BASIC ASSESSMENT FOR THE ILANGA SOLAR FACILITY 2 AND ASSOCIATED INFRASTRUCTURE, UPINGTON, NORTHERN CAPE:

AVIFAUNA SPECIALIST BA REPORT

Karoo Korhaan *Eupodotis vigorsii*

PRODUCED FOR SAVANNAH ENVIRONMENTAL

BY

Simon.Todd@3foxes.co.za

July 2020

EXECUTIVE SUMMARY

Ilanga PV 2 (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure within a development area located approximately 18km south-west of Upington within the Kai!Garib Local Municipality and the ZF Mgcawu District Municipality in the Northern Cape Province. A development area (located within the broader study area) with an extent of ~330ha has been identified by Ilanga PV (Pty) Ltd as a technically suitable site for the development of a solar PV facility with a contracted capacity of up to 100MW. As part of the required Basic Assessment, 3Foxes Biodiversity Solutions has been appointed to provide a specialist avifauna impact assessment study of the development area as part of the BA process.

A desktop review of the available avifaunal information for the area was conducted in order to identify and characterise the avifaunal features of the site. A total of 163 bird species have been recorded within the broader study area and surrounds. Eleven (11) are red-listed species, six (6) are listed as near-endemic and a further ten (10) species are biome-restricted. There are no known Important Bird Areas (IBAs) or wetlands of significant avifaunal importance within the vicinity of the broader study area (other than the Orange River located within 12 km to the north).

Five (5) of the eleven (11) red-listed species are considered most important as they would potentially be impacted the most due to habitat loss and displacement. Species considered to be most important include the Ludwig's Bustard *Neotis ludwigii* (Endangered), Secretarybird *Sagittarius serpentarius* (Vulnerable), Karoo Korhaan *Eupodotis vigorsii* (Near-threatened) and Kori Bustard *Ardeotis kori* (Near-threatened). The White-backed Vulture *Gyps africanus* (Critically Endangered) and Lappet-faced Vulture (*Torgos tracheliotos*) have been recorded in the wider area but are unlikely to be highly affected by the development and as their presence is likely sporadic during infrequent foraging trips. The Black Stork *Ciconia nigra* (Vulnerable) is unlikely to occur due to the absence of suitable habitat, but may occur along the nearby Orange River where more suitable habitat exists. A Black Harrier *Circus maurus* (Endangered) and breeding pair of Verreaux's Eagle *Aquila verreauxii* (Vulnerable) have been recorded within the broader study area however neither species were recorded on either SABAB1 or SABAB2 cards thus likely have a low frequency of occurrence and only be affected by reduced foraging ground. Previous avifauna monitoring on the site (undertaken by Birds and Bats Unlimited in 2016 over 2 seasons) recorded large Sociable Weaver nests on site. No other sensitive breeding or roosting sites of any red-listed species were recorded. A pre-construction survey should be undertaken to confirm if communal roosting and breeding sites of red-listed species are present at the site at that time, and appropriate mitigation measures should be implemented.. . It is possible that there is a Secretarybird nest within the vicinity of the broader study area. Consequently, a

conservative approach has been adopted when assessing the impact of the development on the avifauna

The expected impacts of the proposed solar development within the broader study area include 1) habitat loss and fragmentation associated with plains habitat of the Kalahari Karroid Shrubland vegetation type, 2) disturbance caused during the construction and maintenance phases, and 3) direct mortality of avifauna colliding with solar panels, 4) possible entrapment of terrestrial birds along perimeter fencing, and 5) a cumulative habitat loss at a broader scale from renewable energy developments in the Upington area. The species that will be the most negatively impacted by the proposed development include primarily small passerines, terrestrial (ground-dwelling) non-passerines and large raptors and terrestrial birds that occasionally use the area for foraging. The impacts on the avifauna is expected to be of medium importance and no high post-mitigation impacts are expected.

The primary mitigation measures required to reduce the potential impacts on priority species include 1) restrict habitat destruction and disturbance to within the development footprint of the proposed development, 2) exclusion of major drainage lines and pans from development, where feasible and 3) ensure that the perimeter fencing along the boundaries of the development are bird (especially terrestrial species) and wildlife friendly.

Cumulative impacts associated with the development area may be of concern due to increasing number of solar facility developments proposed for the broader Upington area. Considering that the vegetation and avifauna that occur on the broader study area are rather typical of the bioregion, the overall cumulative avifaunal impact of the development is considered likely to be low. However, in the broader area, corridors of intact habitat, especially the gravel plains and drainage lines should be maintained in a natural state to ensure that ecological connectivity between areas of higher conservation value for certain species such as Karoo Korhaan are maintained.

CONTENTS

COMPLIANCE WITH APPENDIX 6 OF THE 2014 EIA REGULATIONS, AS AMENDED

Requirements of Appendix 6 – GN R326 2014 EIA Regulations, 7 April 2017	**Addressed in the Specialist Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i.the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	6-7
a) a declaration that the specialist is independent in a form as may be specified by the competent authority;	8-9
an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 2.1 & 2.2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 4
the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A
a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
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;	Section 3
an identification of any areas to be avoided, including buffers;	Section 3
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;	Section 3
a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2.3
a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 4
any mitigation measures for inclusion in the EMPr;	Section 5 & 7
any conditions for inclusion in the environmental authorisation;	Section 7
any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7
a reasoned opinion- i.whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities and if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 6
a) a description of any consultation process that was undertaken during the course of preparing the specialist report;	
a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	
any other information requested by the competent authority.	
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

SHORT CV/SUMMARY OF EXPERTISE – SIMON TODD

Simon Todd Pr.Sci.Nat
Director & Principle Scientist
C: 082 3326502
O: 021 782 0377
Simon.Todd@3foxes.co.za

60 Forrest Way
Glencairn
7975

Ecological Solutions for People & the Environment

Simon Todd is Director and principal scientist at 3Foxes Biodiversity Solutions and has over 20 years of experience in biodiversity measurement, management and assessment. He has provided specialist ecological input on more than 200 different developments distributed widely across the country. This includes input on the Wind and Solar SEA (REDZ) as well as the Eskom Grid Infrastructure (EGI) SEA and Karoo Shale Gas SEA. He is on the National Vegetation Map Committee as representative of the Nama and Succulent Karoo Biomes. Simon Todd is a recognised ecological expert and is a past chairman and current deputy chair of the Arid-Zone Ecology Forum. He is registered with the South African Council for Natural Scientific Professions (No. 400425/11).

A selection of recent work is as follows:

Strategic Environmental Assessments

Co-Author. Chapter 7 - Biodiversity & Ecosystems - Shale Gas SEA. CSIR 2016.
Co-Author. Chapter 1 Scenarios and Activities – Shale Gas SEA. CSIR 2016.
Co-Author – Ecological Chapter – Wind and Solar SEA. CSIR 2014.
Co-Author – Ecological Chapter – Eskom Grid Infrastructure SEA. CSIR 2015.
Contributor – Ecological & Conservation components to SKA SEA. CSIR 2017.

Recent Specialist Ecological Studies in the Vicinity of the Current Site

- Bloemsmond Solar 1 and Solar 2. Fauna and Flora EIA Process. Savannah Environmental 2015.
- Karoshoek CSP Development. Fauna and Flora EIA Process. Savannah Environmental 2016.
- Rooipunt 132kV Line, Upington. Fauna and Flora BA study. SiVest 2016.
- Dyason's Klip Solar PV Facility, Upington. Fauna and Flora EIA Proces. Cape EAPrac 2015.
- RE Capital 11 Solar PV Facility, Upington. Fauna and Flora EIA Proces. Cape EAPrac 2015.
- Joram Solar Plant, Upington. Fauna and Flora EIA Proces. Cape EAPrac 2015.
- Adams PV Project – EIA process and follow-up vegetation survey. Aurora Power Solutions. 2016.
- Solis 2 CSP Facility, van Roois Vley, Upington. Flora EIA process. WSP. 2014

Aliénor Brassine

Aliénor (Eleanor) Brassine (Pr. Sci. Nat.) is an independent avifaunal and fauna specialist with over 8 years of experience in biodiversity research and conservation in southern Africa. Aliénor holds a MSc (Zoology) from Rhodes University and is registered as a Professional Natural Scientist (Ecological Science) with the South African Council for Natural Scientific Professions (No. 116197). Aliénor has been involved in general fauna, avifauna and species-specific surveys for the Renewable Energy Projects since 2015 and has worked on over 25 projects. She has extensive field experience especially in the Northern Cape and is familiar with the avifauna of the region.

Tertiary Education:

- 2006 - 2008 – Bachelor of Science, Rhode University
- 2009 - BSc Honours in Zoology, Rhodes University
- 2015 - Master of Science in Zoology, Rhodes University

Work History:

- 2015 - Present – Independent wildlife biologist, fauna and avifaunal specialist for renewable energy projects.
- 2014 - MSc Candidate and demonstrator for Undergraduate students at Rhode University
- 2011 - 2013 – Resident Researcher/Cheetah Specialist at Mashatu Nature Reserve, Botswana
- 2010 – English and French foreign language teacher for AYC Interlectual Programmes, Thailand

Recent Specialist Ecological Studies in the vicinity of the current site:

- Gromis-Nama-Aggeneis Eskom 400kV new power line development, Northern Cape. Faunal Assessment Screening Study. 2019.
- Kuruman Wind Energy Facility, Phase 1 & Phase 2, Kuruman. Southern Mountain Reedbuck Specialist Survey. Arcus Consulting Ltd. 2019/2020.
- Avifaunal monitoring for the Proposed Paulputs Wind Energy Facility, Pofadder, Northern Cape

SPECIALIST DECLARATION 1

I, ..Simon Todd....., as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

- I act as the independent specialist in this application;

I 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;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I 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;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I have no vested interest in the proposed activity proceeding;
I 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;
I 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;
I 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
I 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 the specialist: 

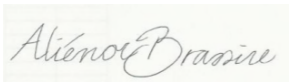
Name of Specialist: ____Simon Todd_____

Date: _____

SPECIALIST DECLARATION 2

I, ...Alienor (Eleanor) Brassine...., as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

I act as the independent specialist in this application;
I 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;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I 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;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I have no vested interest in the proposed activity proceeding;
I 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;
I 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;
I 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
I 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 the specialist: _____  _____

Name of Specialist: __Alienor Brassine_____

Date: _____

1 INTRODUCTION

Emvelo Capital Projects (Pty) Ltd, an independent power developer of solar power plants in South Africa proposes the development of Ilanga PV 2, a 100MW photovoltaic (PV) solar energy facility and associated infrastructure on a site located 28km south-east of the town of Upington in the Northern Cape Province. The project and associated infrastructure is proposed within Lot 944 and will form part of the Upington Ilanga Solar Park located approximately 30 km east of Upington (Figure 1). The site falls within the jurisdiction of the Dawid Kruiper and the greater ZF Mgcawu District Municipality. The development area is located within Focus Area 7 of the Renewable Energy Development Zones (REDZ), which is known as the Upington REDZ. Due to the location of the study area and development area within a REDZ, a Basic Assessment (BA) process is required for the application of an environmental authorisation. Savannah Environmental is conducting the required BA process for the Ilanga PV 2 development and has appointed 3Foxes Biodiversity Solutions to provide a specialist avifauna impact assessment study of the proposed development as part of the BA process.

The purpose of the Ilanga PV 2 Avifaunal Basic Assessment Report is to 1) describe the avian ecological features of the proposed PV project site and broader study area, 2) to provide a preliminary assessment of the avian ecological sensitivity of the affected area, and 3) identify and assess the significance of the likely impacts on the avifauna associated with the development of the proposed Ilanga PV facility, and 4) to provide measures to avoid, minimize and mitigate project related impacts to the avifauna. A desktop review of the available literature for the area was conducted in order to identify and characterise the local avifauna at the site, and use was made of data from two seasons of monitoring from2015 and 2016. Each visit included surveys in 1km transects across the site. These transects covered all main habitat types present. Vantage Point observations were also undertaken covering 12 hours in each season as promoted by the draft BARESG guidelines (Jenkins et al. 2015). . Impacts are assessed for the pre-construction, construction, operation, and decommissioning phases of the development. A variety of avoidance and mitigation measures associated with each identified impact are recommended to reduce the likely impact of the development, which should be included in the Environmental Management Programme (EMPr) for the development. The full scope of study is detailed below.

