increased poaching and/or illegal collection of plants and animals		
Environmental parameter	Any plants and/or animals that are attractive to collectors and/or poachers	
Issue/Impact/Environmental Effect/Nature	Loss of individuals / populations.	
Extent	The impact will affect individuals on site.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	Low to marginal loss of resources will occur.	
Duration	The impact will be permanent (duration of the life of the roads).	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Low)	2 (Low)
Duration	4 (Permanent)	4 (Permanent)
Cumulative effect	2 (Low)	1 (Low)
Intensity/magnitude	2 (Low)	1 (Low)
Significance rating	**-26 (low negative)**	**-12 (low negative)**
Mitigation measures	1. Personnel to be educated about protection status of species, including distinguishing features, to be able to identify protected species. 2. Implement strict access control for the site. 3. No hunting of protected species. 4. Report any illegal collection to conservation authorities.	

Impact 7: Effects on physiological functioning of vegetation due to dust deposition

There is a high risk during construction that dust will be created that will settle on surrounding vegetation. This will be due to earth-moving equipment as well as vehicles moving around on site as well as into and out of the site. There will be a definite increase in the amount of traffic on access roads to the site that will also affect surrounding areas.

Dust deposited on vegetation directly screens incoming radiation as well as affects stomatal gas-exchange. The combined effect is a reduction in fitness of affected vegetation which will lead to reduced potential growth rates , damage to leaves, and possibly reduced ability to resist pathogens.

In addition to direct effects on the vegetation, there is also a possibility that grazing animals will be affected through a reduction in palatability of plants, and increased silica on surfaces of edible plants that will possibly affect dental wear-and-tear.

Table 16: Impact table for Impact 7: Vegetation damage due to dust deposition.

Impaired physiologivcal functioning of vegetation due to increased dust deposition.	
Environmental parameter	Vegetation
Issue/Impact/Environmental Effect/Nature	Dust deposition, resulting in reduced physiological fitness of plants / vegetation.

Extent	The impact will affect vegetation on site and in all areas with access roads leading to site.	
Probability	The impact will almost certainly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	Low to marginal loss of resources will occur.	
Duration	The impact will be permanent (duration of the life of the roads) for access roads (although only subject to high traffic volumes during construction, and short-term for construction areas.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	2 (Local)	2 (Local)
Probability	3 (Probable)	3 (Probable)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Low)	2 (Low)
Duration	1 (Short-term)	1 (Short-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-26 (low negative)**	**-12 (low negative)**
Mitigation measures	1. No speeding on access roads – install speed control measures, such as speed humps, if necessary, and penalties for non-compliance. 2. Undertake dust fall-out monitoring and manage, where necessary.	

Impact 8: Establishment and spread of declared weeds and alien invader plants due to the clearing and disturbance of indigenous vegetation

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

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

Small existing populations of alien plants were see on site or in nearby areas, the potentially most problematic species of which is *Prosopis glandulosa*. There is a high possibility that alien plants could be introduced to areas within the footprint of the proposed activities from surrounding areas in the absence of control measures. The potential consequences may be of moderate seriousness for affected natural habitats. Control measures could prevent the impact from occurring. These control measures are relatively standard and well-known.

Table 17: Impact table for Impact 9: Establishment and spread of declared weeds.

Establishment and spread of declared weeds	
Environmental parameter	Vegetation and habitat

Issue/Impact/Environmental Effect/Nature	Loss of habitat due to invasion by alien plants	
Extent	The impact will affect habitat on site and possibly in immediately surrounding areas.	
Probability	The impact will probably happen in the absence of control measures.	
Reversibility	Partly reversible in the absence of control measures. Completely reversible if mitigation measures applied. Preventative measures will stop the impact from occurring.	
Irreplaceable loss of resources	Marginal to significant loss of resources will occur. Uncontrolled invasion can affect all nearby natural habitats.	
Duration	The impact will be long-term.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. Severe invasion can alter the functioning of natural ecosystems.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	2 (Possible)
Reversibility	2 (Partly)	2 (Partly)
Irreplaceable loss	3 (Significant)	2 (Marginal)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-30 (medium negative)**	**-12 (low negative)**
Mitigation measures	It is possible to avoid impacts due to alien plant invasions by undertaking the following mitigation measures: 1. Compile and implement an alien management plan, which highlights control priorities and areas and provides a programme for long-term control. This should include any areas within proximity to the project that may be affected by the project, or that could have an influence on invasion by alien invasive plants into the property. 2. Undertake regular monitoring to detect alien invasions early so that they can be controlled. 3. Implement control measures.	

Impact 9: Changes to behavioural patterns of animals, including possible migration away or towards the project area
The increased human presence and/or construction operations will increase noise levels as well as light levels at night. The increased human presence, elevated noise and light levels, loss of animal habitat and compaction of soils may alter the behavioural patterns of some animals. Some of these changes may favour certain species and negatively affect others and consequently change the composition of the animal communities. Some of these changes could possibly increase levels of predation. Territorial species such as steenbok and klipspringer, will be negatively affected as well as species that live or move in the soil. These species might undergo a local reduction in their population size.

Table 18: Impact table for impact 10: Changes in behavioural patterns of animals.

Changes in behavioural patterns of fauna	
Environmental parameter	Mobile fauna
Issue/Impact/Environmental Effect/Nature	Displacement of individuals or changes to community structure.
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.
Probability	The impact may possibly happen.
Reversibility	Partly reversible with time.

Irreplaceable loss of resources	No or low loss of resources will occur.	
Duration	The initial impact will be short-term (construction phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Low. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	1 (None)	1 (None)
Duration	1 (Long-term)	1 (Short-term)
Cumulative effect	1 (Low)	1 (Low)
Intensity/magnitude	1 (Low)	1 (Low)
Significance rating	**-8 (low negative)**	**-8 (low negative)**
Mitigation measures	1. Avoid development of designated sensitive habitats. 2. Access to sensitive areas outside of development footprint should not be permitted during construction. 3. Personnel to be educated about environmental sensitivities and issues on site. 4. Report any sitings to conservation authorities. 5. Appropriate lighting should be installed to minimize impacts on nocturnal animals. 6. Construction activities should not be undertaken at night. 7. Noise and light pollution should be managed according to guidelines from the noise specialist study.	

Impact 10: Increased runoff and erosion due to clearing of vegetation, construction of hard surfaces and compaction of surfaces, leading to changes in downslope areas

Increased erosion (water and wind) and water run-off will be caused by the clearing of indigenous vegetation, creation of new hard surfaces and compaction of soil. The pylon footprints will be the main source of disturbance and erosion if not properly constructed and provided with water run-off structures. The construction site, and substation site will furthermore be levelled and compacted causing additional run-off and erosion. Increased run-off and erosion could affect hydrological processes in the area and will change water and silt discharge into drainage lines and streams.

Table 19: Impact table for Impact 11: Increased runoff and erosion.

Increased runoff and erosion		
Environmental parameter	Vegetation and habitat	
Issue/Impact/Environmental Effect/Nature	Runoff and erosion	
Extent	The impact will affect habitat on site.	
Probability	The impact will probably happen in the absence of control measures.	
Reversibility	Partly reversible in the absence of control measures. Completely reversible if mitigation measures applied. Preventative measures will stop the impact from occurring.	
Irreplaceable loss of resources	Marginal to significant loss of resources will occur. Uncontrolled erosion can affect all downslope natural habitats.	
Duration	The impact will be long-term.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. Severe erosion can locally alter the functioning of natural ecosystems and cause additional loss of vegetation.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating

Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	2 (Possible)
Reversibility	2 (Partly)	2 (Partly)
Irreplaceable loss	3 (Significant)	2 (Marginal)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-30 (medium negative)**	**-12 (low negative)**
Mitigation measures	It is possible to avoid impacts due to erosion by undertaking the following mitigation measures: 1. Compile and implement a stormwater management plan, which highlights control priorities and areas and provides a programme for long-term control. 2. Undertake regular monitoring to detect erosion features early so that they can be controlled. 3. Implement control measures. 4. Avoid building on or near steep or unstable slopes. 5. Construct proper culverts, bridges and/or crossings at drainage-line crossings, and other attenuation devices to limit overland flow.	

Operational Phase impacts

Impact 11: Continued disturbance to natural habitats due to general operational activities and maintenance
During the operational phase of the project, there will be continuous activity on site, including normal operational activities, maintenance and monitoring. There may also be minor additional construction. Rehabilitation of various sites, such as the construction camps, will also take place. These activities all have the potential to cause additional direct and/or indirect damage to natural habitat and vegetation.

Table 20: Impact table for Impact 12: Continued disturbance of indigenous natural vegetation.

Loss and/or fragmentation of indigenous natural vegetation		
Environmental parameter	Indigenous natural vegetation	
Issue/Impact/Environmental Effect/Nature	Loss or degradation of vegetation.	
Extent	The impact will affect natural vegetation on site.	
Probability	Continued disturbance will probably happen.	
Reversibility	Partly reversible, on condition no additional vegetation clearing takes place.	
Irreplaceable loss of resources	Marginal loss of resources will occur adjacent to the footprint of the proposed infrastructure since this is the most likely location of operational activities.	
Duration	The impact will be long-term (will continue or last for the entire operational life of the project)	
Cumulative effect	Medium cumulative impact. Added to existing impacts on natural habitat from activities on site, will cause additional loss of vegetation, the cumulative effect of which will be medium.	
Intensity/magnitude	Medium. The quality, use and integrity of vegetation on site will be compromised to some degree, which can be limited to some extent by implementation of mitigation measures.	
Significance rating	Medium negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)

Probability	3 (Probable)	3 (Probable)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Marginal loss of resources)	2 (Marginal loss of resources)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	3 (Medium)	3 (Medium)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-28 (low negative)**	**-14 (low negative)**
Mitigation measures	The following mitigation measures would help to limit impacts: 1. No additional clearing of vegetation should take place without a proper assessment of the environmental impacts and authorization from relevant authorities. 2. If any additional infrastructure needs to be constructed, for example overhead powerlines, communication cables, etc., then these must be located next to existing infrastructure, and clustered to avoid dispersed impacts. 3. No driving of vehicles off-road. 4. Implement Alien Plant Management Plan, including monitoring, to ensure minimal impacts on surrounding areas. 5. Access to sensitive areas outside of development footprint should not be permitted during operation. 6. Surface runoff and erosion must be properly controlled and any issues addressed as quickly as possible.	

Impact 12: Direct mortality of fauna through traffic, illegal collecting, poaching and collisions and/or entanglement with infrastructure

There are various animal species of particular concern for this project, including the Leopard and Littledale's Whistling Rat. There are also other more mobile species that are protected by legislation, including the Cape Fox. It is possible that individuals of these species may suffer mortality or removal of individuals through road kills, encounters with infrastructure, illegal hunting, illegal collecting (especially for the tortoise and lizard) and possible damage to habitats.

Table 21: Impact table for Impact 13: Mortality of fauna during operation.

Loss of individuals of animal species of concern		
Environmental parameter	Fauna, including those of conservation concern (Leopard, and Cape Fox)	
Issue/Impact/Environmental Effect/Nature	Mortaility of individuals due to secondary effects.	
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	Low loss of resources will occur.	
Duration	The impact will be long-term (operation phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Marginal)	1 (None)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	2 (Low)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)

Significance rating	**-24 (low negative)**	**-11 (low negative)**
Mitigation measures	1. Personnel and vehicles to avoid sensitive habitats. 2. No speeding on access roads – install speed control measures, such as speed humps, if necessary 3. No illegal collecting of any individuals, particularly the Armadillo Girdled Lizard. 4. No hunting of protected species or hunting of any other species without a valid permit. 5. Personnel to be educated about protection status of species, including distinguishing features to be able to identify protected species. 6. Report any sitings to conservation authorities. 7. Prevent unauthorised access to the site – project roads provide access to remote areas that were not previously easily accessible for illegal collecting or hunting.	

