ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED DEVELOPMENT OF NALEDI PV SOLAR FACILITY AND ASSOCIATED INFRASTRUCTURE ON A SITE NEAR UPINGTON, IN THE NORTHERN CAPE PROVINCE:

AVIFAUNAL SPECIALIST IMPACT ASSESSMENT REPORT

Grey-backed Sparrowlark *Eremopterix verticalis*

PRODUCED FOR SAVANNAH ENVIRONMENTAL

BY

3Foxes Biodiversity Solutions

Simon.Todd@3foxes.co.za

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EXECUTIVE SUMMARY

Naledi PV (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. The broader study area borders the Dawid Kruiper Local Municipality to the east. Savannah Environmental (Pty) Ltd has been appointed to undertake the required application for environmental authorisation process for the above development. The proposed development is currently undergoing a Basic Assessment (BA) Process and the proponent, Naledi PV (Pty) Ltd has appointed 3Foxes Biodiversity Solutions to provide a specialist avifaunal impact assessment of the broader study and development area as part of the BA Process.

A full onsite field assessment as well as 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. An approximate total of 150 bird species have been recorded within the broader study area and surrounds, of which 68 species were observed on site during a five-day field survey in October 2018 and four-day survey in April 2019. Seven are listed as near-endemic and a further twelve species as 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 10 km to the south-east).

Twelve (12) species that have previously been recorded in the Upington area are red-listed, of which eight (8) species are listed as Threatened, and another four (4) considered Near-Threatened. Two (2) Near-Threatened species were recorded during the site visits, namely Karoo Korhaan *Eupodotis vigorsii* (several sightings) and Kori Bustard *Ardeotis kori* (three sightings) of the eight threatened species known from the area, the most important include White-backed Vulture *Gyps africanus* (Critically Endangered), Ludwig's Bustard *Neotis ludwigii* (Endangered), Lappet-faced Vulture (*Torgos tracheliotos*), Martial Eagle *Polemaetus bellicosus* (Endangered), Lanner Falcon *Falco biarmicus* and Secretarybird *Sagittarius serpentarius* (Vulnerable). The Near-Threatened Kori Bustard would potentially be impacted the most due to habitat loss and displacement. Black Stork *Ciconia nigra* (Vulnerable) and Abdim's Stork *Ciconia abdimii* (Near-Threatened) are unlikely to occur due to the absence of suitable habitat, but may occur along the nearby Orange River where more suitable habitat exists. No sensitive breeding or roosting sites of any red-listed species were observed within the broader study area during the field survey, though it is possible that there is a Secretarybird nest in the vicinity of the broader study area.

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 would normally be expected to be of medium high importance, but due absence of communal roosting and breeding sites of red-listed species and relatively low frequency of occurrence of priority species, the impacts are likely to be medium low 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 Kalahari 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.

Impact statement

The proposed development area for Naledi PV is considered to represent a broadly suitable environment for the location of the proposed solar development. Considering that the broader study area supports a typical bioregional avifaunal assemblage within an extensive vegetation type, and that there are no known communal breeding or roosting sites of red-listed priority species within close proximity, there are no impacts associated with the development that are considered to be of high residual significance and which cannot be mitigated to a low level. Consequently, the development can be supported from an avifaunal perspective. It is, therefore, the reasoned opinion of the specialist that Naledi PV be authorised, subject to the implementation of the recommended mitigation measures.

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;	7-9
a) a declaration that the specialist is independent in a form as may be specified by the competent authority;	10-11
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;	Section 2.2
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 2.4
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;	See Main Report
a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	See Main Report
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 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

Eric Herrmann

Eric Herrmann is an avifaunal specialist with over 15 years of experience in biodiversity research and conservation in the Northern Cape. He completed a B.Tech Degree in Nature Conservation (1999) at the Cape Technikon, followed by a Masters in Conservation Ecology at the University of Stellenbosch (2004). He has worked as a research assistant for the Endangered Wildlife Trust (1999-2001) in the Kgalagadi Transfrontier Park, and then for the Percy FitzPatrick Institute of African Ornithology (University of Cape Town) as project manager of a field research centre near Kimberley (2003 to 2006). In 2006 he joined the provincial Department of Environment and Nature Conservation (DENC) in Kimberley as a faunal scientist until 2012. Since 2016 he has been working independently as an avifaunal specialist largely on wind and solar energy projects in the Western and Northern Cape.

Tertiary Education:

- 1994 - 1997 – National Diploma: Nature Conservation (cum laude), Cape Technikon
- 1998 - 1999 – B.Tech Degree: Nature Conservation (cum laude), Cape Technikon
- 2000 - 2004 – MFor: Conservation Ecology (cum Laude), University of Stellenbosch
- *Employment History*
- 2016 - Present – Independent contractor, avifaunal specialist for renewable energy projects.
- 2006 - 2012 – Senior Conservation Scientist, Department of Environment and Nature Conservation, Kimberley.
- 2003 - 2006 – Research Assistant and Field Projects Manager, Percy Fitzpatrick Institute of African Ornithology, Cape Town
- 2001 - 2002 – Field Researcher, Deciduous Fruit Producers Trust, Stellenbosch.
- 1999 - 2001 – Research Assistant, Endangered Wildlife Trust, Johannesburg.

Recent Specialist Ecological Studies in the vicinity of the current site

- Allepad Solar PV Facility, Upington. Avifaunal Specialist Report. Savannah Environmental. 2018/19.
- Aggeneys Solar PV Facility, Aggeneys. Avifaunal Specialist Report. Savannah Environmental. 2018/19.
- Gaetsewe Solar PV Facility, Kathu. Avifaunal Specialist Report. Cape EAPrac 2018.
- Mogara Solar PV Facility, Kathu. Avifaunal Specialist Report. Cape EAPrac 2018.
- Kathu Hyperion Solar PV Facility, Kathu. Avifaunal Specialist Report. Cape EAPrac 2018.