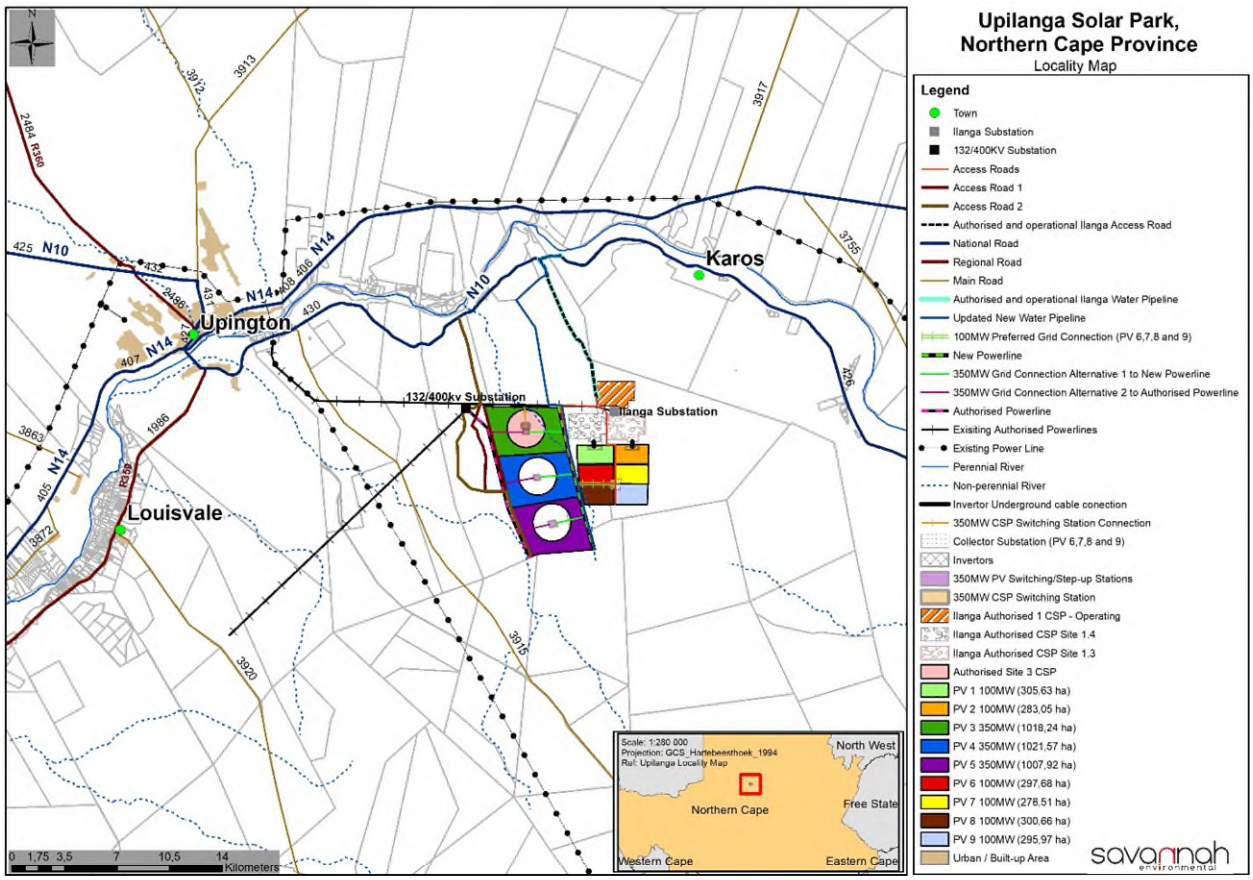


Figure 1 Layout of the Ilanga Solar Park, showing the relative location of Ilanga PV 2, illustrating the study area and the Ilanga PV 2 development area in light orange.

1.1 Scope of Study

The assessment is conducted according to the EIA Regulations, 2014 (Government Notice Regulation 326, as amended) in terms of the National Environmental Management Act (Act 107 of 1998) as amended (NEMA), as well as best-practice guidelines and principles for avifaunal assessment within solar energy facilities as outlined by Birdlife South Africa (Jenkins *et al.*, 2017).

The scope of the study includes the following activities

- a description of the avifauna that may be affected by the activity and the manner in which the avifauna may be affected by the proposed project;
- a description and evaluation of environmental issues and potential impacts on the avifauna (including using direct, indirect and cumulative impacts) that have been identified;
- a statement regarding the potential significance of the identified issues based on the evaluation of the issues/impacts;

- an indication of the methodology used in determining the significance of potential impacts on the avifauna;
- an assessment of the significance of direct indirect and cumulative impacts in terms of the following criteria:
    - the nature of the impact, which shall include a description of what causes the effect, what will be affected, and how it will be affected;
    - the extent of the impact, indicating whether the impact will be local (limited to the immediate area or site of development), regional, national or international;
    - the duration of the impact, indicating whether the lifetime of the impact will be of a short-term duration (0-5 years), medium-term (5-15 years), long-term (> 15 years, where the impact will cease after the operational life of the activity), or permanent;
    - the probability of the impact, describing the likelihood of the impact actually occurring, indicated as improbable (low likelihood) probable (distinct possibility), highly probable (most likely), or definite (impact will occur regardless of any preventable measures);
    - the severity/beneficial scale indicating whether the impact will be very severe/beneficial (a permanent change which cannot be mitigated/permanent and significant benefit with no real alternative to achieving this benefit), severe/beneficial (long-term impact that could be mitigated/long-term benefit), moderately severe/beneficial (medium- to long-term impact that could be mitigated/ medium- to long-term benefit), slight, or have no effect;
    - the significance which shall be determined through a synthesis of the characteristics described above and can be assessed as low medium or high;
    - the status which will be described as either positive, negative or neutral;
    - the degree to which the impact can be reversed;
    - the degree to which the impact may cause irreplaceable loss of resources; and
    - the degree to which the impact can be mitigated.

- a description and comparative assessment of all alternatives;
- recommendations regarding practical mitigation measures for potentially significant impacts, for inclusion in the Environmental Management Programme (EMPr);
- an indication of the extent to which the issue could be addressed by the adoption of mitigation measures;
- a description of any assumptions, uncertainties and gaps in knowledge; and
- an environmental impact statement which contains:
    - a summary of the key findings of the environmental impact assessment;
    - an assessment of positive and negative implications of the proposed activity; and
    - a comparative assessment of the positive and negative implications of identified

alternatives.

General Considerations:

- Disclose any gaps in information or assumptions made.
- Identify recommendations for mitigation measures to minimise impacts.
- Outline additional management guidelines.
- Provide monitoring requirements, mitigation measures and recommendations in a table format as input into the Environmental Management Plan (EMP) for avifaunal related issues.

A description of the potential impacts of the development and recommended mitigation measures are to be provided, which will be separated into the following project phases:

- Preconstruction
- Construction
- Operational Phase
- Decommissioning Phase

1.2 Relevant Aspects of the Development

The proposed project will have a contracted capacity of up to 100MW, and will make use of PV solar technology for the generation of electricity. The project will comprise the following key infrastructure and components:

- Solar PV panels with a maximum height of 2.2m utilising Single axis tracking; Fixed axis tracking; Dual axis tracking or Fixed Tilt mounting structures.
- On-site inverter (step up facility) to convert power from Direct Current (DC) to an Alternative (AC) and step up the electricity current from 33kV to 132kV that will connect to the on-site substation at the authorised site with underground cables to connect to the on-site substations at authorised site 1.3 and authorised grid connection (DEA Ref:. 14/12/16/3/3/2/294) to the Ilanga substation for PV facilities located at site 2.
- A step-up facility (inverter) to step up the electricity current from 33kV to 132kV.
- A temporary laydown area.
- Cabling between the panels, to be laid underground where practical.
- An access road to the development area no more than 6m wide.
- Internal access roads within the PV panel array area with a maximum width of 4m.
- Perimeter security fencing around the development area.
- Operation and Maintenance buildings including a gate house and security building, control centre, offices, warehouses, a workshop and visitors centre.

The electricity current from the Upilanga PV 2 PV facility will be converted and evacuated via an inverter and with the aid of underground cables connect to the authorised Ilanga CSP site 1.3 on-site substation (DEA Ref:. 14/12/16/3/3/2/294). The onsite substation at Site 1.4 will connect to the existing Ilanga substation which ultimately feeds into the national grid via the following possible alternatives that were assessed in this report:

1.On-site inverter (step up facility) to convert power from Direct Current (DC) to an Alternative (AC) and step up the electricity current from 33kV to 132kV that will connect via underground cables to the on-site substations at authorised site 1.3. The electricity will be evacuated via the authorised grid connection (DEA Ref: 14/12/16/3/3/2/294) to the existing Ilanga substation.

2.An onsite 11kV/22kV/33kV collector substation to receive, convert and step up electricity from the PV facility directly to the existing 132kV Ilanga Substation via underground cables (The on-site collector substation at authorised site 1.3 connects to the Ilanga substation)

3.Loop in and loop out the 132kV lines connecting existing Ilanga Substation to Gordonia Substation.

2 METHODOLOGY

2.1 Data Sourcing and Review

Data sources from the literature consulted and used where necessary in the study include the following:

- The Southern African Bird Atlas Project 1 (SABAP 1; Harrison et al., 1997) for bird distribution data between 1987 and 1992, was consulted to determine the bird species likely to occur within the broader study area. The relevant quarter-degree grid cell (QDGC) that covers the broader study area is 2821DA (7 cards, 80 species). More recent bird distribution data were also obtained from the second bird atlas project, which has been on-going since its inception in 2007 (SABAP 2; http://sabap2.adu.org.za/). SABAP2 employs a finer resolution using the pentad scale (5' latitude x 5' longitude) and the relevant pentad code for the development area being 2830_2130. However, because of the remoteness of the area there were no data available for the relevant pentad and additional pentads within the broader study area were also consulted to determine the bird species likely to occur within the developmental area. Pentads that were included being 2825_2130, 2825_2125, and 2830_2120.
- Avifaunal Assessment reports that were conducted within the broader area were consulted to determine the bird species likely to occur on the developmental area.
- The Important Bird Areas of South Africa (IBA; Marnewick et al., 2015) was consulted to determine the location of the nearest IBAs to the broader study area.

- The data from the Coordinated Avifaunal Roadcounts (CAR; Young et al., 2003) were consulted to determine the location of the nearest CAR routes to the broader study area.
- The data from the Coordinated Waterbird Counts (CWAC; Taylor et al., 1999) were consulted to determine the location of the nearest CWAC sites to the broader study area.
- The conservation status, endemism and biology of all species considered likely to occur within the broader study area were determined from Hockey et al. (2005) and Taylor et al. (2015).
- The South African National Vegetation Map (Mucina & Rutherford, 2006) was consulted in order to determine the vegetation types and their conservation status that occur within the broader study area.

The literature review revealed that there are no Important Bird Areas (IBAs), Coordinated Avifaunal Roadcounts (CAR) routes, or Coordinated Waterbird Counts (CWAC) wetlands in the vicinity of the broader study area.

A list was compiled of all the avifaunal species likely to occur within the broader study area, based on a combination of existing distributional data (SABAP 1 and SABAP 2) and previous avifaunal studies. A short-list of priority bird species (including nationally and/or globally threatened, rare, endemic or range-restricted bird species) that could be affected by the proposed development was also compiled. These species will subsequently be considered as adequate surrogates for the local avifauna in general, and mitigation of impacts on these species will be considered likely to accommodate any less important bird populations that may also potentially be affected.

2.2 Sensitivity Mapping & Assessment

An avifaunal sensitivity map of the development area was produced by integrating the available ecological and biodiversity information available in the literature and various spatial databases with mapping based on the satellite imagery of the area and personal knowledge of the area. This includes delineating different habitat units identified on the satellite imagery and assigning likely sensitivity values to the units based on their ecological properties, conservation value and the potential presence of avifaunal species of conservation concern. The ecological sensitivity of the different units identified in the mapping procedure was rated according to the following scale:

- **Low** – Areas of natural or transformed habitat with a low avifaunal sensitivity where there is likely to be a negligible impact on ecological processes and avifaunal biodiversity. Most types of development can proceed within these areas with little avifaunal impact.