Impact 13: Continued establishment and spread of alien invasive plant species due to the presence of migration corridors and disturbance vectors

The presence of disturbed surfaces on site creates ecological edges and corridors along which alien species can travel and become established.

Table 22: Impact table for Impact 14: Continued establishment and spread of declared weeds.

Continued establishment and spread of declared weeds		
Environmental parameter	Vegetation and habitat	
Issue/Impact/Environmental Effect/Nature	Loss of habitat due to invasion by alien plants	
Extent	The impact will affect habitat on site and possibly in immediately surrounding areas.	
Probability	The impact will probably happen in the absence of control measures.	
Reversibility	Partly reversible in the absence of control measures. Completely reversible if mitigation measures applied. Preventative measures will stop the impact from occurring.	
Irreplaceable loss of resources	Marginal to significant loss of resources will occur. Uncontrolled invasion can affect all nearby natural habitats.	
Duration	The impact will be long-term.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. Severe invasion can alter the functioning of natural ecosystems.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	2 (Possible)
Reversibility	2 (Partly)	2 (Partly)
Irreplaceable loss	3 (Significant)	2 (Marginal)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-30 (medium negative)**	**-12 (low negative)**
Mitigation measures	It is possible to avoid impacts due to alien plant invasions by undertaking the following mitigation measures: 1. Compile and implement an alien management plan, which highlights control priorities and areas and provides a programme for long-term control.	

	2. Undertake regular monitoring to detect alien invasions early so that they can be controlled. 3. Implement control measures. 4. Do NOT use any alien plants during rehabilitation.

Impact 14: Continued runoff and erosion due to the presence of hard surfaces that change the infiltration and runoff properties of the landscape

Increased erosion (water and wind) and water run-off will be caused by the clearing of indigenous vegetation, creation of new hard surfaces and compaction of soil. The pylon footprints will be the main source of disturbance and erosion if not properly constructed and provided with water run-off structures. The construction site, substation site laydown areas and access roads will furthermore be levelled and compacted causing additional run-off and erosion. Increased run-off and erosion could affect hydrological processes in the area and will change water and silt discharge into drainage lines and streams.

Table 23: Impact table for Impact 15: Increased runoff and erosion.

Increased runoff and erosion		
Environmental parameter	Vegetation and habitat	
Issue/Impact/Environmental Effect/Nature	Runoff and erosion	
Extent	The impact will affect habitat on site.	
Probability	The impact will probably happen in the absence of control measures.	
Reversibility	Partly reversible in the absence of control measures. Completely reversible if mitigation measures applied. Preventative measures will stop the impact from occurring.	
Irreplaceable loss of resources	Marginal to significant loss of resources will occur. Uncontrolled erosion can affect all downslope natural habitats.	
Duration	The impact will be long-term.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. Severe erosion can locally alter the functioning of natural ecosystems and cause additional loss of vegetation.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	2 (Possible)
Reversibility	2 (Partly)	2 (Partly)
Irreplaceable loss	3 (Significant)	2 (Marginal)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-30 (medium negative)**	**-12 (low negative)**
Mitigation measures	It is possible to avoid impacts due to erosion by undertaking the following mitigation measures: 1. Compile and implement a stormwater management plan, which highlights control priorities and areas and provides a programme for long-term control. 2. Undertake regular monitoring to detect erosion features early so that they can be controlled. 3. Implement control measures. 4. Avoid building on or near steep or unstable slopes. 5. Construct proper culverts, bridges and/or crossings at drainage-line crossings, and other attenuation devices to limit overland flow.	

Impact 15: Changes to behavioural patterns of animals, including possible migration away or towards the project area

The increased human presence and/or operations will increase noise levels as well as light levels at night. The increased human presence, elevated noise and light levels, loss of animal habitat and compaction of soils may alter the behavioural patterns of some animals. Some of these changes may favour certain species and negatively affect others and consequently change the composition of the animal communities. Some of these changes could possibly increase levels of predation. Territorial species such as steenbok and klipspringer will be negatively affected as well as species that live or move in the soil. These species might undergo a local reduction in their population size.

Table 24: Impact table for Impact 16: Changes in behavioural patterns of animals.

Changes in behavioural patterns of fauna		
Environmental parameter	Mobile fauna	
Issue/Impact/Environmental Effect/Nature	Displacement of individuals or changes to community structure.	
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	No or low loss of resources will occur.	
Duration	The initial impact will be short-term (construction phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Low. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	1 (None)	1 (None)
Duration	1 (Long-term)	1 (Short-term)
Cumulative effect	1 (Low)	1 (Low)
Intensity/magnitude	1 (Low)	1 (Low)
Significance rating	**-8 (low negative)**	**-8 (low negative)**
Mitigation measures	1. Personnel to be educated about environmental sensitivities and issues on site. 2. Report any sitings to conservation authorities. 3. Appropriate lighting should be installed to minimize impacts on nocturnal animals. 4. Maintenance activities should not be undertaken at night. 5. Noise and light pollution should be managed according to guidelines from the noise specialist study.	

Decommissioning Phase impacts

It is expected that the project will operate for a minimum of twenty to fifty years or more (a typical planned life-span for a project of this nature. Decommissioning will probably require a series of steps resulting in the removal of equipment from the site and rehabilitation of footprint areas. It is possible that the site could be returned to a rural nature, but it is unlikely that natural vegetation would become established at disturbed locations on site for a very long time thereafter. The reality is that it is not possible to determine at this stage whether rehabilitation measures will be implemented or not or what the future plans for the site would be nor is it possible at this stage to determine what surrounding land pressures would be. These uncertainties make it difficult to undertake any assessment to determine

possible impacts of decommissioning. It is recommended that a closure and rehabilitation plan be compiled near to the stage but in advance of when decommissioning is planned, and that this would be required to be implemented prior to closure of the project. Possible impacts are described below.

Impact 16: Loss and disturbance of natural vegetation due to the removal of infrastructure and need for working sites
During the decommissioning phase of the project, there will be a flurry of activity on site over a period of time, similar to during the construction phase, including dismantling and removal of equipment and rehabilitation. There may also be minor additional construction. Rehabilitation of various sites will also take place. These activities all have the potential to cause additional direct and/or indirect damage to natural habitat and vegetation.

Table 25: Impact table for Impact 17: Disturbance of indigenous natural vegetation.

Loss and/or fragmentation of indigenous natural vegetation		
Environmental parameter	Indigenous natural vegetation	
Issue/Impact/Environmental Effect/Nature	Loss or degradation of vegetation.	
Extent	The impact will affect natural vegetation on site.	
Probability	Continued disturbance will probably happen.	
Reversibility	Partly reversible, on condition no additional vegetation clearing takes place.	
Irreplaceable loss of resources	Marginal loss of resources will occur adjacent to the footprint of the proposed infrastructure since this is the most likely location of operational activities.	
Duration	The impact will be medium-term (until rehabilitation has succeeded in establishing perennial vegetation cover)	
Cumulative effect	Medium cumulative impact. Added to existing impacts on natural habitat from activities on site, will cause additional loss of vegetation, the cumulative effect of which will be medium.	
Intensity/magnitude	Medium. The quality, use and integrity of vegetation on site will be compromised to some degree, which can be limited to some extent by implementation of mitigation measures.	
Significance rating	Medium negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	3 (Probable)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Marginal loss of resources)	2 (Marginal loss of resources)
Duration	2 (Medium-term)	2 (Medium-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-26 (low negative)**	**-12 (low negative)**
Mitigation measures	The following mitigation measures would help to limit impacts: 1. No driving of vehicles off-road. 2. Implement Alien Plant Management Plan, including monitoring, to ensure minimal impacts on surrounding areas. 3. Access to sensitive areas outside of development footprint should not be permitted during decomissioning. 4. Surface runoff and erosion must be properly controlled and any issues addressed as quickly as possible.	

Impact 17: Direct mortality of fauna due to machinery, construction and increased traffic
It is possible that individuals of species of concern, as well as other species, may suffer mortality or removal of individuals through road kills, encounters with infrastructure, illegal hunting, illegal collecting (especially for the tortoise and lizard) and possible damage to habitats.

Table 26: Impact table for Impact 18: Mortality of fauna during operation.

Loss of individuals of animal species of concern		
Environmental parameter	Fauna, including those of conservation concern (Leopard, and Cape Fox)	
Issue/Impact/Environmental Effect/Nature	Mortaility of individuals due to secondary effects.	
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	Low loss of resources will occur.	
Duration	The impact will be long-term (operation phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Marginal)	1 (None)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	2 (Low)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-24 (low negative)**	**-11 (low negative)**
Mitigation measures	1. Personnel and vehicles to avoid sensitive habitats. 2. No speeding on access roads – install speed control measures, such as speed humps, if necessary 3. No illegal collecting of any individuals, particularly the Armadillo Girdled Lizard. 4. No hunting of protected species or hunting of any other species without a valid permit. 5. Personnel to be educated about protection status of species, including distinguishing features to be able to identify protected species. 6. Report any sitings to conservation authorities. 7. Prevent unauthorised access to the site – project roads provide access to remote areas that were not previously easily accessible for illegal collecting or hunting.	

Impact 18: Displacement and/or disturbance of fauna due to increased activity and noise levels
Decommissioning and rehabilitation activities may lead to loss of habitat, noise, dust and general activity that are likely to cause all mobile species to move away from the site.

All these species are mobile terrestrial species with a large home range and the ability to travel long distances in short periods of time. Individuals may be locally displaced, but this will have little effect on the overall range of the species nor is it expected that any overall impacts will result from local displacement.

Table 27: Impact table for Impact 19: Displacement of terrestrial fauna.

Displacement of individuals of mobile terrestrial fauna

Environmental parameter	Mobile fauna of conservation concern	
Issue/Impact/Environmental Effect/Nature	Displacement of individuals.	
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	No or low loss of resources will occur.	
Duration	The impact will be short-term (construction phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Low. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	1 (None)	1 (None)
Duration	1 (Short-term)	1 (Short-term)
Cumulative effect	1 (Low)	1 (Low)
Intensity/magnitude	1 (Low)	1 (Low)
Significance rating	**-8 (low negative)**	**-8 (low negative)**
Mitigation measures	1. Restrict impact to development footprint only and limit disturbance spreading into surrounding areas. 2. Access to sensitive areas outside of infrastructure footprint should not be permitted during construction. 3. No speeding on access roads – install speed control measures, such as speed humps, if necessary 4. No hunting of protected species. 5. Personnel to be educated about protection status of species, including distinguishing features to be able to identify protected species. 6. Report any sitings to conservation authorities.	

Impact 19: Effects on physiological functioning of vegetation due to dust deposition

There is a moderate risk during decommissioning that dust will be created that will settle on surrounding vegetation. This will be due to earth-moving equipment as well as vehicles moving around on site as well as into and out of the site. There will be a definite increase in the amount of traffic on access roads to the site that will also affect surrounding areas.

Table 28: Impact table for Impact 20: Vegetation damage due to dust deposition.

Impaired physiologivcal functioning of vegetation due to increased dust deposition.	
Environmental parameter	Vegetation
Issue/Impact/Environmental Effect/Nature	Dust deposition, resulting in reduced physiological fitness of plants / vegetation.
Extent	The impact will affect vegetation on site and in all areas with access roads leading to site.
Probability	The impact will almost certainly happen.
Reversibility	Partly reversible with time.
Irreplaceable loss of resources	Low to marginal loss of resources will occur.
Duration	The impact will be of short-term duration for access roads (only subject to high traffic volumes during decommissioning).
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.
Intensity/magnitude	Medium. May impact on population processes.

Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	2 (Local)	2 (Local)
Probability	3 (Probable)	3 (Probable)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Low)	2 (Low)
Duration	1 (Short-term)	1 (Short-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-26 (low negative)**	**-12 (low negative)**
Mitigation measures	1. No speeding on access roads – install speed control measures, such as speed humps, if necessary, and penalties for non-compliance. 2. Excessive dust can be controlled by spraying water onto areas affected by construction and/or vehicle traffic or using other suitable dust-control measures.	