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: ____20 April 2020______________________________

SPECIALIST DECLARATION 2

I, ..Eric Herrmann.............................., 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: ____Eric Herrmann______________________

Date: ____20 April 2020____________________________

1 INTRODUCTION

Naledi PV (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure within a study 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 ~300ha has been identified by Naledi PV (Pty) Ltd as a technically suitable development area for the development of a solar PV facility with a contracted capacity of up to 100MW. 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 broader study area and development area within a REDZ, a Basic Assessment (BA) process is required for authorisation. Savannah Environmental is conducting the required BA process for the Naledi PV development and has appointed 3Foxes Biodiversity Solutions to provide a specialist avifaunal impact assessment study of the proposed development as part of the BA process.

The purpose of the Naledi PV Avifaunal Specialist Report is to 1) describe the avian ecological features of the proposed PV broader study and development area, 2) to provide a preliminary assessment of the avian ecological sensitivity of the broader study and development area, and 3) identify and assess the significance of the likely impacts on the avifauna associated with the development of the site as a solar PV facility, and 4) to provide measures to avoid, minimize and mitigate project related impacts to the avifauna. A site visit in spring (4 to 8 Oct 2018) and another in late summer (9 to 12 Apr 2019), as well as a desktop review of the available literature for the area was conducted in order to identify and characterise the local avifauna at the site.

This information is used to derive an avifaunal sensitivity map that presents the ecological constraints and opportunities for development within the broader study area. The information and sensitivity map presented here provides an avifaunal baseline that should be used in the planning phase of the development to ensure that the potential negative avifaunal impacts associated with the development can be minimised. 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.

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

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
- 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;
- 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 broader study area assessed for this study focused on Portion 12 of the Farm Klip Punt 452 and Portion 3 of McTaggarts Camp 453 located approximately 15km south-west of Upington (Figure 1); Naledi PV is proposed on Portion 12 of the Farm Klip Punt 452. A development area (located within the broader study area) with an extent of ~276ha has been identified by Naledi PV (Pty) Ltd as a technically suitable site for the development of a solar PV facility with a contracted capacity of up to 75MW. The entire broader study area and the development area are 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 broader study and development area within a REDZ, a BA process will be undertaken in accordance with GN R114 as formally gazetted on 16 February 2018.

Naledi PV is proposed to accommodate the following infrastructure, which will enable the solar PV facility to supply a contracted capacity of up to 75MW:

- Fixed-tilt or tracking solar PV panels with a maximum height of 3.5m;
- Centralised inverter stations or string inverters;
- A temporary laydown area;
- Cabling between the panels, to be laid underground where practical;
- A 22kV or 33kV/132kV on-site substation of up to 1ha in extent to facilitate the

connection between the solar PV facility and the electricity grid;
- An access road to the development area with a maximum width of 6m;
- Internal access roads within the PV panel array area with a maximum width of 5m;
- Operation and Maintenance buildings including a gate house and security building, control centre, offices, warehouses, a workshop and visitors centre.

The power generated from the project will be sold to Eskom and will feed into the national electricity grid. Ultimately, the project is intended to be a part of the renewable energy projects portfolio for South Africa, as contemplated in the Integrated Resource Plan (IRP).

A separate basic assessment process will be undertaken for the grid connection infrastructure to connect Naledi PV to the Upington Main Transmission Substation (MTS).

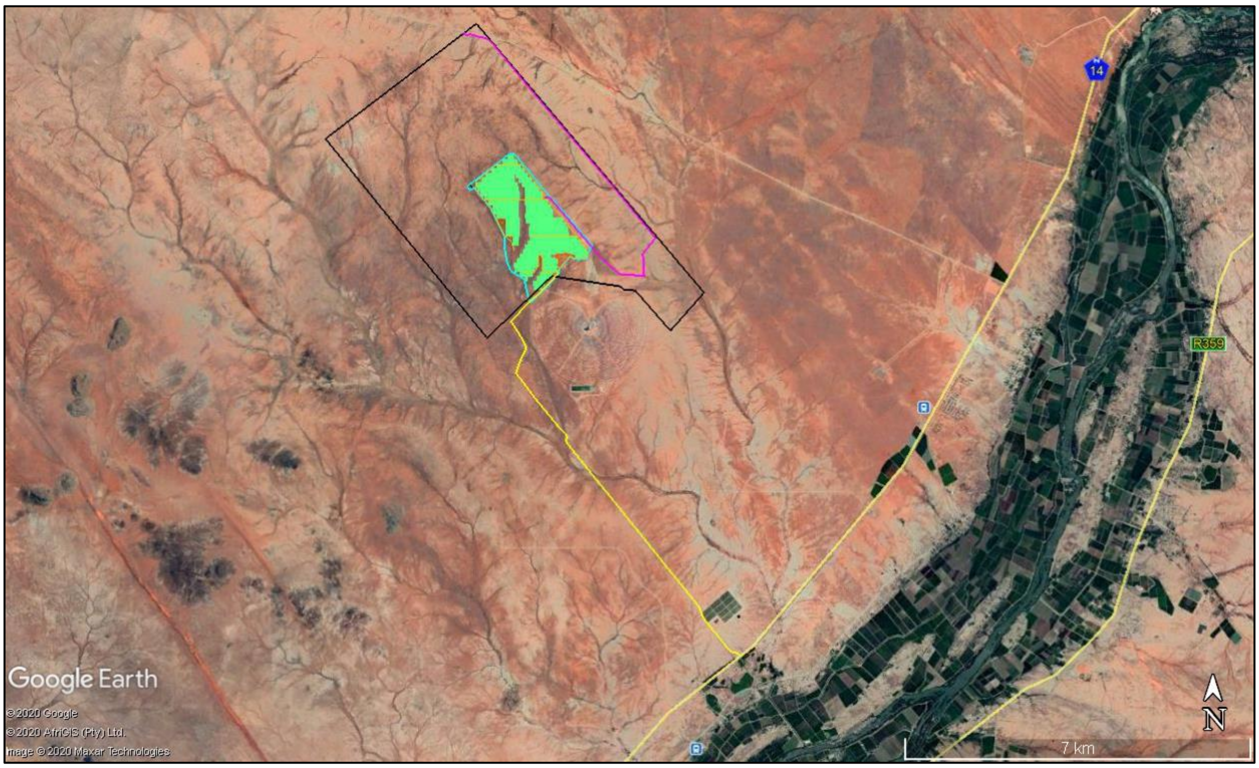

Figure 1. Locality map of the Naledi PV broader study area, illustrating the development area in green with the PV arrays in pale green.