- **Medium -** Areas of natural or previously transformed land where the impacts are likely to be largely local and the risk of secondary impact low. These areas usually comprise the bulk of avifaunal habitats within an area. Development within these areas can proceed with relatively little avifaunal impact provided that appropriate mitigation measures are taken.

- **High** – Areas of natural or transformed land where a high avifaunal impact is anticipated due to the high avifaunal biodiversity value, sensitivity or important ecological role of the area. These areas may contain or be important habitat for avifaunal species or provide important ecological services such as water flow regulation or seasonal feeding areas. Development within these areas is undesirable and should only proceed with caution as it may not be possible to mitigate all impacts appropriately.

- **Very High** – Critical and unique avifaunal habitats that serve as habitat for rare/endangered species or perform critical ecological roles. These areas are essentially no-go areas from a developmental perspective and should be avoided as much as possible.

2.3 Sampling Limitations and Assumptions

The study is based on a desktop study and the monitoring data from two seasons from 2015 and 2016 for the sitedid, which significantly increases the limitations and assumptions required for the study. Limiting factors that could detract from the accuracy of the predicted results:

- • Monitoring data from two seasons of monitoring from 2015 and 2016 were used for the site.There is a scarcity of published, scientifically assessed information regarding the avifaunal impacts at existing Solar Energy Facilities (SEFs). Recent studies at SEFs (all using different solar technologies) in southern California have revealed that a wide range of bird species are susceptible to morbidity and mortality at SEFs, regardless of the type of technology employed. It must however be noted, that facility related factors could influence impacts and mortality rates and as such, each SEF must be assessed individually, taking all variables into account.

- Assessment of the impacts associated with bird-SEF interactions is problematic due to: (i) limitations on the quality of information available describing the composition, abundance and movements of the local avifauna, and (ii) the lack of local, empirical data describing the known impacts of existing SEFs on birds (Jenkins, 2011). A more recent study (Venter, 2016; Visser *et al*., 2018), however, provides some preliminary data within the South African context.

- The SABAP 1 data for the relevant quarter degree squares covering the proposed development area are now >27 years old (Harrison et al., 1997). Further, no data were available for the relevant pentad that cover the developmental area during SABAP 2. In an attempt to ensure a conservative approach with regards to the species included on the final avifaunal list (Annexure 1), the species list derived from the literature was obtained from an area significantly larger than the development area under investigation, and thus likely includes a much wider array of species than actually occur within the developmental area and the site as a whole. This is a cautious and conservative approach which takes the study limitations into account.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT- BASELINE

3.1 Site context & Avifaunal Microhabitats

Broad-scale vegetation patterns influence the distribution and abundance of bird species holistically, while vegetation structure, rather than plant species composition, has a greater influence on local avifauna populations and species assemblages (Harrison *et al*., 1997). According to the National Vegetation Map (Mucina & Rutherford 2006 and 2018 update), there are several vegetation types within the broader study area including Bushmanland Arid Grassland, Gordonia Duneveld, Kalahari Karroid Shrubland and Lower Gariep Broken Veld (Figure 1). However, the Ilanga PV 2 footprint is restricted to the Bushmanland Arid Grassland vegetation type.

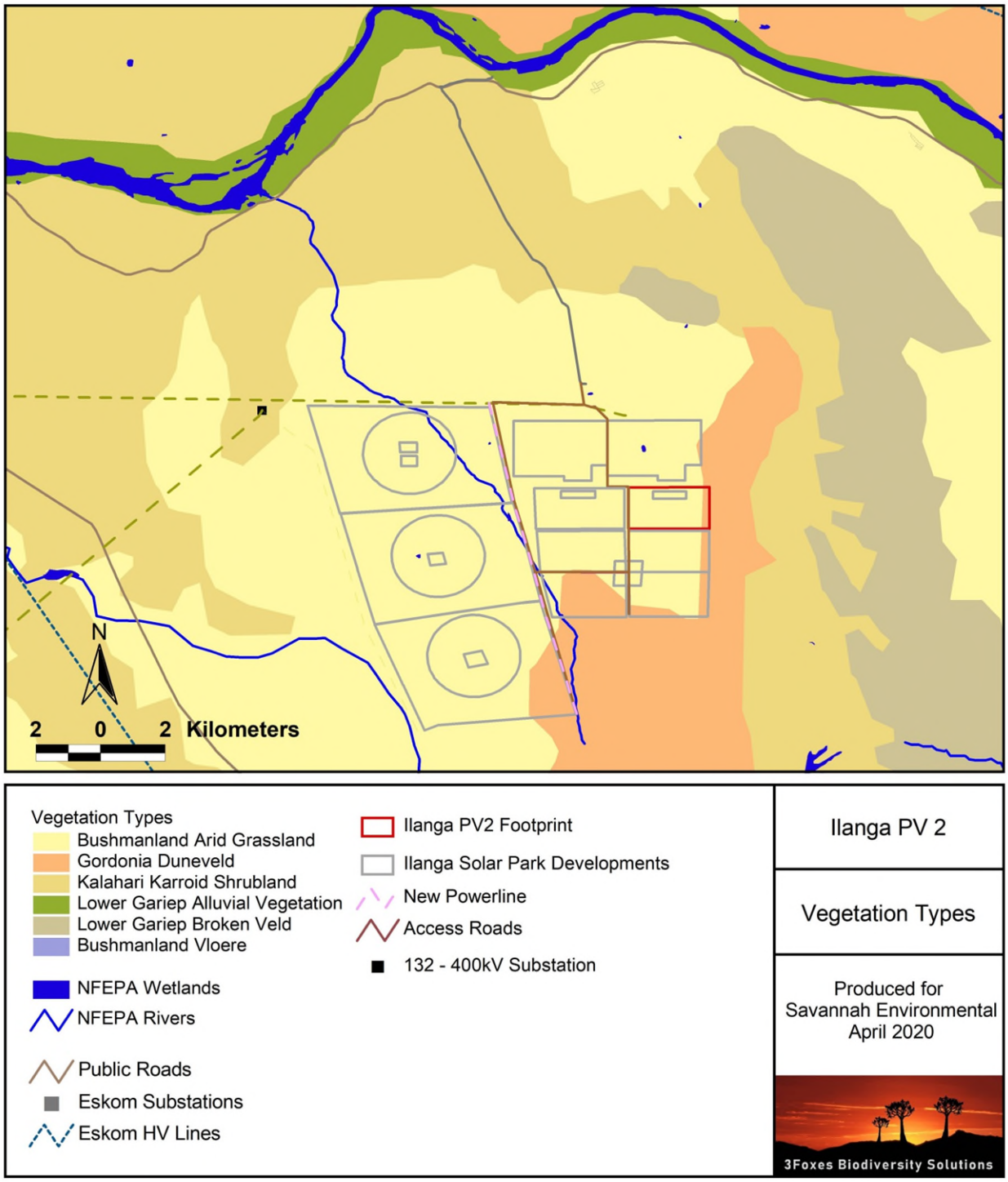


Figure 1. Broad-scale overview of the vegetation in and around the Ilanga PV development area. The vegetation map is an extract of the National Vegetation Map (Mucina & Rutherford 2006 & 2018 update), and also includes drainage lines delineated by the NFEPA Assessment (Nel *et al*., 2011).

The Bushmanland Arid Grassland vegetation type is an extensive vegetation type and is the second most extensive vegetation type in South Africa, occupying an area of 45 478 km^2. It extends from the study area around Aggeneys in the east to Prieska in the west. It is associated largely with red-yellow apedal (without structure), freely drained soils, with a high base status and mostly less than 300mm deep. Due to the arid nature of the unit, which receives between 70 and 200 mm annual rainfall, it has not been significantly impacted by intensive agriculture and more than 99% of the original extent of the vegetation type is still intact. However, the Vegetation map provides a relatively coarse representation of the vegetation of the site and it is clear that there are areas with stony soils within the site that are representative of Kalahari Karroid Shrubland. Kalahari Karroid Shrubland and Bushmanland Arid Grassland form a mosaic across the area reflecting substrate conditions especially soil depth and texture. Areas of deeper sands are dominated by grasses typical of Bushmanland Arid Grassland while areas of shallow soils with exposed calcrete or quartzite are dominated by shrubby vegetation typical of Kalahari Karroid Shrubland.

Although there are no well-developed drainage lines within the footprint, there are some wash areas where runoff water collects during larger showers and which are characterised by taller more dense vegetation. Typically, there are no large trees in the washes although *Vachellia erioloba* may occasionally be present and *Boscia albitrunca* is relatively common and occurs scattered throughout the broader study area

The current veld condition of the development area can be considered to be fair and while there are some areas that have clearly suffered some degradation in the past, the vegetation cover and composition can be considered typical for the study area. There are some localised areas of *Prosopis* invasion, usually around watering points, but in general there are few alien species present across most of the development area and it can be considered to be largely intact.

Avifaunal Microhabitats

Three main avifaunal microhabitats can be distinguished, namely the plains associated with areas of Kalahari Karroid Shrubland (Figure 3), the plains associated with sandy soils and dense grass layer typical of Bushmanland Arid Grassland (Figure 4) and wash areas where runoff water collects during larger showers and characterized by taller more dense vegetation (Figure 5) that is found in the lower-lying parts of the site. The plains are the dominant habitat type constituting a mixed of grasses and shrubs in varying proportions, while the lower lying areas and small drainage lines support some tree species. However, the variety of habitats is fairly low and no apparent permanent waterpoint occurs within the site.

Figure 2. Typical plains habitat of the Kalahari Karroid Shrubland associated with stony soils and sparse grass cover.

Figure 4. Typical plains habitat of Bushmanland Arid Grassland vegetation type with deeper soils and more dense grass cover and shrubs as well as scattered *Boscia albitrunca* trees in the middle ground associated with areas of deeper soils.

3.2 General Avifauna

No SABAP2 data were available for the Ilanga PV 2 developmental area and therefore the bird species list (Annexure 1) is derived from information of a wider area as well as findings from previous avifaunal studies conducted for the Ilanga Solar Park and the broad study area. The bird assemblage recorded within the broader study area is fairly typical of the Kalahari bioregion, with elements of the Nama-Karoo. A total of 163 bird species are known to occur within the broader study area and its surrounds. Eleven (11) of these species are Red data species, six (6) species are considered true near-endemics to South Africa (BirdLife South Africa, 2018), while ten (10) are considered biome-restricted (Marnewick *et al*., 2015).

The bird community within the PV 2 developmental area is unlikely to have all these species present at any one time as wetland species and water dependent species are likely restricted to the immediate vicinity of the Orange River (~12km north). However, large showers may result in seasonal flooding of washes and small pans, attracting wetland species such as Geese, Stilts and Crakes to these washes during such occasions. Other bird species such as Sandgrouse will also be attracted to available water and nomadic species such as Bustards will also follow high rainfall areas to take advantage of influx of insects. Some resident species such as Bokmakieries *Telophorus zeylonus*, Scrub robins, Dusky Sunbirds *Cinnyris fuscus* and Canaries will exhibit relatively stable trends throughout the year whilst other species such as Bishops, Queleas and Mousebirds will likely fluctuate in abundance between the seasons and rainfall trends.

Differences in species composition between the three avifaunal microhabitats are likely to be subtle. The small drainage lines and washes support denser vegetation than the plains and hence are likely characterised by higher occurrences of species preferring wooded habitats such as Mousebirds, Scrub robins, Dusky Sunbird, Black-chested Prinia *Prinia flavicans* and Acacia Pied Barbet *Tricholaema leucomelas*. Bustards, Korhaans and Lark species would generally be associated with the more sparsely vegetated open plains. Other species such as Chat Flycatcher *Bradornis infuscatus*, Southern Fiscal *Lanius collaris*, Ant-eating Chat *Myrmecocichla formicivora*, and Yellow Canary *Crithagra flaviventris* amongst others are more cosmopolitan in their use of the habitats and likely to be more evenly spread across the study area. The taller trees are likely to be exploited by Sociable Weavers *Philetairus socius* and perching raptors, including owl species such as Spotted Eagle Owls *Bubo africanus*. Trees may also be used as nesting sites by a variety of species including red-listed species such as Secretarybirds *Sagittarius serpentarius*. Sociable Weaver nests may also attract predatory species such as the Pygmy Falcon *Polihierax semitorquatus*.