Impact 20: Continued establishment and spread of alien invasive plant species due to the presence of migration corridors and disturbance vectors

The presence of disturbed surfaces on site creates ecological edges and corridors along which alien species can travel and become established.

Table 29: Impact table for Impact 21: Continued establishment and spread of declared weeds.

Continued establishment and spread of declared weeds		
Environmental parameter	Vegetation and habitat	
Issue/Impact/Environmental Effect/Nature	Loss of habitat due to invasion by alien plants	
Extent	The impact will affect habitat on site and possibly in immediately surrounding areas.	
Probability	The impact will probably happen in the absence of control measures.	
Reversibility	Partly reversible in the absence of control measures. Completely reversible if mitigation measures applied. Preventative measures will stop the impact from occurring.	
Irreplaceable loss of resources	Marginal to significant loss of resources will occur. Uncontrolled invasion can affect all nearby natural habitats.	
Duration	The impact will be long-term.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. Severe invasion can alter the functioning of natural ecosystems.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	2 (Possible)
Reversibility	2 (Partly)	2 (Partly)
Irreplaceable loss	3 (Significant)	2 (Marginal)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-30 (medium negative)**	**-12 (low negative)**
Mitigation measures	It is possible to avoid impacts due to alien plant invasions by undertaking the following mitigation measures:	

	1. Implement an alien management plan, which highlights control priorities and areas and provides a programme for long-term control. 2. Undertake regular monitoring to detect alien invasions early so that they can be controlled. Post-decommissioning monitoring should continue for an appropriate length of time to ensure that future problems are avoided. 3. Do NOT use any alien plants during any rehabilitation that may be required.

Impact 21: Continued runoff and erosion due to the presence of hard surfaces that change the infiltration and runoff properties of the landscape

Increased erosion (water and wind) and water run-off will be caused by the creation of new hard surfaces and compaction of soil. The internal access roads will be the main source of disturbance and erosion if not properly constructed and provided with water run-off structures. Increased run-off and erosion could affect hydrological processes in the area and will change water and silt discharge into drainage lines and streams.

Table 30: Impact table for Impact 22: Increased runoff and erosion.

Increased runoff and erosion		
Environmental parameter	Vegetation and habitat	
Issue/Impact/Environmental Effect/Nature	Runoff and erosion	
Extent	The impact will affect habitat on site.	
Probability	The impact will probably happen in the absence of control measures.	
Reversibility	Partly reversible in the absence of control measures. Completely reversible if mitigation measures applied. Preventative measures will stop the impact from occurring.	
Irreplaceable loss of resources	Marginal to significant loss of resources will occur. Uncontrolled erosion can affect all downslope natural habitats.	
Duration	The impact will be long-term.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Medium. Severe erosion can locally alter the functioning of natural ecosystems and cause additional loss of vegetation.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	3 (Probable)	2 (Possible)
Reversibility	2 (Partly)	2 (Partly)
Irreplaceable loss	3 (Significant)	2 (Marginal)
Duration	3 (Long-term)	3 (Long-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	1 (Low)
Significance rating	**-30 (medium negative)**	**-12 (low negative)**
Mitigation measures	It is possible to avoid impacts due to erosion by undertaking the following mitigation measures: 1. Implement a stormwater management plan, which highlights control priorities and areas and provides a programme for long-term control. 2. Following decommissioning, undertake regular monitoring for an appropriate length of time to detect erosion features early so that they can be controlled. 3. Implement any control measures that may become necessary.	

	4. Avoid undertaking any activities on or near steep or unstable slopes.

Impact 22: Changes to behavioural patterns of animals, including possible migration away or towards the project area

The increased human presence and/or construction operations will increase noise levels as well as light levels at night. The increased human presence, elevated noise and light levels, loss of animal habitat and compaction of soils may alter the behavioural patterns of some animals. Some of these changes may favour certain species and negatively affect others and consequently change the composition of the animal communities. Some of these changes could possibly increase levels of predation. Territorial species such as steenbok and klipspringer will be negatively affected as well as species that live or move in the soil. These species might undergo a local reduction in their population size.

Table 31: Impact table for Impact 23: Changes in behavioural patterns of animals.

Changes in behavioural patterns of fauna		
Environmental parameter	Mobile fauna	
Issue/Impact/Environmental Effect/Nature	Displacement of individuals or changes to community structure.	
Extent	The impact will affect individuals on site and possibly in immediately surrounding areas.	
Probability	The impact may possibly happen.	
Reversibility	Partly reversible with time.	
Irreplaceable loss of resources	No or low loss of resources will occur.	
Duration	The initial impact will be short-term (construction phase).	
Cumulative effect	Low cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Low. May impact on population processes.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1 (Site)	1 (Site)
Probability	2 (Possible)	2 (Possible)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	1 (None)	1 (None)
Duration	1 (Long-term)	1 (Short-term)
Cumulative effect	1 (Low)	1 (Low)
Intensity/magnitude	1 (Low)	1 (Low)
Significance rating	**-8 (low negative)**	**-8 (low negative)**
Mitigation measures	1. Avoid disturbance of designated sensitive habitats. 2. Access to sensitive areas outside of infrastructure footprint should not be permitted during decommissioning. 3. Personnel to be educated about environmental sensitivities and issues on site. 4. Appropriate lighting should be installed to minimize impacts on nocturnal animals. 5. Project activities should not be undertaken at night. 6. Noise and light pollution should be managed according to guidelines from the noise specialist study. 7. No dangerous pits, trenches, etc. should remain on site after rehabilitation.	

Cumulative impacts

Impact 23: Cumulative impacts on indigenous natural vegetation

The regional terrestrial vegetation types in the broad study area are listed as Least Threatened and generally have large areas. There are other vegetation types that will be affected, but these are not discussed here. Loss of habitat will definitely occur for each project, each of which will be a small area in comparison to the total area of the vegetation type. The total loss of habitat due to a number of projects together will be greater than for any single project, so a cumulative effect will occur. However, the area lost in total will be small compared to the total area of the vegetation type concerned. Of more concern is the total degree of fragementation due to the combination of all projects, which will be much more significant than gross loss of habitat, measures in hectares. Direct loss of habitat will not result in a change in the conservation status of the vegetation types, but overall degradation due to fragmentation effects may be cause for concern. The cumulative effect will therefore be low for vegetation loss, but possibly significant for fragmentation. In addition, the current project is located in a rural area with the no existing infrastructure nearby, as is the case with all the other proposed projects. This will fundamentally change the character of this area in terms of its natural state.

Table 32: Impact table for Impact 24: Cumulative impacts on natural vegetation.

Loss and/or fragmentation of indigenous natural vegetation		
Environmental parameter	Indigenous natural vegetation	
Issue/Impact/Environmental Effect/Nature	Loss, degradation and/or fragmentation of indigenous natural vegetation.	
Extent	The impact will affect natural vegetation on site and in surrounding areas.	
Probability	Loss and/or disturbance of vegetation will definitely happen for all of the projects.	
Reversibility	In all projects, loss of vegetation is effectively irreversible, since construction of roads and other hard surfaces completely removes vegetation and modifies the substrate upon which it grows. For all the projects, the secondary vegetation in disturbed areas will probably never resemble the original vegetation found on site.	
Irreplaceable loss of resources	For each project, there will locally be marginal to significant loss of resources. Assessed over a wider area (the combined footprint of all projects), there will probably only be marginal loss of resources (in relation to all biodiversity resources within the area).	
Duration	The impact will be permanent.	
Cumulative effect	Medium cumulative impact. Added to existing impacts on natural habitat from activities on site, will cause additional loss of vegetation, the cumulative effect of which will be medium.	
Intensity/magnitude	Medium. At the very minimum, the projects together will alter the quality, use and integrity of vegetation in the area , but the system (vegetation) will continue to function in a moderately modified way and maintain general integrity..	
Significance rating	Medium negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	2 (District)	2 (District)
Probability	4 (Definite)	4 (Definite)
Reversibility	4 (Irreversible)	4 (Irreversible)
Irreplaceable loss	2 (Marginal loss of resources)	2 (Marginal loss of resources)
Duration	4 (Permanent)	4 (Permanent)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	2 (Medium)
Significance rating	**-38 (medium negative)**	**-36 (medium negative)**

Mitigation measures	At a regional level, the only possible mitigation is to limit the number of projects, or else limit the scope of individual projects. These decisions are a function of competent authorities and not of the proponent. The following decisions would then apply: 1. Limit projects to specific zones, for example the Upington REDZ. 2. Limit development within biodiversity zones, especially CBA1 areas.

Impact 24: Cumulative impacts on plant species of concern and protected plant species

There are various plant species of conservation concern and protected plant species that may occur in the study area, all of which are relatively widespread. A distinction is made here between protected species, which are often widespread, and threatened species, which are often rare. Constructing the current project as well as all other renewable energy projects increases the likelihood of individuals being affected, but unless large numbers of individuals are directly affected, there will only be small to moderate cumulative effects. In principle, no development should allow loss of populations of threatened species, so the assessment undertaken below is for protected species (although effects on threatened species are also discussed).

Table 33: Impact table for Impact 25: Loss of individuals of threatened and protected plants.

Loss of individuals of protected plants		
Environmental parameter	Protected plants, as per NEM:BA or NCNCA or listed plants	
Issue/Impact/Environmental Effect/Nature	Loss of individuals occurring within the footprint of construction.	
Extent	The impact will affect local populations or individuals of the affected species. The large number of projects taken together make this a regional effect.	
Probability	Based on the list of species that are protected or listed, the impact is certain to happen to protected plants and probable for threatened plants.	
Reversibility	Partly reversible. Where necessary, individuals can be rescued or else cultivated to replace lost specimens. Unfortunately, this is probably not feasible for threatened plants, which means the impact is barely reversible / irreversible for such species.	
Irreplaceable loss of resources	Marginal loss of resources could occur for protected plants and significant loss of resources for threatened plants. The protected species that are likely to occur on site are likely to be relatively common throughout their range and they have very wide geographical ranges. With a number of projects, however, the chances of threatened species being affected increases.	
Duration	The impact will be medium-term for protected plants and possibly permanent for threatened plants.	
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.	
Intensity/magnitude	Possibly medium for protected plants and very high for threatened plants. Loss of some individuals will be insignificant compared to the number that probably occur in nearby natural areas.	
Significance rating	Low negative impact expected.	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	2 (Local)	2 (Local)
Probability	4 (Definite)	4 (Definite)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	2 (Marginal loss of resources)	2 (Marginal loss of resources)
Duration	2 (Medium-term)	2 (Medium-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	2 (Medium)

Significance rating	**-30 (medium negative)**	**-28 (low negative)**
Mitigation measures	The following mitigation measures would help to avoid and limit impacts: 1. It is a legal requirement to obtain permits for specimens that will be lost. 2. Undertake a detailed pre-construction walk-through survey will be required during a favourable season to locate any additional individuals of protected plants. This survey must cover the footprint of all approved infrastructure, including internal access roads. 3. Plants lost to the development can be rescued and planted in appropriate places in rehabilitation areas. This will reduce the irreplaceable loss of resources as well as the cumulative effect. 4. A Plant Rescue Plan must be compiled to be approved by the appropriate authorities. 5. Where large populations of affected species of high value are encountered, consideration should be given to shifting infrastructure to avoid such areas. 6. No authorization should be given that results in the loss of populations of threatened plants. Infrastructure should be relocated and a suitable buffer zone maintained around such populations. An ecological management plan must be compiled for such areas.	