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), which obtained 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 2821AC (35 cards, 144 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), with the relevant pentad codes for the area being 2825_2100 (8 cards, 84 species) and 2830_2100 (1 card, 44 species). These were consulted to determine the bird species likely to occur within the broader study 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.

2.2 Site Visit & Field Methodology

A site visit of five days was made to the broader study area in Spring (4 to 8 October 2018) and four days in late Summer (9 to 12 April 2019) to determine the *in situ* local avifauna and avian habitats present on site. The timing of the spring survey corresponded with a late dry-season assessment, while the late summer survey corresponded with a late wet-season assessment when most migratory bird species are still present. Environmental conditions during the late summer survey were, however, hot and dry, with the region experiencing poor summer rains locally. The field approach was informed by the *Birds and Solar Energy Best Practice Guidelines* (Jenkins *et al*., 2017) issued by Birdlife South Africa. In terms of these guidelines, the project is seen to fall within the Regime 2 assessment protocol in terms of the extent of the development area and the avifaunal sensitivity.

Linear transects measuring 1km in length were distributed and walked across the whole broader study area (McTaggarts Camp 453 and Klip Punt 452) to ensure adequate coverage of the large area (±20km^2) under the time constraints, both in spring (n = 28) and late summer (n = 22). All birds detected by sight or sound during these transect walks were recorded, as well as the number of birds per detection. Other variables such as time of day and weather conditions were also recorded for each transect. The relative abundance of birds (number of birds/km) was calculated for each species. These walked transects served to:

- Quantify aspects of the local avifauna (such as species diversity and abundance);
- Identify important avian features present within the broader study and development area (such as nesting and roosting sites);
- Confirm the presence, abundance, habitat preference and movements of priority species;
- Identify important flyways across the broader study and development area; and
- Delineate any obvious, highly sensitive, no-go areas to be avoided by the development.

Prior to analysing the transect data, all records of birds that were seen flying over the broader study area (e.g. sandgrouse) or that were seen in large flocks (bishops, queleas, weavers), were excluded from the database. This was to ensure that trends in scarcer, habitat specific species would not be masked by large fluctuations in numbers of flocking species.

In addition, a drive transect of 6.7km in length was driven on three occasions in Spring and on two occasions in late Summer within the broader study area during which all birds were recorded. A second drive transect (control) of similar length, located beyond the boundaries of the development area, was completed on three occasions in both Spring and late Summer. A vantage point count, located in the northern central portion of the broader study area was undertaken in Spring only, with a total of 12 hours of observations (four sessions of three hours) being completed.

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 species seen during the site visit. 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.

2.3 Sensitivity Mapping & Assessment

An avifaunal sensitivity map of the broader study 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, as well as, 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.

2.4 Sampling Limitations and Assumptions

The current study consisted of a relatively detailed field assessment as well as a desktop study, which serves to significantly reduce the limitations and assumptions required for the study. However, it must be noted that there are limiting factors and these could detract from the accuracy of the predicted results:

- 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 >21 years old (Harrison et al., 1997). Further, with only nine (9) cards being submitted for the two relevant pentads that cover the broader study area during SABAP 2, there is some paucity in reliable data with respect to species reporting rates. 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 somewhat larger than the broader study area under investigation, and thus likely includes a much wider array of species than what actually occurs at the site. However, aquatic species that were included on the original SABAP1 list for the area but are largely restricted to permanent water bodies such as the nearby Orange River, were excluded from the final list compiled.
- Limited time in the field and seasonal spread means that important components of the local avifauna (i.e. important nest sites or localised areas of key habitats for rare or threatened species) could have been missed. However, the extent of the development area is not that large with the result that it has been well-covered and as it contains very few large trees, it is highly unlikely that there are any significant nesting sites of larger species present within the affected area that would not have been detected.

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). The broader study area lies within one vegetation type, namely the Kalahari Karroid Shrubland. This vegetation type is classified as Least Threatened, and is predominantly (99%) untransformed. The dwarf shrubs that characterise this habitat include the following genera, *Monechma*, *Salsola*, *Hermannia* and *Zygophyllum*, amongst others, with the grass layer dominated by *Stipagrostis* species. The proportion of grass increases where soils are sandy and deeper, resulting in a patch mosaic of areas with varying densities of grasses and shrub heights. Trees are generally absent on the plains except for the provincially protected *Boscia foetida* which occurs scattered throughout the broader study area.

Three main avifaunal microhabitats can be distinguished, namely the plains associated with the Kalahari Karroid Shrubland (Figure 2 and 3), small drainage lines (Figure 4) that traverse the broader study area, and small pans (Figure 5) scattered throughout. The plains are the dominant habitat type constituting a mixed of grasses and shrubs in varying proportions, while the drainage lines and pans support a more dense woody habitat.

Figure 2. Typical plains habitat of the Kalahari Karroid Shrubland along the eastern boundary of the broader study area, with patches of low grass cover and dwarf shrubs.

Figure 3. Typical plains habitat of the Kalahari Karroid Shrubland within the central and

western portions of the site, showing more dense grass cover and taller shrubs. This is the typical habitat across most of the Naledi development area.

Figure 4. Drainage line within the Kalahari Karroid Shrubland, showing the denser and taller shrubs that line a sandy drainage channel within the broader study area.