Based on the combined SABAP cards from the broader area a number of the larger non-passerine species, including red-listed species, are likely to make use of the developmental

area as they appear to be relatively common within the broader study area this includes the Karoo Korhaan *Eupodotis vigorsii* (Near-Threatened; Biome restricted), Northern Black Korhaan *Afrotis afraoides*, Ludwig's Bustard *Neotis ludwigii* (Endangered; Biome restricted), Kori Bustard *Ardeotis kori* (Near-threatened) and Double-banded Courser *Rhinoptilus africanus* which were more frequently reported within the broader study area. The use of the study site is unknown, but it is likely that they would be present however if more favourable conditions exist outside study area this would affect their abundance at the site.

3.3 Red-listed Species

Red-listed species are considered fundamental to this study, because of their susceptibility to the various threats posed by solar facilities and associated infrastructures. Eleven (11) threatened species are known to occur within the broader study area. The most important of the red-listed species is the Critically Endangered White-backed Vulture *Gyps africanus*, which has been recorded within the broader study area (>40km), however this was a single record and there are no known breeding or roosting sites nearby, primarily due to the absence of suitably large *Acacia erioloba* trees, and hence the species is considered only as an occasional visitor that may occasionally pass by during foraging forays and its presence in the area is infrequent based on SABAP records. Similarly, the Endangered Lappet-faced Vulture *Torgos tracheliotos,* which has been recorded within the broader study area is most likely also only an occasional visitor to the area. The Martial Eagle *Polemaetus bellicosus* (Endangered) is also an important species that has been reported in previous studies, records of an immature bird suggest that the species most likely breeds on a large pylon or tree in the broader study area and is thus most likely a resident. This species will most likely only be impacted indirectly by the loss of a portion of their normal foraging ranges.

Although not recorded during SABAP2, the nomadic Ludwig's Bustard has been recorded by previous studies and found to be relatively common within the Upington Ilanga Solar Park and therefore likely utilizes the site during favourable conditions. Due to its nomadic behaviour, the species will most likely only lose a small portion of range that is only suitable during favourable years. The Tawny Eagle (Endangered) is only known from the area based on local knowledge, but probably only occurs on rare occasions as this species favours more wooded savannas, and can thus be considered to be a rare to uncommon visitor. The Black Harrier *Circus maurus* (Endangered; Near-endemic) and Verreaux's Eagle *Aquila verreauxii* (Vulnerable) have also been recorded within the Upington Ilanga Solar Park. The Black Harrier will most likely be impacted by reduced foraging range within its home range whereas the Verreaux's Eagle is unlikely to be impacted preferring the rocky outcrops and cliffs for foraging and breeding.

In terms of the Vulnerable species, the Black Stork *Ciconia nigra,* Lanner Falcon *Falco biarmicus* and Secretarybird and have been reported in the broad study area but with no

records on either SABAP1 or SABAP2 cards. The Black Stork would most likely frequent more suitable habitats closer to the Orange River as the developmental area does not provide the essential breeding or feeding habitat for the species. The Lanner Falcon is a partial seasonal migrant and would likely loose foraging opportunities to some extent from the development but it appears to occur in the area fairly infrequently. A Secretarybird was recorded close to the north eastern border of the developmental site during a previous avifaunal study and sightings have been recorded in the broader study area. Furthermore, an inactive nest was found within the developmental footprint of the CSP4 Facility of the Ilanga Solar Park. Secretarybirds are known to have bred in the past in the vicinity of the Khi Solar One Concentrated Solar Power (CSP) Facility, prior to its construction. This species uses solitary *Boscia* or other tree species for nesting and site visit would be required to ascertain if any nests are present within the PV 2 developmental site as an active nest would affect the sensitivity of the area. This species is highly mobile and if a resident pair is present, they would be displaced from the study site and the protection of breeding sites outside developmental site should be considered an important mitigation measure.

The two Near-Threatened species that most likely utilize the developmental site include Karoo Korhaan and Kori Bustard. The Karoo Korhaan has a relatively high reporting rate of 83% and therefore very likely to occur in the developmental area fairly frequently. Karoo Korhaans will likely be found on the plains, particularly the more gravel-like plains which this species prefers compared to sandy soils. Due to its high reporting rate, a significant impact on this species is likely. The Kori Bustard has a low reporting rate of 8%. Both species are likely to be displaced from the area as these species are strictly ground-dwelling foragers. The Kori Bustard do, however, have a very wide national range and therefore their regional and national population will not be impacted.

Most of the six near-endemic species reported for the broader study area have not been recorded in the area during SABAP2 or during previous avifauna surveys within the broader study area. They can therefore be considered scarce, and include, The Black Harrier, Fairy Flycatcher *Stenostira scita*, and the nomadic Black-headed Canary *Serinus alario* and Black-eared Sparrow-lark *Eremopterix australis*. The Karoo Thrush *Turdus smithi* has been recorded with a fair reporting rate (33%) and the Fiscal Flycatcher *Sigelus silens* has been reported with low reporting rate (17%). However, both species are likely utilizing nearby habitats associated with the Orange River, such as riverine thickets.

Two (2) of the ten (10) biome-restricted species known from the broader area have some of the highest SABAP2 reporting rates (in parentheses), namely, the Sociable Weaver (92%) and Karoo Korhaan (83%). Sociable Weavers build large communal nests usually in large trees or on man-made structures, their nests will also attract predatory species such as Pygmy Falcons and Pale Chanting Goshawk *Melierax canorus*. Their nests will also provide roosting sites for other bird species such as Pearl Spotted Owlet *Glaucidium perlatum*.

Sociable weavers may attempt to build their nests on the structures of the PV development and management intervention may be required if Sociable Weavers are displaced from natural nest sites. Presence of Sociable Weaver nests on the developmental site is currently unknown. The Karoo Long-billed Lark *Certhilauda subcoronata* is a fairly common bird (58%) in the broader study area whereas all other biome-restricted species had low reporting rates on SBAP2 and are therefore considered to be rare.

In essence, much of the avifauna of the surrounding environment will likely be fairly similar to that found across the Kalahari and Nama-Karoo bioregions of the Northern Cape. However, presence of communal or solitary roosting and nesting sites for red-listed species within the developmental area needs to be ascertained to ensure that no species are at immediate risk. A number of red-listed species do occur in the broader area primarily for foraging within their normally large home ranges, and are therefore not likely to be significantly impacted by the potential loss of a portion of foraging habitat as large tracks of suitable habitat remain within the surrounding environment. In essence, the sensitivity of the area in general can be considered to be of medium significance with respect to avifauna.

Table 1. Red-listed species recorded in the broader study area during SABAP1 (1987-1991), SABAP2 (2007 on-going) and previous avifauna studies, ranked according to their red-list status. Estimated importance of local population and probability of occurrence as well as threats from the development are also provided.

English name	Taxonomic name	Red-list status	Estimated importance of local population	Preferred habitat	Probability of occurrence	Threats
Vulture, White-backed	*Gyps africanus*	Critically Endangered	Low	Savanna	Low	Habitat loss/Disturbance Collisions/Electrocution
Vulture, Lappet-faced	*Torgos tracheliotos*	Endangered	Low	Savanna	Low	Habitat loss/Disturbance Collisions/Electrocution
Bustard, Ludwig's	*Neotis ludwigii*	Endangered	Moderate	Shrubland plains	High	Habitat loss/Disturbance Collisions
Eagle, Martial	*Polemaetus bellicosus*	Endangered	Moderate	Savanna & shrublands	Low	Habitat loss/Disturbance Collisions/Electrocution
Harrier, Black	*Circus maurus*	Endangered	Moderate	Shrublands & grassland	Low	Habitat loss/Disturbance Collisions/Electrocution
Eagle, Verreaux's	*Aquila verreauxii*	Vulnerable	Moderate	Mountainous	Low	Habitat loss/Disturbance Collisions/Electrocution
Falcon, Lanner	*Falco biarmicus*	Vulnerable	Moderate	Widespread	Recorded	Habitat loss/Disturbance Collisions/Electrocution
Secretarybird	*Sagittarius serpentarius*	Vulnerable	Moderate	Open savanna & grassland	High	Habitat loss/Disturbance Collisions
Stork, Black	*Ciconia nigra*	Vulnerable	Low	Water bodies	Low	Collisions
Bustard, Kori	*Ardeotis kori*	Near-Threatened	Moderate	Open savanna	High	Habitat loss/Disturbance Collisions
Korhaan, Karoo	*Eupodotis vigorsii*	Near-Threatened	Moderate	Shrubland plains	High	Habitat loss/Disturbance Collisions

3.4 Avian Sensitivity Assessment

Important avian microhabitats within the broader study area play an integral role within the landscape, providing nesting, foraging and reproductive benefits to the local avifauna. In order to ensure that the development does not have a long-term negative impact on the local avifauna, it is important to delineate these avian microhabitats within the broader study area. An avian sensitivity map (Figure 5) was produced by integrating avian microhabitats present based on satellite imagery. Habitat units identified on the satellite imagery were assigned sensitivity values based on the potential occurrence of species of conservation concern and habitat conservation values.

The broader study area supports three main avifaunal microhabitats, which are referred to as the plains, drainage lines, and small pans. These three habitats have marginally different sensitivities, due to the subtle differences in the avifaunal assemblages that they support. The plains habitat supports a mosaic of open gravel to sandy plains traversed by drainage lines, contributing to the habitat diversity of the area. The plains support the Secretary bird, Karoo Korhaan, Northern Black Korhaan and Kori Bustard, and the Endangered Ludwig's Bustard in favourable years. The sandy and gravel plains are considered to be Medium sensitivity as a result. The major drainage lines and small pans are a restricted habitat within the broader study and development area due to the denser vegetation they support; the larger drainage lines with a significant woody component are considered to be of very high sensitivity, while the washes and less well-developed drainage lines are considered to be of a high sensitivity. Some limited development in these high sensitivity areas is considered acceptable. It is likely that development of the solar energy facility on the medium sensitivity portions of the study area would generate acceptable impacts on the avifauna, provided suitable mitigation measures are employed during construction and operation of the proposed facility. While the development would result in some habitat loss for avifauna of local significance, it will impact some red-listed avifaunal species that use the area more regularly than others, such as Korhaans and Kori Bustard. Other species appear to occur too sparsely to be negatively impacted.

Due to potential impacts on the washes and drainage lines of the site, it is recommended that where possible, buffer zones (50 to 100m width) be included around the largest and most significant of these habitats. This will maintain connectivity of the landscape for smaller bird species and especially those that are associated with more dense riparian vegetation and which may be more reluctant to traverse large open areas.