Impact 25: Cumulative impacts on ecological processes

There are various ecological processes that may be affected at a landscape level by the presence of multiple projects. This includes obvious processes, such as migration, pollination and dispersal, but also more difficult to interpret factors, such as spatial heterogeneity, community composition and environmental gradients, that can become disrupted when landscapes are disturbed at a high level. Disturbance can alter the pattern of variation in the structure or function of ecosystems. Fragmentation is the breaking up of a habitat, ecosystem, or land-use type into smaller parcels. An important consequence of repeated, random clearing is that contiguous cover can break down into isolated patches. This happens when the area cleared exceed a critical level and landscapes start to become disconnected. Spatially heterogenous patterns can be interpreted as individualistic responses to environmental gradients and lead to natural patterns in the landscape. Disrupting gradients and creating disturbance edges across wide areas is very disruptive of natural processes and will lead to fundamental changes in ecosystem function.

Table 34: Impact table for Impact 26: Cumulative impacts on ecological processes.

Disruption of landscape-level ecological processes	
Environmental parameter	Landscape-level ecological processes
Issue/Impact/Environmental Effect/Nature	Disruption, disturbance or alteration of ecological processes
Extent	The large number of projects taken together make this a regional effect.
Probability	Based on the number and the nature of the projects (mostly solar-energy projects), the impact may possibly happen.
Reversibility	Partly reversible, where disruptions to specific processes can be identified and rectified.
Irreplaceable loss of resources	Significant loss of resources could potentially occur , but it is more likely that marginal loss of resources will happen.
Duration	The impact will be long-term to permanent, depending on the process and the specific impact.
Cumulative effect	Medium cumulative impact. Cumulative effects will be minor.
Intensity/magnitude	Based on the nature and number of projects and the ecological process affected, the impact is most likely to be of medium intensity.
Significance rating	Low negative impact expected.

	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	2 (Local)	2 (Local)
Probability	2 (Possible)	4 (Definite)
Reversibility	2 (Partly reversible)	2 (Partly reversible)
Irreplaceable loss	3 (Significant loss of resources)	2 (Marginal loss of resources)
Duration	2 (Medium-term)	2 (Medium-term)
Cumulative effect	3 (Medium)	2 (Low)
Intensity/magnitude	2 (Medium)	2 (Medium)
Significance rating	**-30 (medium negative)**	**-28 (low negative)**
Mitigation measures	The following mitigation measures would help to understand impacts: 1. Undertake a landscape-level assessment of the combined fragmentation index of all projects together. For analysis purposes, a fragmentation value can be assigned to individual projects, and to all projects together. This will provide an indication of the relative contribution to landscape disruption of each project relative to others, the effect on specific parts of the landscape, and the effect on specific components of the landscape, e.g. a climate corridor, south-facing slopes, etc. 2. Limit projects to specific zones, for example the Upington REDZ. 3. Limit development within biodiversity zones, especially CBA1 areas.	

Impact 26: Cumulative impacts on fauna

Construction activities, loss of habitat, noise, dust and general activity associated with the construction phase of the project are likely to cause all mobile species to move away from the area. This effect will be increased if there are a number of projects being constructed at the same time or in quick succession, so the effect is likely to be cumulative. However, the geographical ranges of the species of concern is wide and it is considered that the significance of the effect will be low in the long-term, although probably significant during the combined construction phase of the projects. It is possible that some species will be more significantly negatively affected than others, especially shy species, territorial species that get displaced, or those with large territories that get shrunk. It is also possible that some species will benefit from the increased presence of humans and will migrate into the area. This will possibly cause additional shifts in other species that are affected by the increase in numbers or new species.

Impact 27: Cumulative impacts due to spread of declared weeds and alien invader plants

There is a moderate possibility that alien plants could be introduced to areas within the footprint of the proposed infrastructure from surrounding areas in the absence of control measures. The greater the number of projects, the more likely this effect will happen; therefore, the effect is cumulative. For the current site, the impact is predicted to be low due to the current absence of invasive species on site and the high ability to control any additional impact. The significance will therefore be low, especially if control measures are implemented. However, the increased overall disturbance of the landscape will create opportunities and, if new invasions are not controlled, can create nodes that spread to new locations due to the heightened disturbance levels.

Impact 28: Cumulative impacts due to loss of protected animals

There are various animal species protected according to National legislation that occur in the geographical area covered by the combined projects. Some of these animals may be vulnerable to secondary impacts, such as hunting, road kill and illegal collecting (the Armadillo Girdled Lizard may be particularly vulnerable to this). The greater the number of projects, the more likely this effect will happen; therefore, the effect is cumulative. However, in all cases, the geographical distribution of each species is much wider than the combined project areas. The significance will therefore be low, especially if control measures are implemented.

Impact 29: Cumulative impact on climate change

One of the primary reasons for promoting renewable energy projects is the desire to make South Africa compliant with international treaties regarding climate-change effects. The combined generation capacity of all the renewable energy projects considered here is just less than 700 MW, which is about a quarter of the average size of one of the 14 coal power stations in South Africa (Eskom's Generation Division has 14 coal-fired power stations with an installed capacity of 38 548 MW, www.eskom.co.za). A reduction in reliance on coal power would improve the air quality of the Mpumalanga Highveld (where many of these power stations are located), reduce the amount of coal-mining that would take place (which has a devastating effect on biodiversity resources and water quality) and would reduce the per capita carbon footprint of our country. Greater uptake of renewable energy would furthermore reduce the global risk of climate change, one of the factors taken into account in designing the conservation network in South Africa. The construction of renewable energy projects can, in fact, be seen as an offset for other carbon-generating technology.

DISCUSSION AND CONCLUSIONS

The project study area consists of natural habitat within a largely rural area, although this is close to Upington, the Orange River agricultural belt and the satellite settlements of Keimoes and Kakamas. The proposed facility is also within the designated Upington Renewable Energy Development Zone (REDZ 7), one of the eight REDZ formally gazetted in South Africa for development of solar and wind energy generation facilities. This is within an area where portions of the natural habitat have been assessed as having potential conservation value, although this project site falls outside of the NPAES entirely and are therefore not earmarked for future conservation. Currently, the rates of transformation within the vegetation in this area is low. The regional vegetation types that occur on site, Bushmanland Arid Grassland, Kalahari Karroid Shrubland and Gordonia Duneveld, are listed as Least Threatened in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004). However, the southern and eastern parts of the corridor are within a Provincial Critical Biodiversity (CBA2) Area. Natural habitat on site within this zone was therefore considered to possibly have conservation value and the assessment undertaken with this in mind. This is discussed in more detail in a paragraph below.

The vegetation on site consists largely of a mixture of arid Kalahari grassland and karroid dwarf shrubland typical of the regional vegetation types, Bushmanland Arid Grassland and Kalahari Karroid Shrubland. The pattern observed on site is that local diversity increases with increased surface rockiness, but no habitats of high conservation value occur within this terrestrial habitat. Important habitats on site that require protection are are dry river beds and major drainage lines, as well as the core rocky hills area.

There is one threatened plant species that occurs on site, *Aloidendron dichotomum*, listed as Vulnerable. There were five individuals that were found within or close to the footprint of the proposed infrastructure. It is possible that other individuals also occur on site and approximately 100 individuals occur within the rocky hills. There are also two tree species protected according to the National Forests Act that are found on the property, *Vachellia erioloba* and *Boscia albitrunca*, but were not seen within the footprint area. One of these, *Vachellia erioloba* (camelthorn) is also listed as Declining. It is found in drainage lines on site and is an impotant ecological component of the landscape. Impacts on drainage areas could potentially affect individuals of this species. The other species, *Boscia albitrunca*, was seen primarily within the rocky hills.

There are no plant species found on site that are protected according to the National Environmental Management: Biodiversity Act. There are, however, a number of species protected according to the Northern Cape Nature Conservation Act that were recorded on site. None of these species are of conservation concern, but the fact that they are protected means that a permit will be required for their removal. This is a standard flora permit obtained from the provincial department. Final species and numbers will need to be determined from a walk-through survey of approved infrastructure, but preliminary details are provided here.

There are a small number of fauna of possible conservation concern that were assessed as having a possibility of occurring on site. This includes the Leopard, listed as Vulnerable and protected according to Provincial and National legislation, Littledale's Whistling Rat, listed as Near Threatened, and a number of Nationally protected species, including the Giant Bullfrog and the Cape Fox. There is a long list of Provincially protected fauna that could occur on site (see Appendix 4), The likelihood of these occurring on site varies between species, with the Leopard almost certain to occur there, Littledale's Whistling Rat having a high probability, and the Giant Bullfrog having a moderate probability of occurring there. The two mammal species that could potentially occur on site (Leopard and Litteldale's Whistling Rat) are highly mobile species that are unlikely to be affected by any activities on site, but the Giant Bullfrog is more restricted or territorial and could be more significantly affected, if it occurs there.

A reconnaissance survey was undertaken on site that included compiling a flora list. This data indicated that there is not a high amount of floristic variability across the site (a total of 81 plant species recorded). In terms of the location of parts of the project area within a CBA2 area, this indicates that the floristic composition of areas within and outside the CBA2 areas are essentially the same floristically. The CBA2 area was interpreted as being part of a broader zone defined primarily to protect aquatic function within the Orange River, as well as in quaternary catchments that support ecological function within the Orange River. In line with conservation planning principles, the defined aquatic support

areas also serve to protect minimum areas for protection of ecological patterns, but other similar areas exist on site and in nearby areas with virtually identical habitat characteristics that could have equally served the same purpose, i.e. to conserve minimum areas of vegetation types.

Other than the general floristic biodiversity patterns on site, the main sensitivity on site is the presence of various watercourses in which there are dry river beds and associated riparian vegetation. This habitat is disproportionately important due to the functional value of these watercourses and the important habitat and forage that they provide for animal populations. The habitat is also interconnected and any damage to one point will affect all downstream areas. For this reason, these riparian habitats have been designated as especially sensitive.

The other important sensitivity on site is the location of individuals of the Vulnerable plant species, *Aloidendron dichotomum*. A small number of these are scattered across the plains of the site. The landowner has indicated that these were deliberately planted there many years ago. All other individuals of this species are restricted to hills in the northern half of the same property. Nevertheless, the locations of these individuals on the plains have been designated as sensitive.

The project involves construction of four single or double circuit 33kV or 132kV lines , three switching stations, one collector switching station, and one double circuit 132kV power line from the collector switching station to the Upington Main Transmission Substation. Additional associated infrastructure will also be required for the grid connection solution, including access roads, feeder bays (inclusive of line bays, busbars, bussection and protection equipment), switching stations, a fibre and optical ground wire (OPGW) layout, insulation and assembly structures. Some of this infrastructure, especially substations, will lead to localized loss of habitat, but the overhead lines will only result in loss of habitat at the location of pylon bases. There will therefore be partial and localised loss of vegetation and habitat within these power line areas. Impacts associated with habitat loss are of the greatest significance for the project, although this is relatively insignificant at a regional scale, taking into account the extensive distribution of the regional vegetation types. For all infrastructure components, loss of habitat will occur. **This will be relatively insignificant in comparison to the total area of the regional vegetation types concerned but may be significant in terms of local patterns and diversity that could be affected.**

Conclusions

At the site-specific scale, some sensitivities have been identified, primarily related to natural habitat, but also to some individual species. Many of these can be minimised or avoided with the application of appropriate mitigation or management measures, including, in some cases, slight shifts of infrastructure positions. There will be residual impacts, primarily on natural habitat. **The amount of habitat that will be lost to the project is insignificant compared to the area in hectares of the regional vegetation type that occurs on site and over the entire geographical range of the vegetation type**. In most cases, the exact location of important biodiversity features have been identified in the field and suggestions made to relocate proposed infrastructure to avoid these. The current layout plan has already taken these suggestions into account. From this perspective it is unlikely that the proposed project will have an unacceptable impact on the natural environment. Based on the analysis provided in this report, the conclusion is that the project should be authorised (inclusive of all project alternatives).

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APPENDICES:

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

Sources: see text.