Figure 5. A small pan within the central part of the broader study area, showing the bare pan surface and denser, taller vegetation surrounding the pan. This pan is not within the current development footprint, but is illustrated here as part of the baseline description to provide the broader context for the affected area.

3.2 General Avifauna

An approximate total of 150 bird species are known to occur within the broader study area and its surrounds (Annexure 1), of which 68 species were recorded on site during the two field surveys. Eight (8) of these species are listed as threatened, and another four (4) are considered Near-Threatened. Seven species are considered true near-endemics to South Africa (BirdLife South Africa, 2018), while twelve (12) are considered biome-restricted (Marnewick *et al*., 2015).

The bird assemblage recorded within the broader study area is fairly typical of the Kalahari bioregion, with elements of the Nama-Karoo. Of the 68 species recorded on site, 56 species were detected during walking transects, with 44 and 40 species recorded in Spring and late Summer respectively. Small passerines species made up two-thirds (36 species, 64%) of the species detected, compared to non-passerines (20 species, 36%). During walk transects in Spring, an average of 8.9 species were recorded per transect with an average of 19.0 individual birds per transect. In late summer, somewhat less species (7.6) were recorded per transect but with a similar average of 19.1 birds per transect. While the number of detections and total number of birds seen per transect were fairly similar between the two seasons, there were some marked differences in the species being detected, not only nomadic species but also species usually considered to be sedentary.

Species with relatively high abundance that also exhibited the most stable trends between the two seasons include Spike-heeled Lark *Chersomanes albofasciata*, Sabota Lark *Calendulauda sabota* and Chat Flycatcher *Bradornis infuscatus* (Table 1). Less abundant species with stable trends include Yellow Canary *Crithagra flaviventris*, Southern Fiscal *Lanius collaris*, Bokmakierie *Telophorus zeylonus* and Dusky Sunbird *Cinnyris fuscus* (Table 1). Primarily resident species that showed surprisingly highly variable detections between the seasons include Eastern Clapper Lark *Mirafra fasciolata*, Rufous-eared Warbler *Malcorus pectoralis*, Fawn-coloured Lark *Calendulauda africanoides*, and Black-chested Prinia *Prinia flavicans* (Table 2). The most common non-passerine, the Northern Black Korhaan *Afrotis afraoides,* also exhibited variable detections between the seasons (Table 3). These differences in detections of these species are mostly likely due to reduced vocalisations in late Summer, compared to Spring when most species begin to breed. Highly nomadic species that showed dramatic fluctuations between the seasons include Lark-like Bunting *Emberiza impetuani*, which was only abundant in Spring, and the biome-restricted Stark's Lark *Spizocorys starki*, which was only present in good numbers in late Summer (Table 2).

Table 1. Summary of small passerine and non-passerine species with fairly stable trends, recorded along line transects walked throughout the broader study area during the field survey in Spring (n = 28) and late Summer (n = 22), with respect to the number of detections per species, total number of birds detected per species, and number of birds seen per kilometre, as a measure of relative abundance.

Species	Spring			Summer		
	No. of detections	No. of birds	No. of birds/km	No. of detections	No. of birds	No. of birds/km
Barbet, Acacia Pied	1	1	0.04	3	3	0.14
Bokmakierie	7	10	0.36	6	7	0.32
Canary, Yellow	8	13	0.46	8	13	0.59
Chat, Ant-eating	8	13	0.46	3	4	0.18
Fiscal, Southern	6	7	0.25	6	7	0.32
Flycatcher, Chat	18	22	0.79	21	23	1.05
Lark, Black-eared Sparrow-	-	-	-	1	1	0.05
Lark, Grey-backed Sparrow-	6	12	0.43	2	19	0.86
Lark, Sabota	38	41	1.46	38	40	1.82
Lark, Spike-heeled	29	50	1.79	26	50	2.27
Penduline-tit, Cape	1	2	0.07	1	1	0.05
Robin, Kalahari Scrub	1	1	0.04	1	1	0.05
Robin, Karoo Scrub	1	1	0.04	-	-	-
Sparrow, Cape	7	11	0.39	6	12	0.55
Sunbird, Dusky	3	4	0.14	3	3	0.14

Most of the seven near-endemic species reported for the broader study area have not been recorded in the area during SABAP2, or during the field surveys. They can therefore be considered scarce in the broader study area, and include, Karoo Thrush *Turdus smithi*, Fiscal Flycatcher *Sigelus silens*, Fairy Flycatcher *Stenostira scita*, Sickle-winged Chat *Cercomela sinuata*, the nomadic Black-headed Canary *Serinus alario* (0%), and Jackal Buzzard (0%). Only the highly nomadic Black-eared Sparrowlark *Eremopterix australis* has been recorded with a fair reporting rate (33%), though only one sighting was made during the late summer field survey. Karoo Thrush and Fiscal Flycatcher are both common in nearby habitats associated with the Orange River, such as riverine thickets.

Table 2. Summary of small passerines and non-passerines with variable trends, recorded along line transects walked throughout the broader study area during the field survey in spring (n = 28) and late summer (n = 22), with respect to the number of detections per species, total number of birds detected per species, and number of birds seen per kilometre, as a measure of relative abundance. The two highly nomadic species that showed significant changes in their abundance are marked with an asterix (*).