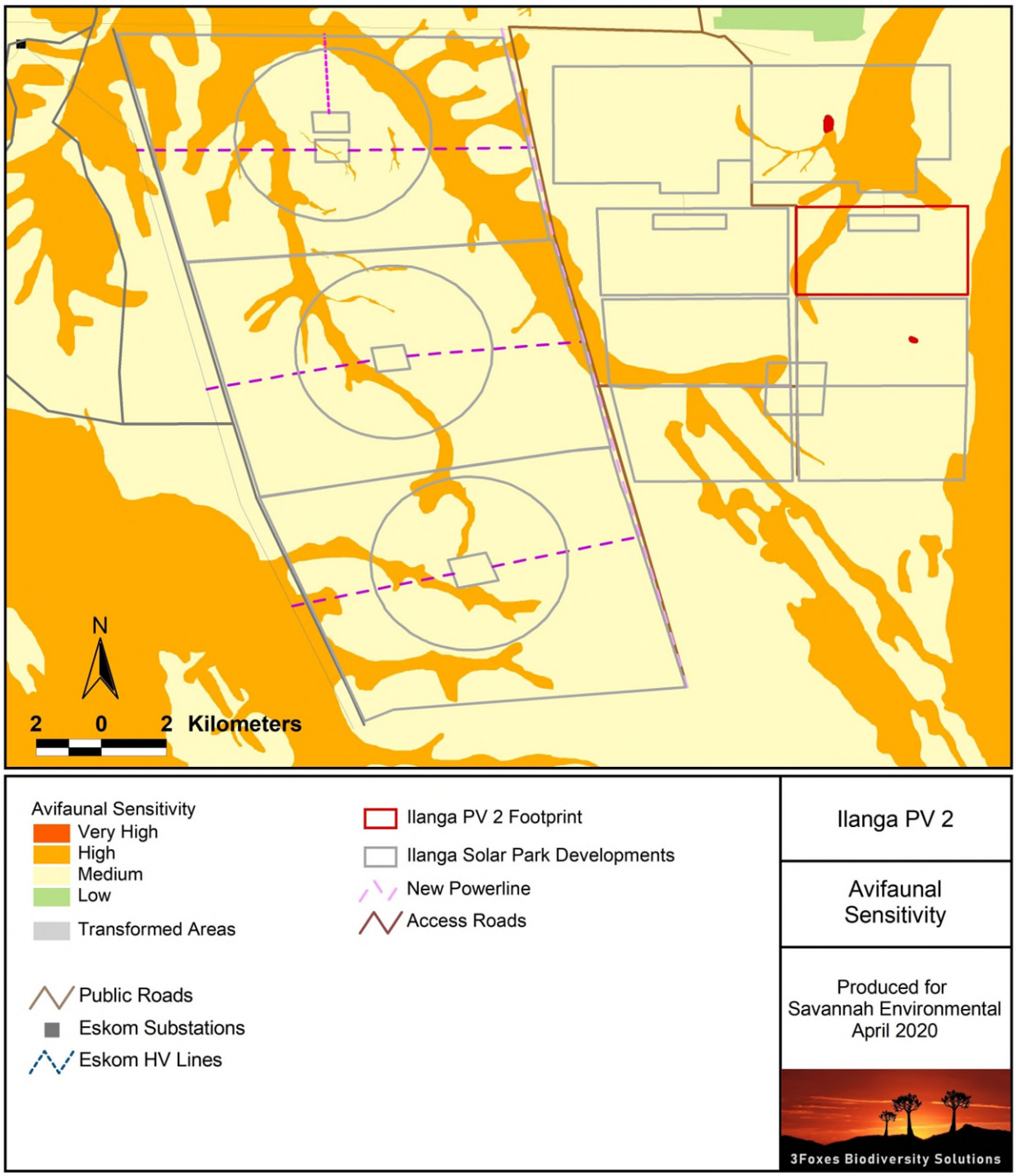


Figure 5. Avifaunal Sensitivity Map for the Ilanga PV 2 broader study and development area, showing the Medium sensitivity plains that cover most of the area and the High sensitivity drainage lines and washes.

4 IDENTIFICATION & NATURE OF IMPACTS

In this section, the potential impacts and associated risk factors that may be generated by the development are identified. In order to ensure that the impacts identified are broadly applicable and inclusive, all the likely or potential impacts that may be associated with the development are listed. The relevance and applicability of each potential impact to the current situation are then examined in more detail in the next section.

The major threats posed to avifauna by SEFs include direct habitat loss, fragmentation and displacement of birds (Lovich & Ennen, 2011). According to a position statement by BirdLife South Africa, the main concerns with PV facilities are the following:

- Displacement or the exclusion of nationally and/or globally threatened, rare, endemic, or range-restricted bird species from important habitats.
- Loss of habitat and disturbance of resident bird species caused by construction, operation and maintenance activities.
- Collision with the solar panels, which may be mistaken for water bodies.
- Collision and electrocution caused when perching on or flying into associated power line infrastructure.
- Habitat destruction and disturbance/exclusion of avifauna through construction (short-term) and maintenance (long-term) of new power line infrastructure.
- Habitat destruction and disturbance of birds caused by the construction and maintenance of new roads and other infrastructure.

The habitat within the broader study and development area represents typical vegetation of the surrounding environment, with no features of concern present across most of the habitat. While the development may have an insignificant impact on most of the species with wide-ranging populations, it will nevertheless result in habitat loss for the local bird assemblages primarily through direct habitat loss and displacement. Species are expected to be impacted to varying degrees based on their life-history strategies, abundance and general susceptibility to the threats posed by PV facilities. While habitat loss can be quantified by extent of the development footprint, there are other impacts such as direct mortalities caused by collisions with solar panels, which are still poorly understood.

Data on estimates of birds killed at solar facilities as a direct result of collisions with associated infrastructure are limited, especially in South Africa. A study at a large PV solar facility in the Northern Cape (Visser, 2016) provides the first estimates of the potential impact on birds within the region, with direct mortalities amounting to 4.5 birds/MW/year. This short term study also concluded, however, that there was no significant association with collision-related mortality at that study site, and that further studies were required. Most injuries that were recorded were related to species such as francolin colliding with the underside of PV panels when startled, and korhaans becoming entrapped along the

perimeter fencing, between the mesh and electrical strands (Visser, 2016). A PV solar facility in the United States is reported to result in the deaths of 0.5 birds/MW/year as a direct result of the collisions with infrastructure (Walston *et al*., 2016).

4.1 Identification of Potential Impacts and Damaging Activities

In this section each of the potential impacts on avifauna associated with the development are explored in more detail with reference to the features and characteristics of the broader study and development area and the likelihood that each impact would occur given the characteristics of the site and the extent and nature of the development. While renewable energy sources, such as solar energy, are important to the future development of power generation and hold great potential to alleviate the dependence on fossil fuels, they are not without environmental risks and negative impacts. Poorly sited or designed SEFs can have negative impacts on not only vulnerable species and habitats, but also on entire ecosystem functionalities. These impacts are extremely variable, differing from site to site, and are dependent on numerous contributing factors which include the design and specifications of the development, the importance and sensitivity of avian microhabitats present on site and the diversity and abundance of the local avifauna.

Potential avifaunal impacts resulting from the development of Ilanga PV 2 would stem from a variety of different activities and risk factors associated with the pre-construction, construction and operational phases of the project including the following:

Pre-construction Phase:

- Human presence and uncontrolled access to the site may result in negative impacts on the avifauna through poaching and uncontrolled collection of fauna and flora for traditional medicine or other purpose.
- Site clearing and exploration activities for site establishment may have a negative impact on avifaunal biodiversity if this is not conducted in a sensitive manner.

Construction Phase:

- Vegetation clearing for the solar field, access roads, site fencing and associated infrastructure will impact the local avifauna directly through habitat loss. Vegetation clearing will therefore lead potentially to the loss of avifaunal species, habitats and ecosystems as birds are displaced from their habitat.
- Presence and operation of construction machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.
- Increased human presence can lead to poaching, illegal fauna collecting and other forms of disturbance such as fire.

Operational Phase:

- The operation of the facility will generate noise and disturbance which may deter some avifauna from the area, especially red-listed avifaunal species which are less tolerant of disturbances. Such indirect impacts are still largely understudied and poorly understood, but preliminary data suggest that bird communities can be altered by solar PV facilities (DeVault *et al*., 2014; Smith & Dwyer, 2016).
- Mortality among the local avifauna may result due to direct collisions with solar panels (Kagan *et al*., 2014) or entrapment along the fenced boundaries of the facility (Visser, 2016).
- The areas inside the facility will require management and if this is not done appropriately, it could impact adjacent intact areas through impacts such as erosion, alien plant invasion and contamination from pollutants, herbicides or pesticides.

Cumulative Impacts:

- The loss of unprotected vegetation types on a cumulative basis from the surrounding environment may impact avifauna, as habitat loss is a major contributor to declines in avifauna (BirdLife International, 2018). The aggregation of numerous SEFs in a region has the potential to compound environmental impacts, and because this impact has been mostly understudied, it should be considered during the early stages of land use planning (Moore-O'Leary *et al*., 2017).
- Transformation of intact habitat would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for fauna and flora and impair their ability to respond to environmental fluctuations. This is particularly a concern with regards to species and ecosystems with limited geographical distributions (Rudman *et al.*, 2017).

Project specific impacts on particular groups of avifauna are as follows:

Habitat loss and disturbance of small passerines

For the smaller passerine species the most important impacts will involve displacement from the area encompassed by the development footprint as a result of habitat destruction. The loss of habitat will be permanent while disturbance may be continuous during the operational phase of the solar facility. While numerous species will be impacted, all of these species have large distribution ranges and will therefore only experience population decline within the footprint and immediate surroundings, and not regionally or nationally. Some of the most abundant species that will be impacted, and which are also common in neighbouring habitats, include (reporting rates in parentheses) Black-chested Prinia (100%), Sociable Weaver (92%), Acacia Pied Barbet (83%), Bokmakierie (83%), Yellow Canary (83%), Cape Sparrow *Passer melanurus* (83%), Southern Masked Weaver *Ploceus velatus* (83%), Lark-like Bunting *Emberiza impetuani* (75%), Sabota Lark *Calendulauda*

sabota (75%), Dusky Sunbird (75%), Spike-heeled Lark *Chersomanes albofasciata* (67%), Southern Fiscal *Lanius collaris* (67%), and Rufous-eared Warbler *Malcorus pectoralis* (67%). Other impacts such as disturbances caused by reflective panels and grid connection power lines are not likely to have any appreciable impact on the populations of most of these small species. The impacts in general can be expected to be minimal as these smaller species are far less susceptible to the associated impacts than larger species.

Habitat loss, disturbance and collision risk of medium terrestrial birds and raptors

Small to medium-sized non-passerines that may be impacted to some extent due to habitat loss and displacement include resident raptors such as Pale Chanting Goshawk, and the terrestrial Namaqua Sandgrouse *Pterocles namaqua*, Northern Black Korhaan and Double-banded Courser, and the potentially the Near-Threatened Karoo Korhaan. These species may also be susceptible to collisions with associated infrastructure such as the PV panels, but this is not expected to have a major impact on most of these species. Northern Black Korhaan and Karoo Korhaan, may, however, be at more risk based on the recent research depending on the type of perimeter fencing used (Visser, 2016).

Habitat loss, disturbance and collision risk of large terrestrial birds and raptors

The group of primary concern is the medium to large non-passerines, which include the large terrestrial birds and diurnal raptors. Many of these are also red-listed, such as the White-backed Vulture, Lappet-faced Vulture, Ludwig's Bustard, Martial Eagle, Verreaux's Eagle, Secretarybird and the Lanner Falcon, as well as the Near Threatened Kori Bustard. These species are expected to lose a portion of their large foraging ranges, while disturbances during construction and maintenance of the facility is also expected to have some negative impact, but primarily on the Karoo Korhaan, Kori Bustard and possibly the Secretarybird.

5 ASSESSMENT OF IMPACTS

The various identified avifaunal impacts are assessed below for the different phases of the proposed development. It is important to note that this is contingent on the layout as provided and any changes to the layout or project description would potentially invalidate the assessment.

5.1 Ilanga PV 2 Development

The following is an assessment of Ilanga PV 2, for the planning, construction and operational phase of the development. The construction phase will result in the direct loss of habitat due to clearing of vegetation and avifaunal microhabitats for the solar fields, road infrastructure, perimeter fencing, auxiliary buildings and associated infrastructure.

Disturbances will be caused by increased traffic of vehicles, and particularly heavy machinery used for clearing vegetation and road construction. During the operational phase, the impacts that can be expected include direct bird mortalities through collisions with PV panels and entrapment along perimeter fencing (double-fence designs), and disturbances in the form of vehicular and personnel traffic during maintenance of solar facilities and other infrastructure. Night lighting may also disturb nocturnal birds, those attracted to the facility to prey on insects drawn to lights, and those flying over the facility at night.

5.1.1 Planning & Construction Phase Impacts

Impact Nature: Direct avifaunal impacts during construction – habitat loss and disturbance due to vegetation clearing		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Low to Moderate (5)
Probability	Definite (5)	Definite (5)
Significance	Medium (45)	Medium (40)
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Low	Low
Can impacts be mitigated?	This impact cannot be well mitigated because the loss of habitat is unavoidable and is a definite outcome of the development.	