Family	Taxon	Status	Habitat	Likelihood of occurrence on site
FABACEAE	**Vachellia erioloba**	**LC (protected)**	**Savanna, semi-desert and desert areas with deep, sandy soils and along drainage lines in very arid areas, sometimes in rocky outcrops**	**DEFINITE**
ASPHODALACEAE	**Aloidendron dichotomum**	**VU**	**North-facing rocky slopes (particularly dolomite) in the south of its range. Any slopes and sandy flats in the central and northern parts of range.**	**DEFINITE**
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
PEDALIACEAE	Harpagophytum procumbens	LC (protected)	Specimens have primarily been collected from red, sandy soils in sandveld, but also in savanna, grassveld, disturbed localities, at roadsides and on sand dunes. Found in bush savanna in deep red or brown sand, often in overgrazed localities. Sometimes a weed of roadsides and waste areas. Not previously recorded in grid, but geographical distribution of subspecies *procumbens* includes study area.	HIGH
PEDALIACEAE	Harpagophytum zeyheri	LC (protected)	Not previously recorded in grid, but geographical distribution of species includes study area.	HIGH
APOCYNACEAE	Hoodia gordonii	Declining	Wide variety of arid habitats. Not previously recorded in grid, but geographical distribution includes study area.	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).

Vachellia erioloba	Vachellia 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 longependuncula ta
Sideroxylon inerme subsp. inerme	Tephrosia pondoensis
Warburgia salutaris	Widdringtonia cedarbergensis
Widdringtonia schwarzii	

Vachellia erioloba, Vachellia haematoxylon, Boscia albitrunca and *Euclea pseudebenus* have a geographical distribution that is close to the study area.

Appendix 3: Plant species previously recorded in the general area.

This list was compiled by extracting a list of species that have been recorded within a rectangular area that includes the study area as well as similar habitats in surrounding areas, as obtained from http://newposa.sanbi.org/ accessed on 10 October 2018. It is probable that it includes some species that occur in habitats that do not occur on site.

The list is arranged in alphabetical order. Species in green were observed on site and listed on iNaturalist. Species in blue were recorded in nearby areas.

ACANTHACEAE
Acanthopsis hoffmannseggiana
Barleria greenii
Barleria lichtensteiniana
Barleria rigida
Blepharis furcata
Blepharis mitrata
Justicia australis
Justicia divaricata
Justicia incana
Justicia spartioides
Monechma spartioides

AIZOACEAE
Aizoon burchellii
Aizoon canariense
Dinteranthus pole-evansii
Dinteranthus wilmotianus
Galenia africana
Galenia sarcophylla
Lithops bromfieldii
Lithops hookeri
Lithops julii subsp. fulleri
Mesembryanthemum articulatum
Mesembryanthemum coriarium
Mesembryanthemum crystallinum
Mesembryanthemum guerichianum
Mesembryanthemum lignescens
Mesembryanthemum subnodosum
Mesembryanthemum tetragonum
Prenia tetragona
Ruschia barnardii
Ruschia canonotata
Ruschia hamata
Ruschia ruralis
Ruschia species
Tetragonia arbuscula
Tetragonia calycina
Tetragonia reduplicata
Titanopsis calcarea
Trianthema parvifolia var. parvifolia

AMARANTHACEAE
Amaranthus thunbergii
Atriplex semibaccata Naturalised; Invasive
Atriplex species

Caroxylon calluna
Caroxylon rabieanum
Hermbstaedtia fleckii
Leucosphaera bainesii
Salsola aphylla
Salsola barbata
Salsola geminiflora
Salsola inaperta
Salsola kali Naturalised; Invasive
Salsola tuberculata
Salsola tuberculatiformis
Sericocoma avolans
Sericocoma pungens
Sericorema remotiflora
Suaeda caespitosa
Suaeda fruticosa
Suaeda merxmuelleri

AMARYLLIDACEAE
Boophone disticha
Crinum bulbispermum
Haemanthus humilis subsp. humilis
Nerine gaberonensis
Nerine laticoma

ANACAMPSEROTACEAE
Anacampseros baeseckei
Anacampseros filamentosa subsp. filamentosa
Anacampseros filamentosa subsp. namaquensis
Anacampseros filamentosa subsp. tomentosa
Avonia (Anacampseros) albissima

ANACARDIACEAE
Schinus molle Naturalised; Invasive
Searsia ciliata
Searsia lancea
Searsia pendulina

APOCYNACEAE
Adenium oleifolium
Cryptolepis decidua
Cynanchum orangeanum
Cynanchum viminale
Gomphocarpus fruticosus subsp. fruticosus
Hoodia gordonii
Hoodia officinalis subsp. officinalis
Larryleachia marlothii
Microloma incanum
Microloma sagittatum
Orbea lutea subsp. lutea
Orbea species
Pachycarpus dealbatus
Pergularia daemia subsp. garipensis

ASPARAGACEAE
Asparagus pearsonii
Asparagus suaveolens

ASPHODELACEAE
Aloe claviflora
Aloe gariepensis
Aloidendron dichotomum
Trachyandra divaricata

ASTERACEAE
Amellus epaleaceus
Amellus strigosus subsp. strigosus
Amellus tridactylus subsp. arenarius
Arctotis campanulata var. campanulata
Arctotis leiocarpa
Athanasia minuta subsp. minuta
Athrixia heterophylla subsp. sessilifolia
Berkheya annectens
Berkheya chamaepeuce
Berkheya spinosissima subsp. spinosissima
Bidens bipinnata Naturalised
Cotula anthemoides
Dicoma capensis
Dimorphotheca pluvialis
Dimorphotheca polyptera
Dimorphotheca sinuata
Erigeron sumatrensis Naturalised
Eriocephalus ambiguus
Eriocephalus decussatus
Eriocephalus scariosus
Eriocephalus species
Felicia clavipilosa subsp. clavipilosa
Felicia deserti
Felicia muricata subsp. muricata
Felicia namaquana
Foveolina dichotoma
Gazania lichtensteinii
Geigeria filifolia
Geigeria ornativa subsp. ornativa
Geigeria pectidea
Gorteria corymbosa
Helianthus annuus Invasive
Helichrysum argyrosphaerum
Helichrysum gariepinum
Helichrysum herniarioides
Helichrysum micropoides
Helichrysum zeyheri
Hirpicium echinus
Ifloga molluginoides
Kleinia longiflora
Laggera decurrens
Litogyne gariepina
Nidorella resedifolia subsp. resedifolia
Nolletia annetjieae
Nolletia gariepina
Oedrea humilis
Oncosiphon piluliferus
Osteospermum armatum
Osteospermum microcarpum subsp. microcarpum

Pentzia argentea
Pentzia pinnatisecta
Pteronia leucoclada
Pteronia mucronata
Senecio consanguineus
Senecio laxus
Senecio niveus
Senecio sisymbriifolius
Senecio sophioides
Senecio trachylaenus
Tarchonanthus parvicapitulatus
Ursinia nana subsp. nana

AYTONIACEAE
Plagiochasma rupestre var. rupestre

BIGNONIACEAE
Rhigozum obovatum
Rhigozum trichotomum
Tecoma stans Naturalised; Invasive

BORAGINACEAE
Codon royenii
Heliotropium curassavicum Naturalised
Heliotropium ovalifolium
Trichodesma africanum

BRASSICACEAE
Heliophila carnosa
Heliophila deserticola var. deserticola
Heliophila minima
Heliophila seselifolia
Heliophila seselifolia var. nigellifolia
Heliophila trifurca
Lepidium englerianum

BRYACEAE
Bryum argenteum

BURSERACEAE
Commiphora gracilifrondosa

CACTACEAE
Cylindropuntia fulgida Naturalised; Invasive
Opuntia ficus-indica Naturalised; Invasive
Tephrocactus articulatus Naturalised; Invasive

CAMPANULACEAE
Wahlenbergia androsacea
Wahlenbergia denticulata var. denticulata

CAPPARACEAE
Boscia albitrunca
Boscia foetida subsp. foetida
Cadaba aphylla

CARYOPHYLLACEAE

Pollichia campestris
Spergularia media Naturalised

CELASTRACEAE
Gymnosporia linearis subsp. lanceolata

CLEOMACEAE
Cleome angustifolia subsp. diandra
Cleome gynandra
Cleome oxyphylla var. oxyphylla
Cleome paxii
Cleome rubella

COLCHICACEAE
Colchicum melanthoides subsp. melanthoides
Ornithoglossum undulatum
Ornithoglossum vulgare

CONVOLVULACEAE
Ipomoea oenotheroides
Merremia verecunda

CORBICHONIACEAE
Corbichonia decumbens

CRASSULACEAE
Cotyledon orbiculata var. dactylopsis
Cotyledon orbiculata var. orbiculata
Crassula muscosa var. muscosa
Crassula sericea var. sericea
Tylecodon rubrovenosus

CUCURBITACEAE
Citrullus lanatus (
Corallocarpus schinzii
Cucumis africanus
Cucumis maderaspatanus
Kedrostis capensis

CYPERACEAE
Cyperus longus var. tenuiflorus
Cyperaceae Cyperus marginatus
Cyperaceae Cyperus usitatus
Cyperaceae Schoenoplectus leucanthus

DIDIEREACEAE
Portulacaria namaquensis

EBENACEAE
Euclea pseudebenus

EUPHORBIACEAE
Euphorbia avasmontana
Euphorbia braunsii
Euphorbia gariepina subsp. gariepina
Euphorbia glanduligera
Euphorbia gregaria

Euphorbia mauritanica
Euphorbia spinea
Euphorbia Sect. Tenellae

FABACEAE
Adenolobus garipensis
Aspalathus hirta subsp. hirta
Bauhinia bowkeri
Calobota linearifolia
Calobota spinescens
Crotalaria meyeriana
Crotalaria virgultalis
Cullen tomentosum
Cyamopsis serrata
Indigastrum argyroides
Indigastrum niveum
Indigofera alternans
Indigofera alternans var. alternans
Indigofera charlieriana var. lata
Indigofera heterotricha
Indigofera heterotricha subsp. pechuelii
Indigofera pungens
Leobordea platycarpa
Lessertia excisa
Lessertia frutescens subsp. microphylla
Lessertia macrostachya var. macrostachya
Listia marlothii
Lotononis falcata
Lotononis rabenaviana
Melolobium candicans
Melolobium macrocalyx
Parkinsonia africana
Pomaria lactea
Prosopis chilensis Naturalised
Prosopis glandulosa var. glandulosa Naturalised
Prosopis glandulosa var. torreyana Naturalised; Invasive
Prosopis velutina Naturalised; Invasive
Ptycholobium biflorum subsp. biflorum
Requienia sphaerosperma
Rhynchosia totta var. rigidula
Rhynchosia species
Schotia afra var. angustifolia
Senegalia mellifera subsp. detinens
Senna italica subsp. arachoides
Tephrosia dregeana var. dregeana
Vachellia erioloba
Vachellia haematoxylon
Vachellia karroo

FRANKENIACEAE
Frankenia pulverulenta

GENTIANACEAE
Sebaea pentandra var. pentandra

GERANIACEAE
Monsonia crassicaulis

Monsonia glauca
Monsonia luederitziana
Monsonia parvifolia
Monsonia spinosa

GISEKIACEAE
Gisekia africana var. africana

HYACINTHACEAE
Albuca collina
Albuca gariepensis
Albuca longipes
Albuca suaveolens
Albuca virens subsp. arida
Dipcadi bakerianum
Dipcadi crispum
Dipcadi gracillimum
Dipcadi papillatum
Drimia cf. fasciata
Ledebouria apertiflora
Ornithogalum deltoideum

IRIDACEAE
Babiana curviscapa
Babiana flabellifolia
Ferraria variabilis
Gladiolus saccatus
Lapeirousia littoralis
Lapeirousia littoralis subsp. littoralis
Lapeirousia plicata subsp. foliosa
Lapeirousia plicata subsp. plicata
Moraea polystachya
Moraea venenata
Romulea obscura var. subtestacea