Species	Spring			Summer		
	No. of detections	No. of birds	No. of birds/km	No. of detections	No. of birds	No. of birds/km
Bishop, Southern Red	7	159	5.68	-	-	-
Bunting, Lark-like *	17	49	1.75	1	2	0.09
Chat, Familiar	-	-	-	4	4	0.18
Cisticola, Desert	4	4	0.14	-	-	-
Dove, Namaqua	16	21	0.75	-	-	-
Eremomela, Yellow-bellied	5	6	0.21	1	1	0.05
Finch, Scaly-feathered	5	13	0.46	1	1	0.05
Lark, Eastern Clapper	23	26	0.93	-	-	-
Lark, Fawn-coloured	35	38	1.36	4	5	0.23
Lark, Stark's*	-	-	-	29	114	5.18
Mousebird, White-backed	8	15	0.54	1	3	0.14
Prinia, Black-chested	14	19	0.68	3	3	0.14
Quelea, Red-billed	1	23	0.82	-	-	-
Warbler, Rufous-eared	35	43	1.54	12	15	0.68
Weaver, Sociable	1	17	0.61	4	99	4.50
Wheatear, Capped	-	-	-	9	10	0.45

Seven (7) of the 12 biome-restricted species known from the area were recorded during the field surveys, which also have some of the highest SABAP2 reporting rates (in parentheses), namely, Sociable Weaver *Philetairus socius* (100%), Karoo Korhaan *Eupodotis vigorsii* (89%), Kalahari Scrub Robin *Cercotrichas paena* (67%), Black-eared Sparrowlark (33%), Stark's Lark *Spizocorys starki* (22%), Tractrac Chat *Cercomela tractrac,* and Karoo Chat *Cercomela schlegelii* (11%). Sociable Weavers were fairly common with several of their large communal nests located on man-made structures along the western boundary of the broader study area, and in large *Acacia* trees to the south. Karoo Korhaan appeared to be scarce during the Spring survey but were far more vocal during the late Summer survey (Table 3), when several pairs were found primarily along the eastern boundary of the broader study area. Here the soil is more gravel-like, which this species prefers compared to sandy soils which characterise most of the broader study area and the Naledi site. No Karoo Korhaan were observed within the Naledi site itself and the nearest observations are from approximately 500m east of the development footprint. As such, a significant impact on this species is unlikely. The Kalahari Scrub Robin was not common in the broader study area, as this species prefers more wooded environments, while Karoo Long-billed Lark *Certhilauda subcoronata*, and Pale-winged Starling *Onychognathus nabouroup* prefer rocky habitats, absent within the broader study area. Stark's Lark was common within the broader study area during the late Summer survey, being spread out across the area in fair numbers. The species were, however, entirely absent during the Spring survey, illustrating the highly nomadic tendencies of this species. Biome-restricted species which have not yet been recorded during SABAP2 include Sickle-winged Chat and the nomadic Black-headed Canary, of which the former may occur in low numbers in some years while the latter will show nomadic tendencies with variable abundances.

Differences in species composition between the three avifaunal microhabitats were subtle. The drainage lines and pans support denser vegetation than the plains and hence were characterised by higher occurrences of species preferring wooded habitats. Mousebirds, scrub robins, Dusky Sunbird, Black-chested Prinia and Acacia Pied Barbet, in particular, were more frequently encountered in these habitats than the plains. In contrast, the numerous lark species recorded within the broader study area were generally associated with the more sparsely vegetated open plains. Other species were more cosmopolitan in their use of the habitats, such as Chat Flycatcher, Southern Fiscal, Ant-eating Chat, and Yellow Canary amongst others.

Table 3. Summary of medium to large non-passerines, recorded along line transects walked throughout the broader study area during the field survey in Spring (n = 28) and late Summer (n = 22), with respect to the number of detections per species, total number of birds detected per species, and number of birds seen per kilometre, as a measure of relative abundance. Note that not all of these species were observed within the Naledi development footprint, rather within a larger area that includes the Naledi site.

Species	Spring			Summer		
	No. of detections	No. of birds	No. of birds/km	No. of detections	No. of birds	No. of birds/km
Bustard, Kori	-	-	-	1	1	0.05
Courser, Double-banded	1	1	0.04	4	6	0.27
Goshawk, Pale Chanting	1	1	0.04	1	1	0.05
Kestrel, Rock	-	-	-	1	1	0.05
Korhaan, Karoo	1	1	0.04	9	17	0.77
Korhaan, Northern Black	47	53	1.89	24	27	1.23
Sandgrouse, Namaqua	3	13	0.46	3	5	0.23
Vulture, White-backed	-	-	-	1	2	0.09

Based on the combined drive transect surveys during both seasons, a number of the larger non-passerine species, including red-listed species, appeared to be detected with greater frequency (birds/km) along the control transect compared to the transect within the broader study area (Figure 7). Only the Northern Black Korhaan and Double-banded Courser were more regularly encountered within the broader study area. This may possibly suggest that conditions beyond the broader study area are more favourable for most of these species, although, care should be taken to not interpret these differences as significant. The results at least indicate that certain priority species, such as the Karoo Korhaan and Kori Bustard, are as likely to occur beyond the broader study area as within.