Mitigation

- Preconstruction walk-through of the development footprint to locate and identify any bird nests within the site that need to be avoided if active or removed prior to construction.
- The use of laydown areas within the footprint of the development should be used where feasible, to avoid habitat loss and disturbance to adjoining areas.
- The major drainage lines and pans within the plains habitat should be avoided were feasible, as these contribute to habitat diversity and connectivity.
- All building waste produced during the construction phase should be removed from the development area and be disposed of at a designated waste management facility. Similarly, all liquid wastes should be contained in appropriately sealed vessels/ponds within the development area and be disposed of at a designated waste management facility after use. Any liquid and chemical spills should be dealt with accordingly to avoid contamination of the environment.
- Pre-construction environmental induction for all construction staff on site to ensure that basic environmental principles are adhered to, and awareness about not harming or hunting terrestrial species (e.g. bustards, korhaans, thick-knees and coursers), and owls, which are often persecuted out of superstition.
- This induction should also include awareness as to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimizing wildlife interactions, remaining within demarcated construction areas etc.
- All construction vehicles should adhere to clearly defined and demarcated roads. No off-road driving to be allowed

outside of the construction area. • All construction vehicles should adhere to a low speed limit (40km/h on site) to avoid collisions with susceptible species such nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest along roads. • Any avifauna threatened by the construction activities should be removed to safety by Environmental Officer (EO) or any suitably qualified person. • If holes or trenches need to be dug, these should not be left open for extended periods of time as terrestrial avifauna or their flightless young may fall in and become trapped in them. Holes should only be dug when they are required and should be used and filled shortly thereafter. • No construction activity should occur near to active raptor or Secretarybird nests should these be discovered prior to or during the construction phase. If there are active nests near construction areas, these should be reported to Environmental Control Officer (ECO) and should be monitored until the birds have finished nesting and the fledglings left the nest. • The perimeter fence around the facility should be designed with potential impacts on terrestrial avifauna in mind. Double-fence designs where the inner electric fence is positioned within one (1) metre of the outer mesh fence may result in medium-sized non-passerine species colliding with either fence when trapped between these (Visser, 2016). Single-fence designs, whereby the electrical fencing component is attached to the inside of the mesh fence, are considered preferable as terrestrial birds cannot be trapped between these components.	
Cumulative Impacts	The development will contribute to cumulative impacts on avifaunal habitat loss and transformation in the area.
Residual Risks	As the loss of currently intact habitat is an unavoidable consequence of the development, the habitat loss associated with the development remains a moderate residual impact even after mitigation and avoidance of more sensitive areas.

5.1.2 Operational Phase Impacts

Impact Nature: Avifaunal Impacts due to operational activities – collisions with PV panels, potential entrapment along perimeter fencing, and disturbance due to traffic and night lighting		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low to Moderate (5)	Low (4)
Probability	Highly Probable (4)	Probable (3)
Significance	Medium (40)	Low (27)
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Low	Low
Can impacts be mitigated?	Yes, to a large degree, but it may be more difficult to prevent collisions and impacts related to the perimeter fence where double-fencing is used as opposed to bird-friendly single-fencing.	

Mitigation • All incidents of collision with panels should be recorded as meticulously as possible, including data related to the species involved, the exact location of collisions within the facility, and suspected cause of death. Post-construction monitoring with the aid of video surveillance should be considered, particularly if there are high collision rates, as this will contribute towards understanding bird interactions with solar panels. • If the site must be lit at night for security purposes, this should be done with downward-directed low-UV type lights (such as most Light-emitting diodes (LEDs)), which do not attract insects. The use of lighting at night should be kept to a minimum, so as not to unnecessarily attract invertebrates to the solar facility and possibly their avian predators, and to minimise disturbance to birds flying over the facility at night. • If birds nest on the infrastructure of the facility and cannot be tolerated due to operational risks of fire, electrical shorts, soiling of panels or other concerns, birds should be prevented from accessing nesting sites by using mesh or other manner of excluding them. Birds should not be shot, poisoned or harmed as this is not an effective control method and has negative ecological consequences. Birds with eggs or nestlings should be allowed to fledge their young where possible or be removed to a suitable area outside of the facility area. • If there are any persistent problems with avifauna, then an avifaunal specialist should be consulted for advice on further mitigation. • Any movements by vehicle and personnel should be limited to within the footprint of the solar facility and other associated infrastructure, especially during routine maintenance procedures. • All vehicles accessing the site should adhere to a low speed limit (40km/h max) to avoid collisions with susceptible species such as nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest on roads at night. • Maintenance of the perimeter fencing must ensure that it minimises impacts on terrestrial species susceptible to entrapment between the fencing components, where double-fence designs are used (though not recommended). If double-fence designs must be used instead of preferred single-fence designs, the space between the outer mesh fence and inner electrical fence should be kept clear of vegetation which may attract terrestrial species to forage there, while also ensuring that there are no gaps/holes in these fences that will allow terrestrial birds to enter the space between the two fences.	
Cumulative Impacts	The development will contribute to cumulative impacts on avifaunal habitat loss and transformation in the area, as well as minor disturbances (traffic and night lighting).
Residual Risks	Although high rates of mortality due to collisions have not been recorded in South Africa, there is some risk that this may occur, in addition to some potential mortality associated with entrapment of terrestrial birds along perimeter fencing (double-fence designs only).

5.1.3 Decommissioning Phase Impacts

The decommissioning phase will result in disturbance and loss of avifaunal microhabitats due to removal and clearing of the solar facility and associated infrastructure. Disturbances will be caused by increased traffic of vehicles, and particularly heavy machinery used for uninstalling and removing the infrastructure.

Impact Nature: Avifaunal impacts due to decommissioning activities – habitat loss due to clearing of solar facility, and disturbance due to traffic and presence of personnel.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)

Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (4)	Low to Moderate (3)
Probability	Definite (5)	Definite (5)
Significance	Medium (35)	Medium (30)
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Low	Low
Can impacts be mitigated?	The disturbance impact can be mitigated to an extent as it will be transient and have no long-term impact.	

Mitigation

- All infrastructure should be removed from the development area and disposed of in the appropriate manner.
- All waste produced during decommissioning must be disposed of at a designated waste management facility.
- Environmental induction for all personnel on site to ensure that basic environmental principles are adhered to, and awareness about not harming or hunting terrestrial species (e.g. bustards, korhaans, thick-knees and coursers), and owls, which are often persecuted out of superstition.
- This induction should also include awareness as to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimising wildlife interactions, and remaining within demarcated decommissioning areas.
- All construction vehicles should adhere to clearly defined and demarcated roads. No off-road driving to be allowed in undisturbed natural areas outside of the decommissioning area.
- All construction vehicles should adhere to a low speed limit (40km/h on site) to avoid collisions with susceptible species such as nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest along roads.
- Any avifauna threatened by the activities should be removed to safety by the EO or any suitably qualified person.
- If holes or trenches need to be dug, these should not be left open for extended periods of time as terrestrial avifauna or their flightless young may become entrapped in them. Holes should only be dug when they are required and should be used and filled shortly thereafter.
- No activity should occur near to active raptor/Secretarybird nests should these be discovered prior to or during the decommissioning phase. If there are active nests near the decommissioning areas, these should be reported to the ECO and should be monitored until the birds have finished nesting and the fledglings left the nest.

Cumulative Impacts	There are no cumulative impacts associated with the decommissioning of the proposed development.
Residual Risks	Disturbance during the decommissioning phase is an unavoidable consequence but will have low residual impact with implementation of the mitigations.

5.1.4 Cumulative Impacts

The following are the cumulative impacts that are assessed as being a likely consequence of the development of the Ilanga PV facility. These are assessed in context of the extent of the current site, other developments in the area as well as general habitat loss and transformation resulting from other activities in the area.

Impact Nature: Impact on avifaunal habitats, migration routes and nesting areas due to cumulative loss and fragmentation of habitat.

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low to Moderate (5)
Probability	Improbable (2)	Probable (3)
Significance	Low (18)	Medium (33)
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Low	Low
Can impacts be mitigated	Impacts can be mitigated to some degree, but the majority of the long-term impact results from the presence of the facility and other developments in the area which cannot be well mitigated.	

Mitigation:

- Minimise the development footprint as far as possible, as well as disturbance of the topsoil. A cover of indigenous grasses should be encouraged and maintained within the facility area. This prevents the invasion of weeds and is the easiest to manage in the long-term. Furthermore, the developer could consider the option of allowing livestock (sheep) grazing for maintaining a low height of the grass, which is being successfully used at existing PV facilities. This will assist in maintaining natural vegetative cover which may support avifaunal population, as opposed to complete clearing of all vegetation which is undesirable.
- Ensure that suitable ecological corridors within the surrounding area are identified and maintained, whereby ecological connectivity between areas of higher conservation value are preserved.
- The facility should be fenced off in a manner which allows small fauna to pass through the facility, but that does not result in terrestrial avifauna (e.g. bustards, korhaan, thick-knees, coursers) being trapped and electrocuted along the boundary fences (Venter, 2016). In practical terms, this means that the facility should be fenced-off to include only the developed areas and should include as little undeveloped ground or natural veld as possible. Single-fence designs (with the electrical fencing attached to the inside) as opposed to double-fence designs are preferred so as to avoid terrestrial birds becoming entrapped in the space between the two fences. In addition, there should be no electrified ground-strands present within 30cm of the ground, while the electrified strands should also be located on the inside of the fence and not the outside. Images of suitable fencing types from existing PV facilities are available on request.

6 CONCLUSION & RECOMMENDATIONS

The current study is based on a desktop study of the proposed development area. Consequently, the impact assessment and sensitivity map presented herein are based on expected occurrence, however information from the site was drawn on results from field assessments from adjacent sites which has somewhat similar habitat characteristics and thus provide a good idea of the likely habitat and site use by red listed species. Nonetheless a preconstruction walk-through would be required to ensure that the development would not affect possible active nests of priority species such as Secretarybirds that have been recorded close to the site. Due to the use of data from two seasons of monitoring from 2015 and 2016 a conservative approach has been adopted when assigning sensitivity score and in order to further ensure a conservative approach, the species lists derived for the development area from the literature were obtained from an area significantly larger than the study area and are likely to include a much wider array of species than actually occur within the development area and the site as a whole.

The broader study and development area consists primarily of Bushmanland Arid Grassland habitat with some components of Kalahari Karroid Shrubland in some areas and likely supports a fairly typical avifaunal assemblage expected for the area. Eleven (11) red data listed species are known to occur within the surrounding environment, of which at least four (4) terrestrial species (Ludwig's Bustard, Karoo Korhaan, Kori Bustard, and Secretarybird) are considered common while others appear to occur less frequently. Due to the presence of these species and likely utilization of the plains the developmental area is generally considered of medium sensitivity and areas where well-developed drainage lines and washes occur have been classified as high sensitivity. Some limited development in these high sensitivity areas is considered acceptable. Apart from the pans, the broader study area supports no known features of very high sensitivity, such as nesting or roosting sites of red-listed species, however verification would be required prior to construction. The extent of habitat loss along the below-ground grid connection would be low and would not significantly affect any high sensitivity habitats along the route. There is however also an overhead line alternative associated with the project and in terms of the three alternatives, either of the two underground cables are considered preferable to the overhead line. However, given the length of the overhead line (320m), it is also considered acceptable and would not generate significant impact with the appropriate mitigation.

The expected impacts of the proposed solar development area will include the following, 1) habitat loss and fragmentation, 2) disturbance and displacement caused during the construction and maintenance phases, and 3) possible direct mortality of avifauna colliding with solar panels, and 4) possible entrapment of terrestrial birds along perimeter fencing, and 5) a cumulative habitat loss at a broader scale from renewable energy developments within the surrounding environment. Habitat loss and disturbance during the construction

phase of the development will impact mostly small passerine species and medium-sized non-passerines, with consequences restricted to the local area only. Impacts related to collisions with PV panels and associated infrastructure (such as fencing) will impact mostly medium-sized non-passerines (e.g. Karoo Korhaan, Northern Black Korhaan and possibly sandgrouse). Red-listed species will be impacted by the loss of foraging habitat and disturbances. However, given the extensive national ranges of these species, the impact of the development on habitat loss for these species would be minimal and a long-term impact unlikely.

Several mitigation measures can be implemented during the construction and operational phase of the proposed development to reduce the impacts on the avifauna. During the construction phase, mitigation measures may assist in reducing habitat displacement and disturbance by restricting habitat loss and disturbance to within the development area. Identified sensitive habitats, such as major drainage lines and pans, should be excluded from the development footprint as much as possible where feasible. With the implementation of the mitigation measures, the impact of the development can be reduced to an acceptable level and there are no fatal flaws associated with the development that should prevent it from proceeding.

Cumulative impacts in the area are a concern due to the proliferation of solar energy developments in the Upington area. In terms of habitat loss, the affected habitat types are widespread in the area and have not experienced significant levels of transformation to date. As a result, the transformation and loss of approximately 330ha of this habitat is not considered highly significant for avifaunal habitat loss. In terms of potential losses to landscape connectivity, the development area is not considered to lie within an area that is considered a likely avifaunal movement corridor or along an important ecological gradient, and as such, the overall cumulative impact of the development is considered acceptable.