KEWACEAE
Kewa salsoloides

LAMIACEAE
Ocimum americanum var. americanum
Salvia garipensis
Salvia verbenaca

LIMEACEAE
Limeum aethiopicum var. aethiopicum
Limeum dinteri
Limeum fenestratum var. fenestratum
Limeum viscosum

LOASACEAE
Kissenia capensis

LORANTHACEAE
Tapinanthus oleifolius

MALVACEAE
Abutilon dinteri

Abutilon pycnodon
Grewia flava
Hermannia abrotanoides Schrad.
Hermannia bicolor
Hermannia comosa
Hermannia erodioides
Hermannia grandiflora
Hermannia minutiflora
Hermannia modesta
Hermannia spinosa
Hermannia stricta
Hermannia tomentosa
Hibiscus elliottiae
Hibiscus engleri
Radyera urens
Sida rhombifolia subsp. rhombifolia

MELIACEAE
Melia azedarach Naturalised; Invasive
Nymania capensis

MOLLUGINACEAE
Suessenguthiella scleranthoides

MONTINIACEAE
Montinia caryophyllacea

MORACEAE
Ficus cordata subsp. cordata

NEURADACEAE
Grielum humifusum var. humifusum
Grielum sinuatum

NYCTAGINACEAE
Phaeoptilum spinosum

ONAGRACEAE
Epilobium salignum

OXALIDACEAE
Oxalis lanata var. lanata
Oxalis lawsonii
Oxalis laxicaulis

PEDALIACEAE
Harpagophytum procumbens subsp. procumbens
Rogeria longiflora
Sesamum capense

PHYLLANTHACEAE
Phyllanthus parvulus var. parvulus

PLUMBAGINACEAE
Dyerophytum africanum

POACEAE

Anthephora pubescens
Aristida adscensionis
Aristida congesta subsp. congesta
Aristida engleri var. engleri
Aristida vestita
Brachiaria glomerata
Cenchrus ciliaris
Cenchrus incertus Naturalised
Centropodia glauca
Chloris virgata
Dactyloctenium aegyptium
Dichanthium annulatum var. papillosum
Digitaria argyrograpta
Digitaria sanguinalis Naturalised
Dinebra retroflexa
Echinochloa holubii
Echinochloa stagnina
Enneapogon cenchroides
Enneapogon desvauxii
Enneapogon scaber
Enneapogon scoparius
Eragrostis annulata
Eragrostis aspera
Eragrostis biflora
Eragrostis brizantha
Eragrostis caesia
Eragrostis curvula
Eragrostis echinochloidea
Eragrostis homomalla
Eragrostis lehmanniana var. lehmanniana
Eragrostis mexicana (subsp. virescens Naturalised
Eragrostis nindensis
Eragrostis porosa
Eragrostis procumbens
Eragrostis rotifer
Eriochloa fatmensis
Leptochloa fusca
Leucophrys mesocoma
Melinis repens subsp. repens
Odyssea paucinervis
Oropetium capense
Panicum arbusculum
Panicum coloratum
Panicum lanipes
Panicum stapfianum
Phalaris canariensis Naturalised
Schmidtia kalahariensis
Setaria appendiculata
Setaria homonyma
Setaria italica Naturalised
Setaria pumila
Setaria verticillata
Sorghum bicolor subsp. arundinaceum
Sporobolus coromandelianus
Sporobolus ioclados
Stipagrostis amabilis
Stipagrostis anomala

Stipagrostis ciliata var. capensis
Stipagrostis namaquensis
Stipagrostis obtusa
Stipagrostis uniplumis var. uniplumis
Stipagrostis zeyheri
Tragus berteronianus
Tragus racemosus
Tricholaena capensis subsp. capensis
Triraphis ramosissima
Urochloa panicoides

POLYGALACEAE
Polygala leptophylla var. armata
Polygala leptophylla var. leptophylla
Polygala seminuda

POLYGONACEAE
Oxygonum alatu. var. alatum
Persicaria lapathifolia Naturalised; Invasive

PORTULACACEAE
Portulaca hereroensis
Portulaca oleracea Naturalised
Portulaca trianthemoides

PTERIDACEAE
Cheilanthes deltoidea subsp. deltoidea
Pellaea calomelanos var. calomelanos

RHAMNACEAE
Ziziphus mucronata. subsp. mucronata

RUBIACEAE
Kohautia caespitosa subsp. brachyloba
Kohautia cynanchica

RUSCACEAE
Eriospermum bakerianum subsp. bakerianum
Eriospermum roseum
Eriospermum species

RUTACEAE
Thamnosma africana

SALICACEAE
Salix babylonica Naturalised; Invasive
Salix mucronata subsp. mucronata

SALVINIACEAE
Azolla filiculoides Naturalised; Invasive

SANTALACEAE
Lacomucinaea lineata
Thesium hystricoides

SAPINDACEAE
Pappea capensis

SCROPHULARIACEAE
Antherothamnus pearsonii
Aptosimum albomarginatum
Aptosimum elongatum
Aptosimum lineare
Aptosimum procumbens
Aptosimum spinescens
Diascia engleri
Diclis petiolaris
Freylinia lanceolata
Gomphostigma virgatum
Jamesbrittenia aridicola
Jamesbrittenia atropurpurea subsp. pubescens
Jamesbrittenia canescens var. canescens
Jamesbrittenia integerrima
Jamesbrittenia maxii
Jamesbrittenia cf megadenia
Limosella longiflora
Lyperia tristis
Manulea schaeferi
Nemesia fruticans
Nemesia maxii
Peliostomum leucorrhizum
Selago divaricata
Selago paniculata
Zaluzianskya diandra

SOLANACEAE
Lycium bosciifolium
Lycium cinereum
Lycium oxycarpum
Lycium pumilum
Nicotiana glauca Naturalised; Invasive
Solanum burchellii
Solanum capense
Solanum elaeagnifolium Naturalised; Invasive

TALINACEAE
Talinum crispatulum

TAMARICACEAE
Tamarix usneoides

TECOPHILAEACEAE
Cyanella lutea

THYMELAEACEAE
Lasiosiphon polycephalus

URTICACEAE
Forsskaolea candida

VAHLIACEAE
Vahlia capensis subsp. vulgaris var. vulgaris

VERBENACEAE

Chascanum garipense
Chascanum pinnatifidum var. pinnatifidum

ZYGOPHYLLACEAE
Augea capensis
Roepera leptopetala
Roepera lichtensteiniana
Tetraena microcarpa
Tetraena retrofracta
Tetraena rigida
Tetraena simplex
Tribulus cristatus
Tribulus pterophorus
Tribulus terrestris
Tribulus zeyheri subsp. zeyheri
Zygophyllum dregeanum

Appendix 4: 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 National Environmental Management: Biodiversity Act of 2004 (Act 10 of 2000) (see Appendix 6) marked with "N"

Mammals:

Artiodactyla

[P]Springbok
[NP]White rhinoceros
[NP]Black rhinoceros (*Diceros bicornis bicornis*)CR
[NP]Hartmann's mountain zebra EN
[P]South African giraffe
Klipspringer
[P]Gemsbok
[P]Steenbok
[P]Common duiker
Common eland
Greater kudu

Rock hyrax

Carnivora

[NP]Cape clawless otter NT
[P]Water mongoose
Black-backed jackal
Caracal
[P]Yellow mongoose
[P]African wild cat
[P]Cape grey mongoose
[P]Slender mongoose
[P]Small-spotted genet
[P]Striped polecat
[N]PHoney badger
[P]Bat-eared fox
[N]PLeopard VU
[P]Aardwolf
[P]Suricate
[NP]Cape fox

Chiroptera

Lesueur's hairy bat
[P]Cape serotine bat
[P]Egyptian slit-faced bat
Geoffroy's horseshoe bat
[P]Darling's horseshoe bat
[P]Dent's Horseshoe Bat NT
Rupppell's horseshoe bat
[P]Flat-headed free-tail bat
[P]Egyptian free-tailed bat

Insectivora

[P]Reddish-grey musk shrew
[P]Lesser red musk shrew

Lagomorpha

[P]Cape/Desert hare
[P]Scrub/Savannah hare
[P]Smith's red rock rabbit

Primata

Vervet monkey
Chacma baboon

Rodentia

[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 NT
[P]Springhare
[P]Pygmy rock mouse
[P]Striped mouse
[P]Pouched mouse
[P]Bushveld gerbil
[P]Cape ground squirrel

Macroscelididae

[P]Bushveld sengi
[P]Western rock sengi
[P]Karoo round-eared sengi

Orycteropodidae

[P]Aardvark

Reptiles:

Testudinidae

[P]Leopard tortoise
[P]Serrated tent tortoise
[P]Tent tortoise

Gekkonidae

[P]Common giant gecko
[P]Bibron's gecko

[P]Turner's gecko
[P]Kalahari ground gecko
[P]Striped ground gecko
[P]Bradfield's dwarf gecko
[P]Cape gecko
[P]Quartz gecko
[P]Namaqua mountain gecko
[P]Purcell's gecko
[P]Common rough gecko
[P]Common barking gecko
[P]Spotted barking gecko

Amphisbaenidae
[P]Dusky worm lizard
[P]Maurice's worm lizard

Lacertidae
[P]Bushveld lizard
[P]Spotted desert lizard
[P]Spotted sandveld lizard
[P]Western sandveld lizard
[P]Plain sand lizard
[P]Karoo sand lizard
[P]Spotted sand lizard
[P]Common sand lizard
[P]Namaqua sand lizard

Cordylidae
[P]Southern karusa lizard

Gerrhosauridae
Scincidae
[P]Kgalagadi legless skink
[P]Striped dwarf legless skink
[P]Cape skink
[P]Western three-striped skink
[P]Karasburg tree skink
[P]Kalahari tree skink
[P]Western rock skin k
[P]Variegated skink

Varanidae
[P]Southern rock monitor
[P]Nile monitor

Chamaelaeonidae
[P]Common flap-necked chameleon

Agamidae
[P]Western ground agama
[P]Anchieta's agama
[P]Southern rock agama

Typhlopidae
Delelande's beaked blind snake
Schinz's beaked blind snake

Leptotyphlopidae
Peter's thread snake

Pythonidae
Viperidae
[P]Puff adder
[P]Horned adder

Lamprophiidae
Bicoloured quill-snouted snake
Common house snake
Cape Wolf snake
Dwarf beaked snake
Karoo sand snake
Fork-marked sand snake
Two-striped shovel-snout
Southwestern shovel-snout
Sundevall's shovel-snout
Mole snake

Elapidae
[P]Coral shield cobra
[P]Black spitting cobra
[P]Cape cobra

Colubridae
[P]Rhombic egg-eater
[P]Beetz's tiger snake

Natricidae

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

Appendix 5: Flora protected under the Northern Cape Nature Conservation Act No. 9 of 2009.