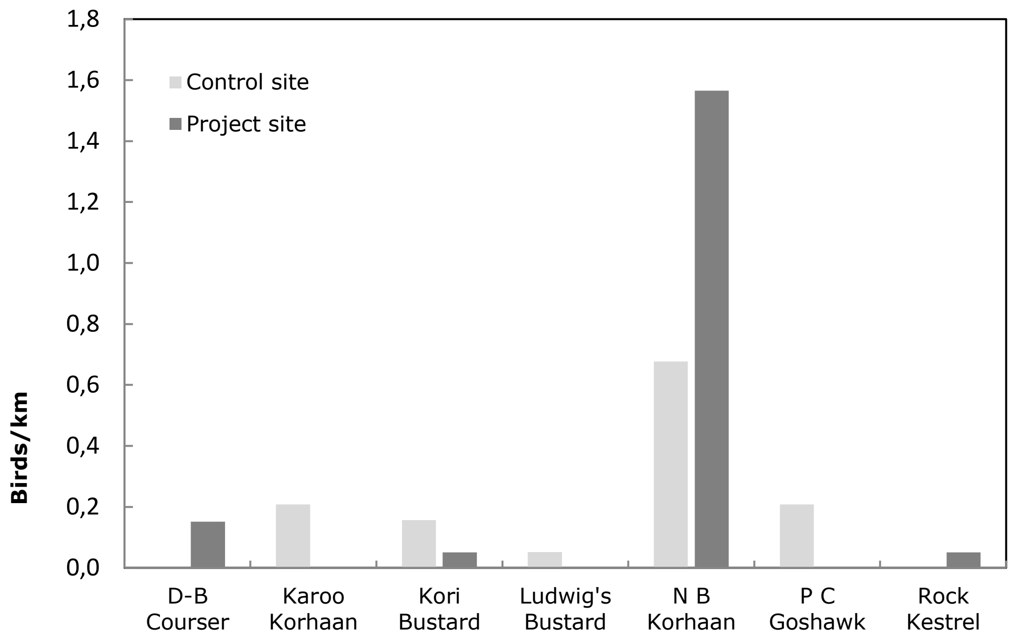

Figure 7. The primary medium to large sized non-passerines detected along drive transects within the broader study area (n=5) and neighbouring control site (n=6) during the combined Spring and late Summer season.

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. Five (5) of the eight (8) threatened species known from the broader study area were recorded during the field surveys, and a further two (2) of the four (4) Near-Threatened species (Table 4). One species (Tawny Eagle *Aquila rapax*) has not been recorded in the area during SABAP surveys, but is known to occur on occasion based on local knowledge.

The most important of the red-listed species is the Critically Endangered White-backed Vulture *Gyps africanus*, which was recorded on two separate days during the late Summer site visit. At least two immature birds were seen on each occasion, soaring at varying heights across the broader study area, presumably searching for food. The broader study area is currently being used for cattle ranching, hence vultures may occasionally pass by during foraging forays. There are no 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, corroborated by its infrequent presence in the area based on SABAP records. Similarly, the Endangered Lappet-faced Vulture *Torgos tracheliotos,* which was seen on one occasion (one individual) together with two White-backed Vultures, is most likely also only an occasional visitor to the area. The Martial Eagle *Polemaetus bellicosus* (Endangered) is also an important species, as two individuals were recorded on separate occasions in close proximity to the broader study area, one adult and one immature bird, both perched on utility poles. The species most likely breeds on a large pylon in the broader study area and is thus most likely a resident. However, considering that there are no suitable pylons or trees for nesting within the broader study area itself, the species is not likely to be impacted directly by the proposed development. These species will therefore most likely only be impacted indirectly by the proposed development 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 local knowledge, and one sighting was made during the late Summer survey, suggesting the species does occur 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 two Near-Threatened species that were recorded during the field surveys include Karoo Korhaan (several sightings) and Kori Bustard (3 sightings, 5 individuals). The Karoo Korhaan were recorded along the eastern boundary of the broader study area where gravel plains predominate, their preferred habitat. It was not however encountered within the Naledi PV development footprint, that being about 500 west of the nearest Karoo Korhaan sighting. The Kori Bustard was recorded both within and beyond the boundaries of the broader study area. In terms of the Vulnerable species, both the Secretarybird *Sagittarius serpentarius* (Vulnerable) and Lanner Falcon *Falco biarmicus* (Vulnerable) have a relatively moderate SABAP2 reporting rate of 22% and are therefore very likely to occur in the area fairly frequently. One Lanner Falcon was seen perched on a pylon a few kilometres south of the broader study area, so may occasionally frequent the area during hunting forays. It is suspected that a pair of Secretarybirds nest in the vicinity of the broader study area, but no sightings were made during the site visits. They 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. All other red-listed species have rather low SABAP2 reporting rates (<5%) for the area, and include the Black Stork *Ciconia nigra* (Vulnerable), Pallid Harrier *Circus macrourus* (Near-Threatened), and Abdim's Stork *Ciconia abdimii* (Near-Threatened). The local populations of these species are, however, mostly of low to moderate importance, as these species appear to be only very occasional visitors based on their low reporting rates. The broader study area and surrounds do not provide essential breeding or feeding habitat for these species. The stork species, in particular, would most likely frequent more suitable habitats closer to the Orange River.

During the walking transects regular scans were made to detect any large flying birds to establish the presence of flight paths across the broader study area. Besides the two sightings of vultures made during these scans, the additional 12 hours of observations from the vantage point revealed only one Pale Chanting Goshawk *Melierax canorus* in flight over the area. This bird was seen soaring at a low to moderate height (<200 m), for a period of a few minutes. Karoo Korhaan were only observed on the gravel plains at least 500m to the east of the proposed Naledi PV footprint. Besides the predominantly terrestrial Karoo Korhaan and Kori Bustard, no other red-list species were seen using the site or flying routine flight paths. This may be due to the apparent absence of communal roosting and breeding sites, therefore birds may be traversing the site on an *ad hoc* basis. Besides the absence of communal nest sites, no individual nests were located during the field survey. However, it may be possible that species such as the Secretarybird may use solitary *Boscia* or other tree species for nesting, which may have been missed during the site visits.

In essence, much of the avifauna of the surrounding environment appears fairly similar to that found across the Kalahari and Nama-Karoo bioregions of the Northern Cape. The absence of communal or solitary roosting and nesting sites for red-listed species within the broader study area ensures that no species are at immediate risk. A number of species do occur in the 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. Large tracks of suitable habitat remain within the surrounding environment, particularly to the north of the broader study area. Species that clearly use the surrounding environment as part of their foraging ranges include the White-backed Vulture, Lappet-faced Vulture, Martial Eagle, Tawny Eagle, Lanner Falcon, Karoo Korhaan and the Secretarybird. However, at least one Near-Threatened species, the Kori Bustard, is likely to be displaced from the area as this species is strictly a ground-dwelling forager. Kori Bustard do, however, have a very wide national range and therefore their regional and national population will not be impacted. In essence, the sensitivity of the area in general can be considered to be of medium significance with respect to avifauna.