Avifaunal Impact Statement:

The proposed development area for the Ilanga PV 2 facility is considered to represent a broadly suitable environment for the location of a solar PV facility. Considering that the broader study area supports a typical bioregional avifaunal assemblage, there are no impacts associated with the development that are considered to be of high residual significance and which cannot be mitigated to an acceptable level. As there are no high residual impacts associated with the development it can be supported from an avifaunal perspective. It is, therefore, the reasoned opinion of the specialists that the Ilanga PV 2 development be authorised, subject to a verification site visit and the implementation of the recommended mitigation measures.

7 ACTIVITIES FOR INCLUSION IN DRAFT EMPR

An Environmental Management Programme (EMPr) provides a link between the predicted impacts and mitigation measures recommended within the BA Report and the implementation and operational activities of a project. As the construction and operation of the Ilanga PV facility may impact the environment, activities which pose a threat should be managed and mitigated so that unnecessary or preventable environmental impacts do not result. The primary objective of the EMPr is to detail actions required to address the impacts identified in the BA process during the establishment, operation and rehabilitation of the proposed infrastructure. The EMPr provides an elaboration on how to implement the mitigation measures documented in the BA process. As such the purpose of the EMPr can be outlined as follows:

- To outline mitigation measures and environmental specifications that are required to be implemented for the planning, establishment, rehabilitation and operation/maintenance phases of the project in order to minimise and manage the extent of environmental impacts.
- To ensure that the establishment and operation phases of the solar facility do not result in undue or reasonably avoidable adverse environmental impacts, and to also ensure that any potential environmental benefits are enhanced.
- To identify entities who will be responsible for the implementation of the measures and outline functions and responsibilities.
- To propose mechanisms for monitoring compliance, and preventing long-term or permanent environmental degradation.
- To facilitate appropriate and proactive response to unforeseen events or changes in project implementation that were not considered in the BA process.

Below are the ecologically orientated measures that should be implemented as part of the EMPr for the development to reduce the significance or extent of the above impacts. The measures below do not exactly match with the impacts that have been identified, as certain mitigation measures, such as limiting the loss of vegetation, may be effective at combating several other impacts.

7.1 Construction Phase Activities

Objective: Limit disturbance and loss of avifaunal microhabitats during construction			
Project component/s	All infrastructure and activities that result in disturbance and loss of intact vegetation: » Vegetation clearing for establishment of solar arrays » Vegetation clearing for construction camps and other temporary infrastructure. » Vegetation clearing for access roads. » Human presence. » Operation of heavy machinery.		
Potential Impact	Disturbance and loss of avifaunal microhabitats, leading to displacement and loss of resident avifaunal species.		
Activity/risk source	» Clearing for solar arrays and infrastructure construction » Clearing for laydown areas and construction camps. » Clearing for construction of access roads. » Presence of construction crews. » Operation of heavy vehicles.		
Mitigation: Target/Objective	» Low footprint and low impact on avifaunal habitats. » Low disturbance of avifauna during construction. » Low disturbance and impact on red-listed avifaunal species.		
Mitigation: Action/control		Responsibility	Timeframe
» Pre-construction environmental induction for all construction personnel regarding basic environmental principles.		ECO	Pre-construction
» The use of laydown areas within the footprint of the development should be used where feasible, to avoid habitat loss and disturbance to adjoining areas. » All construction vehicles should adhere to clearly defined and demarcated roads. » All construction vehicles should adhere to a low speed limit (40km/h on site) to avoid collisions with susceptible species such as nocturnal and crepuscular species, as well as reduce dust. » The fence around the facility should be designed to be bird friendly, to prevent entrapment and electrocutions of terrestrial birds. In practical terms, this means that the perimeter fence of the facility should only include the developed areas and as little undeveloped ground or natural veld as possible. All		Contractor	Construction

electrified strands should be located on the inside of the fence and not the outside, while there should be no electrified ground-strands present within a 30cm height from the ground. Furthermore, the fence should be a single-fence design and not a double-fence with a large space between (up to 1m or more), which can cause terrestrial birds to become entrapped between these. » If holes or trenches are to be dug, these should not be left open for extended periods of time as terrestrial avifauna may become entrapped therein. » No construction activity should occur near to active raptor/Secretarybird nests should these be discovered prior to or during the construction phase.		
» ECO to monitor and enforce ban on hunting and collecting of avifauna or their products (e.g. eggs). » Any avifauna threatened or injured by the construction activities should be removed to safety by the EO or appropriately qualified professional. » If there are active nests near construction areas, these should be reported to the ECO and should be monitored until the birds have finished nesting and the fledglings have left the nest.	ECO and EO	Construction
Performance Indicator	» Avifaunal microhabitat loss restricted to infrastructure footprint. » Low disturbance and impact on red-listed avifaunal species. » Low mortality of avifauna due to construction machinery and activities. » No disturbance of breeding raptors/ Secretarybird (i.e. no nest abandonment due to disturbance). » No poaching or collecting of avifauna or their products (e.g. eggs or nestlings) by construction personnel. » Removal to safety of entrapped/injured avifauna encountered during construction.	
Monitoring	ECO to monitor construction to ensure that: » Vegetation is cleared only within footprint areas during construction. » Perimeter fencing is constructed in a manner that is considered bird friendly, especially with respect to terrestrial birds. » No birds or eggs are disturbed or removed by construction personnel. » Any raptor nests (especially of red-listed species) discovered on site or nearby, are monitored weekly until the post-fledging period.	

7.2 Operation Phase Activities

OBJECTIVE: Limit direct and indirect impacts and disturbances of avifauna during operation			
Project component/s	All activities that result in disturbance of avifauna, including: » Avifaunal collisions with PV panels » Human presence » Vehicle traffic		
Potential Impact	» Mortality and disturbance of avifauna within and beyond the footprint of the facility due to collisions with solar panels, presence of personnel and vehicle traffic.		
Activity/risk source	» Avifaunal collisions with PV panels. » Presence of operational phase personnel. » Presence of personnel during solar field, road and fence maintenance activities. » Birds entrapped along perimeter fencing (double-fence designs).		
Mitigation: Target/Objective	Low disturbance and impact of avifauna and low collision rates of avifauna with PV panels and power line during operation.		
Mitigation: Action/control		Responsibility	Timeframe
» All incidents of collision with PV panels should be recorded as meticulously as possible, including data related to the species involved, the exact location of collisions within the facility, and suspected cause of death. » Post-construction monitoring with the aid of video surveillance should be considered, as this will contribute towards understanding bird interactions with solar panels, in accordance with suggestions made by Visser (2016).		ECO	Operation
» Maintenance of the perimeter fencing must ensure that it fulfils the guidelines (Visser, 2016) to minimise impacts on species susceptible to entrapment. » Any movements by vehicle and personnel should be limited to within the footprint of solar field and other associated infrastructure, especially during routine maintenance procedures. » All vehicles accessing the site should adhere to a low speed limit (40km/h max) to avoid collisions with susceptible species such nocturnal and crepuscular species. » If birds nesting on infrastructure cannot be tolerated due to operational risks, birds should be prevented from accessing nesting sites using exclusion methods.			

» An avifaunal specialist should be consulted for advice on further mitigation if problems persist. » All night-lighting should use low-UV type lights (such as most LEDs), which do not attract insects, and be directed downwards.	Contractors	Operation

Performance Indicator	» No disturbance of breeding raptors/ Secretarybird (i.e. no nest abandonment due to disturbance). » No disturbance of red-listed avifaunal species perched or foraging in the vicinity of the solar field. » No poaching or collecting of avifauna or their products (e.g. eggs or nestlings) by maintenance personnel. » Removal to safety of entrapped/injured avifauna encountered during routine maintenance. » Low impact on nocturnal and crepuscular species along roads. » Low impact on large raptors and terrestrial birds (e.g. bustards) along the power line corridor.
Monitoring	ECO to monitor operational phase to ensure that: » No birds or eggs are disturbed or removed by maintenance personnel. » Perimeter fencing is maintained in manner that ensures it is bird friendly, with respect to terrestrial species. » Any raptor nests (especially of red-listed species) discovered on site or nearby, are monitored weekly until the post-fledging period.

7.3 Decommissioning Phase Activities

Objective: Limit disturbance and loss of avifaunal microhabitats during decommissioning.	
Project component/s	All infrastructure and activities that result in transformation and loss of intact or rehabilitated avifauna microhabitats: » Removal and clearing of solar arrays and other infrastructure. » Removal and clearing of camps and other temporary infrastructure. » Removal of access roads.
Potential Impact	Disturbance and loss of avifaunal microhabitats, leading to displacement and loss of resident avifaunal species.
Activity/risk source	» Clearing and removal of solar arrays and other infrastructure. » Clearing and removal of camps and other temporary infrastructure. » Removal of access roads. » Presence of decommissioning crews. » Operation of heavy vehicles.
Mitigation: Target/Objective	» Low disturbance and low impact on avifauna and avifaunal habitats. » Low disturbance and impact on red-listed avifaunal species.

Mitigation: Action/control	Responsibility	Timeframe
» The use of laydown areas within the footprint of the development should be used where feasible, to avoid habitat loss and disturbance to adjoining areas » The removal and clearing of the solar arrays and other associated infrastructure (buildings, reservoirs, ponds, fencing etc) should be done in such a manner that does not cause destruction and pollution of rehabilitated habitats on site or adjoining natural areas. » All vehicles should adhere to clearly defined and demarcated roads. » All vehicles on site should adhere to a low speed limit (40km/h) to avoid collisions with susceptible species such nocturnal and crepuscular species, as well as reduce dust. » If holes or trenches are to be dug, these should not be left open for extended periods of time as terrestrial avifauna may become entrapped therein. » No decommissioning activity should occur near to active raptor nests, should these be discovered prior to or during the decommissioning phase.	Contractor	Decommissioning
» Environmental induction for all personnel regarding basic environmental principles. » ECO to monitor and enforce ban on hunting and collecting of avifauna or their products (e.g. eggs and nestlings). » Any avifauna threatened or injured by the construction activities should be removed to safety by the EO or appropriately qualified professional.	ECO and EO	Decommissioning
Performance Indicator	» Avifaunal microhabitat loss restricted to infrastructure footprint. » Low disturbance of avifauna within footprint and adjacent areas.	
Monitoring	ECO to monitor construction to ensure that: » Vegetation clearing is limited as far as possible within footprint and adjoining areas during decommissioning. » No birds or eggs are unnecessarily disturbed or removed by personnel. » Any raptor nests (especially of red-listed species) discovered on site or nearby, are monitored weekly to ensure zero disturbances.	

8 REFERENCES

BirdLife International. 2018. State of the world's birds: taking the pulse of the planet. BirdLife International, Cambridge.

BirdLife South Africa. 2018. Checklist of birds in South Africa. BirdLife South Africa, Johannesburg.

DeVault, T.L., Seamans, T.W., Schmidt, J.A., Belant, J.L., & Blackwell, B.F. 2014. Bird use of solar photovoltaic installations at US airports: Implications for aviation safety. Landscape and Urban Planning 122: 122–128.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1 & 2. BirdLife South Africa, Johannesburg.

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (eds). 2005. Roberts Birds of Southern Africa, 7th edition. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Jenkins, A.R., Ralston-Paton, S. & Smit-Robinson, H.A. 2017. Birds and solar energy. Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. Birdlife South Africa, Johannesburg.

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards Neotis ludwigii. Bird Conservation International 21: 303–310.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.

Kagan, R.A., Verner, T.C., Trail, P.W. & Espinoza, E.O. 2014. Avian mortality at solar energy facilities in southern California: a preliminary analysis. Unpublished report National Fish & Wildlife Forensics Laboratory, USA.

Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: A global review. Biological Conservation 136: 159-174.

Lovich, J.E. and J.R. Ennen. 2011. Wildlife conservation and solar energy development in the desert southwest, United States. BioScience 61: 982-992.

Marnewick, M.D., Retief, E.F., Theron, N.T., Wright, D.R. & Anderson, T.A. 2015. Important Bird and Biodiversity Areas of South Africa. Birdlife South Africa, Johannesburg.

Martin, G.R. & Shaw, J.M. 2010. Bird collisions with power lines: Failing to see the way ahead? Biological Conservation 143: 2695-2702.

Moore-O'Leary, K.A., Hernandez, R.R., Johnston, D.S., Abella, S.R., Tanner, K.E., Swanson, A.C., Kreitler, J., Lovich, J.E. 2017. Sustainability of utility-scale solar energy - critical ecological concepts. Frontiers in Ecology and the Environment 15: 385-394.