SCHEDULE 1: SPECIALLY PROTECTED SPECIES
As per the Northern Cape Nature Conservation Act, No. 9 of 2009, Schedule 1

Family: AMARYLLIDACEAE	
Clivia mirabilis	Oorlofskloof bush lily / Clivia
Haemanthus graniticus	April fool
Hessea pusilla	
Strumaria bidentata	
Strumaria perryae	
Family: ANACARDIACEAE	
Ozoroa spp.	All species
Family: APIACAEAE	
Centella tridentata	
Chamarea snijmaniae	
Family: APOCYNACEAE	
Hoodia gordonii	
Pachypodium namaquanum	Elephant's trunk
Family: ASPHODOLACEAE	
Aloe buhrii	
Aloe dichotoma	
Aloe dichotoma var. rumosissima	Maiden quiver tree
Aloe dabenorisana	
Aloe erinacea	
Aloe meyeri	
Aloe pearsonii	
Aloe pillansii	
Trachyandra prolifera	
Family: ASTERACEAE	
Athanasia adenantha	
Athanasia spathulata	
Cotula filifolia	
Euryops mirus	
Euryops rosulatus	
Euryops virgatus	
Felicia diffusa subsp. khamiesbergensis	
Othonna armiana	
Family: CRASSULACEAE	
Tylecodon torulosus	
Family: DIOSCORACEAE	
Dioscorea spp.	Elephant's foot, all species
Family: ERIOSPERMACEAE	
Eriospermum erinum	
Eriospermum glaciale	
Family: FABACEAE	
Amphithalea obtusiloba	
Lotononis acutiflora	
Lotononis polycephala	
Lessertia spp.	
Sceletium toruosum	
Sutherlandia spp.	Cancer Bush, all species

Wiborgia fusca subsp. macrocarpa	
Family: GERANIACEAE	
Pelargonium spp.	Pelargonium, all species
Family: HYACINTHACEAE	
Drimia nana	
Ornithogalum bicornutum	
Ornithogalum inclusum	
Family: IRIDACEAE	
Babiana framesii	
Ferraria kamiesbergensis	
Freesia marginata	
Geissorhiza subrigida	
Hesperantha minima	
Hesperantha oligantha	
Hesperantha rivulicola	
Lapeirousia verecunda	
Moraea kamiesensis	
Moraea namaquana	
Romulea albiflora	
Romulea discifera	
Romulea maculata	
Romulea rupestris	
Family: MOLLUGINACEAE	
Hypertelis trachysperma	
Psammotropha spicata	
Family: ORCHIDACEAE	
Corycium ingeanum	
Disa macrostachya	Disa
Family: OXALIDACEAE	
Oxalis pseudo-hirta	Sorrel
Family: PEDALIACEAE	
Harpagophytum spp.	Devils' claw
Family: POACEAE	
Prionanthium dentatum	
Secale strictum subsp. africanum	Wild rye
Family: PROTEACEAE	
Leucadendron meyerianum	Tolbos
Mimetes spp.	All species
Orothamnus zeyheri	
Family: ROSACEAE	
Cliffortia arborea	Sterboom
Family: SCROPHULARIACEAE	
Charadrophila capensis	Cape Gloxinia
Family: STANGERIACEAE	
Stangeria spp.	Cycads, all species
Family: ZAMIACEAE	
Encephalartos spp.	Cycads, all species

SCHEDULE 2: PROTECTED SPECIES
As per the Northern Cape Nature Conservation Act, No. 9 of 2009, Schedule 2

Family: ACANTHACEAE	
Barleria paillosa	
Monechme saxatile	

Peristrophe spp.	All species
Family: ADIANTHACEAE	
Adiantium spp.	Maidenhair Fern, all species
Family: AGAPANTHACEAE	
Agapanthus spp.	All species
Family: AIZOACEAE (MESEMBRYANTHEMACEAE)	**All species**
Family:AMARYLLIDACEAE	All species except those listed in Schedule 1
Family: ANTHERICACEAE	All species
Family: APIACEAE	All species except those listed in Schedule 1
Family: APOCYNACEAE	All species except those listed in Schedule 1
Family: AQUIFOLIACEAE	All species
Ilex mitis	
Family: ARACEAE	
Zantedeschia spp.	Arum lilies, all species
Family: ARALIACEAE	
Cussonia spp.	Cabbage trees, all species
Family: ASPHODOLACEAE	**All species except those listed in Schedule 1 and the species *Aloe ferox***
Family: ASTERACEAE	
Helichrysum jubilatum	
Felicia deserti	
Gnaphalium simii	
Lopholaena longipes	
Senecio albo-punctatus	
Senecio trachylaenus	
Trichogyne lerouxiae	
Tripteris pinnatilobata	
Troglophyton acocksianum	
Vellereophyton lasianthum	
Family: BURMANNIACEAE	
Burmannia madagascariensis	Wild ginger
Family: BURSERACEAE	
Commiphora spp.	All species
Family: CAPPARACEAE	
Boscia spp.	Shepherd's trees, all species
Family: CARYOPHYLLACEAE	
Dianthus spp.	All species
Family: CELASTRACEAE	
Gymnosporia spp.	All species
Family: COLCHICACEAE	
Androcymbium spp.	All species
Gloriosa spp.	All species
Family: COMBRETACEAE	
Combretum spp.	All species
Family: CRASSULACEAE	All species except those listed in Schedule 1
Family: CUPPRESSACEAE	
Widdringtonia spp.	Wild cypress, all species
Family: CYATHEACEAE	
Cyathea spp.	Tree ferns, all species
Cyathea capensis	Tree Fern
Family: CYPERACEAE	
Carex acocksii	
Family: DROSERACEAE	
Drosera spp.	Sundews, all species

Family: DRYOPTERIDACEAE	
Rumohra spp.	Seven Weeks Fern, all species
Family: ERICACEAE	Erica, all species
Family: EUPHORBIACEAE	
Alchornea laxiflora	Venda Bead-string
Euphorbia spp.	**All species**
Family: FABACEAE	
Aspalathus spp.	Tea Bush, all species
Erythrina zeyheri	Ploughbreaker
Argyrolobium petiolare	
Caesalpinia bracteata	
Calliandra redacta	
Crotalaria pearsonii	
Indigofera limosa	
Lebeckia bowieana	
Polhillia involucrate	
Rhynchosia emarginata	
Wiborgia humilis	
Family: HYACINTHACEAE	
Daubenya spp	
Lachenalia spp.	Daubenya, all species
Veltheimia spp.	Viooltjie, all species
Eucomis spp.	Pineapple flower, all species
Neopatersonia namaquensis	
Ornithogalum spp.	All species
Family: IRIDACEAE	All species except those listed in Schedule 1
Family: LAURACEAE	
Ocotea spp.	Stinkwood, all species
Family: MESEMBRYANTHEMACEAE	**All species**
Family: MELIACEAE	
Nymania capensis	Chinese Lantern
Family: OLEACEAE	
Olea europea subsp. africana	Wild olive
Family: ORCHIDACEAE	Orchids, all species except those listed in Schedule 1
Family: OROBANCHACEAE	
Harveya spp.	Harveya, all species
Family: OXALIDACEAE	
Oxalis spp.	Sorrel, all species except those listed in Schedule 1
Family: PLUMBAGINACEAE	
Afrolimon namaquanum	
Family: POACEAE	
Brachiaria dura var. dura	
Dregeochloa calviniensis	
Pentaschistis lima	
Family: PODOCARPACEAE	
Podocarpus spp.	Yellowwoods, all species
Family: PORTULACACEAE	
Anacampseros spp.	All species
Avonia spp.	All species
Portulaca foliosa	
Family: PROTEACEAE	All species except those listed in Schedule 1
Family: RESTIONACEAE	All species
Family: RHAMNACEAE	

Phylica spp.	All species
Family: RUTACEAE	
Agathosma spp.	Buchu, all species
Family: SCROPHULARIACEAE	
Diascia spp.	All species
Halleria spp.	All species
Jamesbrittenia spp.	All species
Manulea spp.	All species
Nemesia spp.	All species
Phyllopodium spp.	All species
Polycarena filiformis	
Chaenostoma longipedicellatum	
Family: STRELITZIACEAE	
Strelitzia spp.	All species
Family: TECOPHILACEAE	
Cyanella spp.	All species
Family: THYMELAEACEAE	
Gnidia leipoldtii	
Family: ZINGIBERACEAE	
Siphonochilus aethiopicus	Wild ginger

Appendix 6: Flora and vertebrate animal species protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004)

(as updated in R. 1187, 14 December 2007)

CRITICALLY ENDANGERED SPECIES

Flora

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

Reptilia

Loggerhead sea turtle
Leatherback sea turtle
Hawksbill sea turtle

Aves

Wattled crane
Blue swallow
Egyptian vulture
Cape parrot

Mammalia

Riverine rabbit
Rough-haired golden mole

ENDANGERED SPECIES

Flora

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

Reptilia

Green turtle
Giant girdled lizard
Olive ridley turtle
Geometric tortoise

Aves

Blue crane
Grey crowned crane
Saddle-billed stork
Bearded vulture
White-backed vulture
Cape vulture
Hooded vulture
Pink-backed pelican
Pel's fishing owl
Lappet-faced vulture

Mammalia

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

VULNERABLE SPECIES

Flora

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

Aves

White-headed vulture
Tawny eagle
Kori bustard
Black stork
Southern banded snake eagle
Blue korhaan
Taita falcon
Lesser kestrel
Peregrine falcon

Bald ibis
Ludwig's bustard
Martial eagle
Bataleur
Grass owl

Mammalia
Cheetah
Samango monkey
Giant golden mole
Giant rat
Bontebok
Tree hyrax
Roan antelope
Pangolin
Juliana's golden mole
Suni
Large-eared free-tailed bat
Lion
Leopard
Blue duiker

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

Amphibia
Giant bullfrog
African bullfrog

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

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

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

Appendix 7: Curriculum vitae: Dr David Hoare

Education
Matric - Graeme College, Grahamstown, 1984
B.Sc (majors: Botany, Zoology) - Rhodes University, 1991-1993
B.Sc (Hons) (Botany) - Rhodes University, 1994 with distinction
M.Sc (Botany) - University of Pretoria, 1995-1997 with distinction
PhD (Botany) – Nelson Mandela Metropolitan University, Port Elizabeth

Main areas of specialisation

- Vegetation ecology, primarily in grasslands, thicket, coastal systems, wetlands.
- Plant biodiversity and threatened plant species specialist.
- Alien plant identification and control / management plans.
- Remote sensing, analysis and mapping of vegetation.
- Specialist consultant for environmental management projects.

Membership
Professional Natural Scientist, South African Council for Natural Scientific Professions, 16 August 2005 – present. Reg. no. 400221/05 (Ecology, Botany)
Member, International Association of Vegetation Scientists (IAVS)
Member, Ecological Society of America (ESA)
Member, International Association for Impact Assessment (IAIA)
Member, Herpetological Association of Africa (HAA)

Employment history
1 December 2004 – present, Director, David Hoare Consulting (Pty) Ltd. Consultant, specialist consultant contracted to various companies and organisations.
1January 2009 – 30 June 2009, Lecturer, University of Pretoria, Botany Dept.
1January 2013 – 30 June 2013, Lecturer, University of Pretoria, Botany Dept.
1 February 1998 – 30 November 2004, Researcher, Agricultural Research Council, Range and Forage Institute, Private Bag X05, Lynn East, 0039. Duties: project management, general vegetation ecology, remote sensing image processing.

Experience as consultant
Ecological consultant since 1995. Author of over 500 specialist ecological consulting reports. Wide experience in ecological studies within grassland, savanna and fynbos, as well as riparian, coastal and wetland vegetation.

Publication record:

Refereed scientific articles (in chronological order):

Journal articles:

HOARE, D.B. & BREDENKAMP, G.J. 1999. Grassland communities of the Amatola / Winterberg mountain region of the Eastern Cape, South Africa. *South African Journal of Botany* 64: 44-61.

HOARE, D.B., VICTOR, J.E., LUBKE, R.A. & MUCINA, L., 2000. Vegetation of the coastal fynbos and rocky headlands south of George, South Africa. *Bothalia* 30: 87-96.

VICTOR, J.E., **HOARE, D.B.** & LUBKE, R.A., 2000. Checklist of plant species of the coastal fynbos and rocky headlands south of George, South Africa. *Bothalia* 30: 97-101.

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

HOARE, D.B. & BREDENKAMP, G.J. 2001. Syntaxonomy and environmental gradients of the grasslands of the Stormberg / Drakensberg mountain region of the Eastern Cape, South Africa.. *South African Journal of Botany* 67: 595 – 608.