Table 4. Red-listed species recorded in the broader study area during SABAP1 (1987-1991), SABAP2 (2007 on-going) and the Spring (4 to 8 October 2018) and late Summer (9 to 12 April 2019) site visit, ranked according to their red-list status. All species, besides the White-backed Vulture, Ludwig's Bustard and the Tawny Eagle have been recorded during the SABAP2 period. Seven species were observed during the two site visits (marked in bold).

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**	**Recorded**	**Habitat loss/Disturbance Collisions/Electrocution**
Vulture, Lappet-faced	***Torgos tracheliotos***	**Endangered**	**Low**	**Savanna**	**Recorded**	**Habitat loss/Disturbance Collisions/Electrocution**
Bustard, Ludwig's	***Neotis ludwigii***	**Endangered**	**Moderate**	**Shrubland plains**	**Recorded**	**Habitat loss/Disturbance Collisions**
Eagle, Martial	***Polemaetus bellicosus***	**Endangered**	**Moderate**	**Savanna & shrublands**	**Recorded**	**Habitat loss/Disturbance Collisions/Electrocution**
Eagle, Tawny	*Aquila rapax*	Endangered	Low	Savanna & Karoo plains	High	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**	**Recorded**	**Habitat loss/Disturbance Collisions**
Harrier, Pallid	Circus macrourus	Near-Threatened	Low	Grassland & floodplains	Low	Habitat loss/Disturbance/Collisions
Korhaan, Karoo	***Eupodotis vigorsii***	**Near-Threatened**	**Moderate**	**Shrubland plains**	**Recorded**	**Habitat loss/Disturbance Collisions**
Stork, Abdim's	*Ciconia abdimii*	Near-threatened	Low	Grassland & savanna	Low	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. To this end, an avian sensitivity map (Figure 8) was generated by integrating avian microhabitats present within the broader study area and avifaunal information collected during the site visits.

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 Near-Threatened Karoo Korhaan and Kori Bustard, and the Endangered Ludwig's Bustard in favourable years. The typical sandy plains are considered to be Medium sensitivity as a result, while the gravel plains are Medium High sensitivity due to the consistent presence of the Karoo Korhaan (Figure 9). Due to the absence of the gravel plains habitat on the Naledi project site, no Karoo Korhaans were observed in the affected area and are therefore unlikely to be impacted by the proposed Naledi development. The drainage lines and small pans are a restricted habitat within the broader study and development area due to the denser vegetation they support; these features can be considered to be of High Sensitivity even though red-listed species may not be directly associated with these habitats. It is likely that development of the solar energy facility on the lower sensitivity portions of the broader study area, such as the plains habitat, would generate low 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 Kori Bustard. Other species appear to occur too sparsely to be negatively impacted.

Since the High Sensitivity habitats such as drainage lines and small pans occur throughout the site, development of the solar energy facility would potentially result in much of these habitats and their ecological functioning being lost. It has therefore been recommended that where possible, buffer zones (50 to 100m width) be included around the largest and most significant of these habitats. Preservation of the larger drainage lines will also ensure adequate drainage of the broader study area during significant rainfall events. Under the final layout assessed, these features have been largely avoided and adequate buffers provided.

The final layout of Naledi PV accommodates most of the recommended mitigation measures. The Naledi PV area does not infringe into the Karoo Korhaan habitat area along the eastern boundary of the broader study area (Figure 9). This area has been identified as a possible corridor for this species based on the consistent presence of the Karoo Korhaan which occupies the plains (with mostly gravel substrate) along this eastern boundary of the site (Figure 9). This preferred habitat for korhaans does extend further east and north of the broader study area and hence has a wider distribution in the broader area and would not be directly affected by the current development. As a result a significant impact on the Karoo Korhaan as a result of the Naledi PV development is unlikely. The development does impinge to some degree into the high sensitivity areas associated with the more-densely vegetated washes and drainage lines of the site. Approximately 36ha of high sensitivity habitat would be contained within the Naledi PV fenced area of which approximately 7-10ha would be lost to the development. While this would have a local impact on the affected washes and drainage lines, the overall extent of habitat loss is considered relatively low and would not result in a significant impact on the availability of this habitat in the wider area.