Mucina L. & Rutherford M.C. (eds) 2006. *The Vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Rudman, J., Gauché, P., Esler, K.J. 2017. Direct environmental impacts of solar power in two arid biomes: An initial investigation. South African Journal of Science 113(11/12), Art. #2017-0113, 13 pages. http://dx.doi.org/10.17159/sajs.2017/20170113

Shaw, J.M. 2013. Power line collisions in the Karoo: conserving Ludwig's Bustard. Unpublished PhD thesis, University of Cape Town, Cape Town.

Smith, J.A., & Dwyer, J.F. 2016. Avian interactions with renewable energy infrastructure: an update. Condor 118: 411-423.

Southern African Bird Atlas Project 2 (SABAP2). http://sabap2.adu.org.za Accessed July 2020.

Taylor, M.R., Peacock, F. & Wanless, R.W. (eds) 2015. The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

Taylor, P.B., Navarro, R.A., Wren-Sargent, M., Harrison, J.A. & Kieswetter, S.L. (eds) 1999. TOTAL CWAC Report: Coordinated Waterbird Counts in South Africa, 1992-1997. Avian Demography Unit, University of Cape Town, Cape Town.

Visser, E. 2016. The impact of South Africa's largest photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Unpublished MSc thesis, University of Cape Town, Cape Town.

Visser, E., Perold, V., Ralston-Paton, S., Cardenal, A.C., & Ryan, P.G. 2018. Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Renewable Energy 133: 1285-1294.

Walston, L.J, Rollins, K.E, LaGory, K.E., Smith, K.P. & Meyers, S.A. 2016. A preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States. Renewable Energy 92: 405-414.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.A. & Colahan, B.D. 2003. Big birds on farms: Mazda CAR report 1993-2001. Avian Demography Unit, Cape Town.

9 Annex 1. List of Avifauna

A consolidated avifaunal list for the broader Ilanga PV project site and surrounds, including records from SABAP1, SABAP2 and previous avifauna studies, and includes red-list status (Taylor *et al.*, 2015), regional endemism (BLSA, 2018), and SABAP2 reporting rates (based on 12 cards). Species with an asterix (*) are biome-restricted (Taylor *et al*., 2015).

Species name	Taxonomic name	Red-list Status	Regional Endemism	Reporting Rate (%)
Barbet, Acacia Pied	*Tricholaema leucomelas*			83
Barbet, Crested	*Trachyphonus vaillantii*			33
Batis, Pririt	*Batis pririt*			50
Bee-eater, European	*Merops apiaster*			8
Bee-eater, Swallow-tailed	*Merops hirundineus*			25
Bee-eater, White-fronted	*Merops bullockoides*			17
Bishop, Southern Red	*Euplectes orix*			42
Bittern, Little	*Ixobrychus minutus*			17
Bokmakierie	*Telophorus zeylonus*			83
Brubru	*Nilaus afer*			25
Bulbul, African Red-eyed	*Pycnonotus nigricans*			42
Bunting, Lark-like	*Emberiza impetuani*			75
Bustard, Kori	*Ardeotis kori*	Near-Threatened		8
Bustard, Ludwig's*	*Neotis ludwigii*	Endangered		17
Canary, Black-headed*	*Serinus alario*		Near-endemic	
Canary, Black-throated	*Crithagra atrogularis*			25
Canary, White-throated	*Crithagra albogularis*			17
Canary, Yellow	*Crithagra flaviventris*			83
Chat, Ant-eating	*Myrmecocichla formicivora*			33
Chat, Familiar	*Cercomela familiaris*			42
Chat, Karoo*	*Cercomela schlegelii*			8
Chat, Tractrac*	*Cercomela tractrac*			0.0
Cisticola, Desert	*Cisticola aridulus*			
Cisticola, Levaillant's	*Cisticola tinniens*			33
Cisticola, Zitting	*Cisticola juncidis*			42
Cormorant, Reed	*Phalacrocorax africanus*			33
Cormorant, White-breasted	*Phalacrocorax carbo*			8
Coucal, Burchell's	*Centropus burchellii*			17
Courser, Double-banded	*Rhinoptilus africanus*			
Crake, Black	*Amaurornis flavirostris*			8

Crombec, Long-billed	*Sylvietta rufescens*			8
Crow, Pied	*Corvus albus*			42
Cuckoo, Diderick	*Chrysococcyx caprius*			25
Cuckoo, Jacobin	*Clamator jacobinus*			17
Darter, African	*Anhinga rufa*			33
Dove, Ringed-necked	*Streptopelia capicola*			75
Dove, Laughing	*Streptopelia senegalensis*			83
Dove, Namaqua	*Oena capensis*			67
Dove, Red-eyed	*Streptopelia semitorquata*			42
Dove, Rock	*Columba livia*			8
Duck, African Black	*Anas sparsa*			8
Duck, Yellow-billed	*Anas undulata*			25
Eagle, African Fish	*Haliaeetus vocifer*			33
Eagle, Booted	*Aquila pennatus*			
Eagle, Martial	*Polemaetus bellicosus*	Endangered		
Eagle, Verreaux's	*Aquila verreauxii*	Vulnerable		
Eagle, Black-chested Snake	*Circaetus pectoralis*			
Egret, Western Cattle	*Bubulcus ibis*			33
Egret, Little	*Egretta garzetta*			17
Eremomela, Yellow-bellied	*Eremomela icteropygialis*			50
Falcon, Lanner	*Falco biarmicus*	Vulnerable		
Falcon, Peregrine	*Falco peregrinus*			8
Falcon, Pygmy	*Polihierax semitorquatus*			
Finch, Red-headed	*Amadina erythrocephala*			17
Finch, Scaly-feathered	*Sporopipes squamifrons*			58
Firefinch, Red-billed	*Lagonosticta senegala*			8
Fiscal, Southern	*Lanius collaris*			67
Flycatcher, Chat	*Bradornis infuscatus*			33
Flycatcher, Fairy	*Stenostira scita*		Near-endemic	
Flycatcher, Fiscal	*Sigelus silens*		Near-endemic	17
Goose, Egyptian	*Alopochen aegyptiacus*			50
Goshawk, Pale Chanting	*Melierax canorus*			17
Grebe, Little	*Tachybaptus ruficollis*			8
Guineafowl, Helmeted	*Numida meleagris*			33
Hamerkop	*Scopus umbretta*			25
Harrier, Black	*Circus maurus*	Endangered	Near-endemic	
Heron, Black-headed	*Ardea melanocephala*			33
Heron, Goliath	*Ardea goliath*			25

Heron, Grey	*Ardea cinerea*			17
Honeyguide, Lesser	*Indicator minor*			
Hoopoe, African	*Upupa africana*			17
Ibis, African Sacred	*Threskiornis aethiopicus*			33
Ibis, Hadeda	*Bostrychia hagedash*			42
Kestrel, Rock	*Falco rupicolus*			8
Kingfisher, Brown hooded	*Halcyon albiventris*			17
Kingfisher, Giant	*Megaceryle maximus*			17
Kingfisher, Malachite	*Alcedo cristata*			8
Kingfisher, Pied	*Ceryle rudis*			8
Kite, Black-shouldered	*Elanus caeruleus*			17
Korhaan, Karoo*	*Eupodotis vigorsii*	Near-Threatened		83
Korhaan, Northern Black	*Afrotis afraoides*			50
Lapwing, Blacksmith	*Vanellus armatus*			33
Lapwing, Crowned	*Vanellus coronatus*			8
Lark, Black-eared Sparrow-*	*Eremopterix australis*		Near-endemic	
Lark, Grey-backed Sparrow-	*Eremopterix verticalis*			
Lark, Eastern Clapper	*Mirafra fasciolata*			
Lark, Fawn-coloured	*Calendulauda africanoides*			33
Lark, Karoo Long-billed*	*Certhilauda subcoronata*			58
Lark, Sabota	*Calendulauda sabota*			75
Lark, Spike-heeled	*Chersomanes albofasciata*			67
Lark, Stark's*	*Spizocorys starki*			17
Martin, Brown-throated	*Riparia paludicola*			42
Martin, Rock	*Hirundo fuligula*			50
Moorhen, Common	*Gallinula chloropus*			25
Mousebird, Red-faced	*Urocolius indicus*			33
Mousebird, White-backed	*Colius colius*			50
Nightjar, Rufous cheeked	*Caprimulgus rufigena*			17
Ostrich, Common	*Struthio camelus*			
Owl, Spotted Eagle-	*Bubo africanus*			
Owl, Western Barn	*Tyto alba*			8
Owlet, Pearl-spotted	*Glaucidium perlatum*			17
Palm-swift, African	*Cypsiurus parvus*			25
Penduline-tit, Cape	*Anthoscopus minutus*			17
Pigeon, Speckled	*Columba guinea*			50
Pipit, African	*Anthus cinnamomeus*			25
Plover, Three-banded	*Charadrius tricollaris*			33
Prinia, Black-chested	*Prinia flavicans*			100

Quail, Common	*Coturnix coturnix*			
Quelea, Red-billed	*Quelea quelea*			25
Reed-warbler, African	*Acrocephalus baeticatus*			17
Robin, Kalahari Shrub*	*Cercotrichas paena*			17
Robin, Karoo Scrub	*Cercotrichas coryphoeus*			50
Robin-chat, Cape	*Cossypha caffra*			42
Rock-thrush, Short-toed	*Monticola brevipes*			8
Ruff	*Philomachus pugnax*			8
Sandgrouse, Namaqua	*Pterocles namaqua*			75
Sandpiper, Wood	*Tringa glareola*			17
Scimitarbill, Common	*Rhinopomastus cyanomelas*			25
Secretarybird	*Sagittarius serpentarius*	Vulnerable		
Shelduck, South African	*Tadorna cana*			8
Shrike, Lesser Grey	*Lanius minor*			
Shrike, Red-backed	*Lanius collurio*			8
Sparrow, Cape	*Passer melanurus*			83
Sparrow, House	*Passer domesticus*			17
Sparrow, Southern Grey-headed	*Passer diffusus*			33
Sparrow-weaver, White-browed	*Plocepasser mahali*			33
Sparrow-lark, Grey-backed	*Eremopterix verticalis*			8
Sparrow-lark, Black-eared	*Eremopterix australis*			
Starling, Cape Glossy	*Lamprotornis nitens*			42
Starling, Wattled	*Creatophora cinerea*			17
Stork, Black	*Ciconia nigra*	Vulnerable		
Sunbird, Dusky	*Cinnyris fuscus*			75
Swallow, Barn	*Hirundo rustica*			17
Swallow, Greater Striped	*Cecropis cucullata*			17
Swallow, White-throated	*Hirundo albigularis*			33
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*			33
Swift, African Black	*Apus barbatus*			8
Swift, Common	*Apus apus*			8
Swift, Little	*Apus affinis*			33
Swift, White-rumped	*Apus caffer*			8
Teal, Red-billed	*Anas erythrorhyncha*			33
Thick-knee, Spotted	*Burhinus capensis*			25
Thrush, Karoo	*Turdus smithi*		Near-endemic	33
Thrush, Olive	*Turdus olivaceus*			
Tit-Babbler, Chestnut-vented	*Sylvia subcaerulea*			42
Tit-Babbler, Layard's	*Sylvia layardi*			

Tit, Ashy	*Parus cinerascens*		25
Vulture, Lappet-faced	*Torgos tracheliotos*	Endangered	
Vulture, White-backed	*Gyps africanus*	Critically Endangered	
Wagtail, Cape	*Motacilla capensis*		25
Warbler, Namaqua	*Phragmacia substriata*		33
Warbler, Rufous-eared	*Malcorus pectoralis*		67
Waxbill, Black-faced	*Estrilda erythronotos*		
Waxbill, Common	*Estrilda astrild*		25
Weaver, Sociable*	*Philetairus socius*		92
Weaver, Southern Masked	*Ploceus velatus*		83
Wheatear, Capped	*Oenanthe pileata*		17
Wheatear, Mountain	*Oenanthe monticola*		
White-eye, Orange River	*Zosterops pallidus*		42
Whydah, Pin-tailed	*Vidua macroura*		17
Woodpecker, Cardinal	*Dendropicos fuscescens*		8
Woodpecker, Golden-tailed	*Campethera abingoni*		25