LUBKE, R.A., **HOARE, D.B.**, VICTOR, J.E. & KETELAAR, R. 2003. The vegetation of the habitat of the Brenton blue butterfly, Orachrysops niobe (Trimen), in the Western Cape, South Africa. *South African Journal of Science* 99: 201–206.

HOARE, D.B & FROST, P. 2004. Phenological classification of natural vegetation in southern Africa using AVHRR vegetation index data. *Applied Vegetation Science* 7: 19-28.

FOX, S.C., HOFFMANN, M.T. and HOARE, D. 2005. The phenological pattern of vegetation in Namaqualand, South Africa and its climatic correlates using NOAA-AVHRR NDVI data. South African Geographic Journal, 87: 85–94.

Pfab, M.F., Compaan, P.C., Whittington-Jones, C.A., Engelbrecht, I., Dumalisile, L., Mills, L., West, S.D., Muller, P., Masterson, G.P.R., Nevhutalu, L.S., Holness, S.D., **Hoare, D.B.** 2017. The Gauteng Conservation Plan: Planning for biodiversity in a rapidly urbanising province. Bothalia, Vol. 47:1. a2182. https://doi.org/10.4102/abc.v47i1.2182.

Book chapters and conference proceedings:

HOARE, D.B. 2002. Biodiversity and performance of grassland ecosystems in communal and commercial farming systems in South Africa. Proceedings of the FAO's Biodiversity and Ecosystem Approach in Agriculture, Forestry and Fisheries Event: 12–13 October, 2002. Food and Agriculture Organisation of the United Nations, Viale delle Terme di Caracalla, Rome, Italy. pp. 10 - 27.

STEENKAMP, Y., VAN WYK, A.E., VICTOR, J.E., **HOARE, D.B.**, DOLD, A.P., SMITH, G.F. & COWLING, R.M. 2005. Maputaland-Pondoland-Albany Hotspot. In: Mittermeier, R.A., Gil, P.R., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J. & Fonseca, G.A.B. da (eds.) *Hotspots revisited.* CEMEX, pp.218–229. ISBN 968-6397-77-9

STEENKAMP, Y., VAN WYK, A.E., VICTOR, J.E., **HOARE, D.B.**, DOLD, A.P., SMITH, G.F. & COWLING, R.M. 2005. Maputaland-Pondoland-Albany Hotspot. http://www.biodiversityhotspots.org/xp/hotspots/maputaland/.

HOARE, D.B., MUCINA, L., RUTHERFORD, M.C., VLOK, J., EUSTON-BROWN, D., PALMER, A.R., POWRIE, L.W., LECHMERE-OERTEL, R.G., PROCHES, S.M., DOLD, T. and WARD, R.A. *Albany Thickets.* in Mucina, L. and Rutherford, M.C. (eds.) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19, South African National Biodiversity Institute, Pretoria.

MUCINA, L., **HOARE, D.B.**, LÖTTER, M.C., DU PREEZ, P.J., RUTHERFORD, M.C., SCOTT-SHAW, C.R., BREDENKAMP, G.J., POWRIE, L.W., SCOTT, L., CAMP, K.G.T., CILLIERS, S.S., BEZUIDENHOUT, H., MOSTERT, T.H., SIEBERT, S.J., WINTER, P.J.D., BURROWS, J.E., DOBSON, L., WARD, R.A., STALMANS, M., OLIVER, E.G.H., SIEBERT, F., SCHMIDT, E., KOBISI, K., KOSE, L. 2006. *Grassland Biome.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

RUTHERFORD, M.C., MUCINA, L., LÖTTER, M.C., BREDENKAMP, G.J., SMIT, J.H.L., SCOTT-SHAW, C.R., **HOARE, D.B.**, GOODMAN, P.S., BEZUIDENHOUT, H., SCOTT, L. & ELLIS, F., POWRIE, L.W., SIEBERT, F., MOSTERT, T.H., HENNING, B.J., VENTER, C.E., CAMP, K.G.T., SIEBERT, S.J., MATTHEWS, W.S., BURROWS, J.E., DOBSON, L., VAN ROOYEN, N., SCHMIDT, E., WINTER, P.J.D., DU PREEZ, P.J., WARD, R.A., WILLIAMSON, S. and HURTER, P.J.H. 2006. *Savanna Biome.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

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

MUCINA, L., SCOTT-SHAW, C.R., RUTHERFORD, M.C., CAMP, K.G.T., MATTHEWS, W.S., POWRIE, L.W. and **HOARE, D.B.** 2006. *Indian Ocean Coastal Belt.* In: Mucina, L. & Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

Conference Presentations:

HOARE, D.B. & LUBKE, R.A. *Management effects on diversity at Goukamma Nature Reserve, Southern Cape*; Paper presentation, Fynbos Forum, Bienne Donne, July 1994

HOARE, D.B., VICTOR, J.E. & LUBKE, R.A. *Description of the coastal fynbos south of George, southern Cape*; Paper presentation, Fynbos Forum, Bienne Donne, July 1994

HOARE, D.B. & LUBKE, R.A. *Management effects on fynbos diversity at Goukamma Nature Reserve, Southern Cape*; Paper presentation, South African Association of Botanists Annual Congress, Bloemfontein, January 1995

HOARE, D.B. & BOTHA, C.E.J. *Anatomy and ecophysiology of the dunegrass Ehrharta villosa var. maxima*; Poster presentation, South African Association of Botanists Annual Congress, Bloemfontein, January 1995

HOARE, D.B., PALMER, A.R. & BREDENKAMP, G.J. 1996. *Modelling grassland community distributions in the Eastern Cape using annual rainfall and elevation*; Poster presentation, South African Association of Botanists Annual Congress, Stellenbosch, January 1996

HOARE, D.B. Modelling vegetation on a past climate as a test for palaeonological hypotheses on vegetation distributions; Paper presentation, Randse Afriakaanse Universiteit postgraduate symposium, 1997

HOARE, D.B., VICTOR, J.E. & BREDENKAMP, G.J. *Historical and ecological links between grassy fynbos and afromontane fynbos in the Eastern Cape*; Paper presentation, South African Association of Botanists Annual Congress, Cape Town, January 1998

LUBKE, R.A., HOARE, D.B., VICTOR, J.E. & KETELAAR, R. *The habitat of the Brenton Blue Butterfly*. Paper presentation, South African Association of Botanists Annual Congress, Cape Town, January 1998

HOARE, D.B. & PANAGOS, M.D. Satellite stratification of vegetation – structure or floristic composition? Poster presentation at the 34th Annual Congress of the Grassland Society of South Africa, Warmbaths, 1-4 February 1999.

HOARE, D.B. & WESSELS, K. Conservation status and threats to grasslands of the northern regions of South Africa, Poster presentation at the South African Association of Botanists Annual Congress, Potchefstroom, January 2000.

HOARE, D.B. Phenological dynamics of Eastern Cape vegetation. Oral paper presentation at the South African Association of Botanists Annual Congress, Grahamstown, January 2002.

HOARE, D.B., MUCINA, L., VAN DER MERWE, J.P.H. & PALMER, A.R. Classification and digital mapping of grasslands of the Eastern Cape Poster presentation at the South African Association of Botanists Annual Congress, Grahamstown, January 2002.

HOARE, D.B. Deriving phenological variables for Eastern Cape vegetation using satellite data Poster presentation at the South African Association of Botanists Annual Congress, Grahamstown, January 2002.

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

HOARE, D.B. 2003. Species diversity patterns in moist temperate grasslands of South Africa. Proceedings of the VIIth International Rangeland Congress, 26 July – 1 August 2003, Durban South Africa. African Journal of Range and Forage Science. 20: 84.

Unpublished technical reports:

PALMER, A.R., HOARE, D.B. & HINTSA, M.D., 1999. Using satellite imagery to map veld condition in Mpumalanga: A preliminary report. Report to the National Department of Agriculture (Directorate Resource Conservation). ARC Range and Forage Institute, Grahamstown.

HOARE, D.B. 1999. The classification and mapping of the savanna biome of South Africa: methodology for mapping the vegetation communities of the South African savanna at a scale of 1:250 000. Report to the National Department of Agriculture (Directorate Resource Conservation). ARC Range and Forage Institute, Pretoria.

HOARE, D.B. 1999. The classification and mapping of the savanna biome of South Africa: size and coverage of field data that exists on the database of vegetation data for South African savanna. Report to the National Department of Agriculture (Directorate Resource Conservation). ARC Range and Forage Institute, Pretoria.

THOMPSON, M.W., VAN DEN BERG, H.M., NEWBY, T.S. & HOARE, D.B. 2001. Guideline procedures for national land-cover mapping and change monitoring. Report no. ENV/P/C 2001-006 produced for Department of Water Affairs and Forestry, National Department of Agriculture and Department of Environment Affairs and Tourism. Copyright: Council for Scientific and Industrial Research (CSIR) and Agricultural Research Council (ARC).

HOARE, D.B. 2003. Natural resource survey of node O R Tambo, using remote sensing techniques, Unpublished report and database of field data for ARC Institute for Soil, Climate & Water, ARC Range and Forage Institute, Grahamstown.

HOARE, D.B. 2003. Short-term changes in vegetation of Suikerbosrand Nature Reserve, South Africa, on the basis of resampled vegetation sites. Gauteng Department of Agriculture, Conservation, Environment and Land Affairs, Conservation Division.

BRITTON, D., SILBERBAUER, L., ROBERTSON, H., LUBKE, R., HOARE, D., VICTOR, J., EDGE, D. & BALL, J. 1997. The Life-history, ecology and conservation of the Brenton Blue Butterfly (*Orachrysops niobe*) (Trimen)(*Lycaenidea*) at Brenton-on-Sea. Unpublished report for the Endangered Wildlife Trust of Southern Africa, Johannesburg. 38pp.

HOARE, D.B., VICTOR, J.E. & MARNEWIC, G. 2005. Vegetation and flora of the wetlands of Nylsvley River catchment as component of a project to develop a framework for the sustainable management of wetlands in Limpopo Province.

Consulting reports:

Total of over 380 specialist consulting reports for various environmental projects from 1995 – present.

Workshops / symposia attended:

International Association for Impact Assessment Annual Congress, Durban, 16 – 19 May 2018.

Workshop on remote sensing of rangelands presented by Paul Tueller, University of Nevada Reno, USA, VIIth International Rangeland Congress, 26 July – 1 August 2003, Durban South Africa.

VIIth International Rangeland Congress, 26 July – 1 August 2003, Durban South Africa.

BioMap workshop, Stellenbosch, March 2002 to develop strategies for studying vegetation dynamics of Namaqualand using remote sensing techniques

South African Association of Botanists Annual Congress, Grahamstown, January 2002.

28th International Symposium on Remote Sensing of Environment, Somerset West, 27-31 March 2000.

Workshop on Vegetation Structural Characterisation: Tree Cover, Height and Biomass, 28th International Symposium on Remote Sensing of Environment, Strand, 26 March 2000.

South African Association of Botanists Annual Congress, Potchefstroom, January 2000

National Botanical Institute Vegmap Workshop, Kirstenbosch, Cape Town, 30 September-1 October 1999.

Sustainable Land Management – Guidelines for Impact Monitoring, Orientation Workshop: Sharing Impact Monitoring Experience, Zithabiseni, 27-29 September 1999.

WWF Macro Economic Reforms and Sustainable Development in Southern Africa, Environmental Economic Training Workshop, development Bank, Midrand, 13-14 September 1999.

34th Annual Congress of the Grassland Society of South Africa, Warmbaths, 1-4 February 1999

Expert Workshop on National Indicators of Environmental Sustainable Development, Dept. of Environmental Affairs and Tourism, Roodevallei Country Lodge, Roodeplaat Dam, Pretoria, 20-21 October 1998.

South African Association of Botanists Annual Congress, Cape Town, January 1998

Randse Afriakaanse Universiteit postgraduate symposium, 1997.

South African Association of Botanists Annual Congress, Bloemfontein, January 1995.