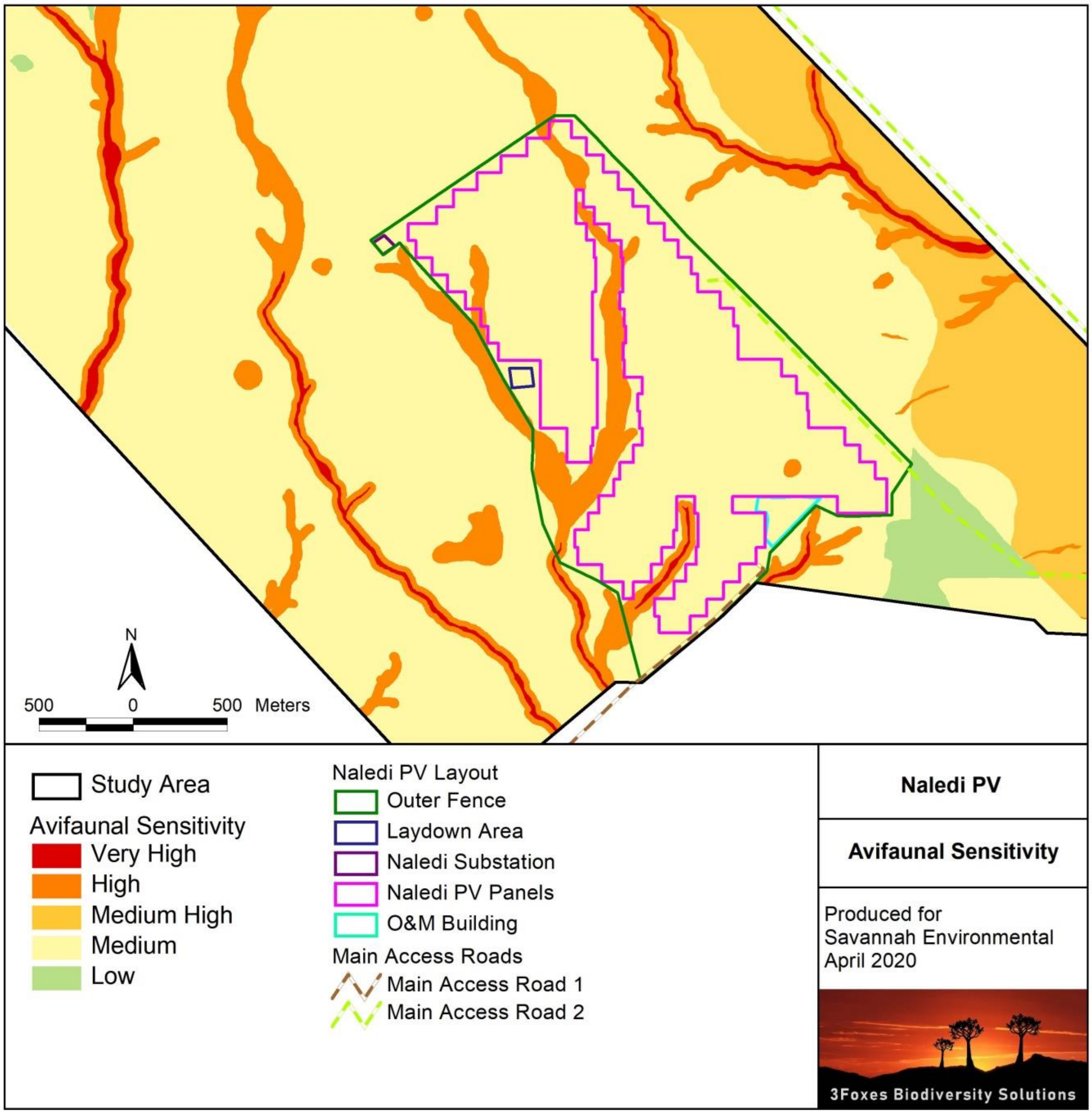

Figure 8. Avifaunal Sensitivity Map for the Naledi PV broader study and development area, showing the Medium sensitivity plains that cover most of the area, the Medium High sensitivity gravel plains east of the Naledi site and the High sensitivity drainage lines and small pans.

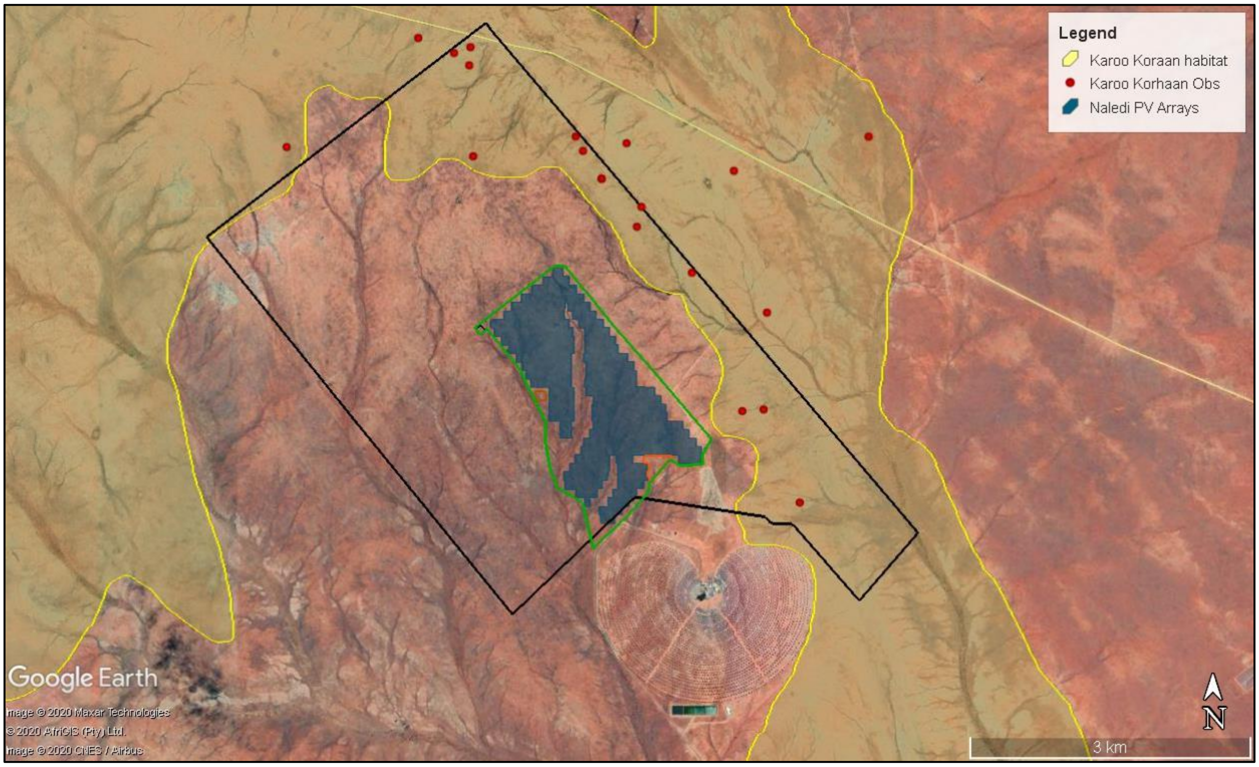

Figure 9. The sightings of Karoo Korhaan in and near the site, as well as the area mapped as potential habitat in the wider area, showing that the Naledi PV development would not impact this habitat.

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. Of the twelve red-listed species that are known to occur within the surrounding environment, seven were seen during the site visit, while most of the near-endemic species and biome-restricted species occur throughout much of the vegetation type. 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 recent 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 Naledi PV 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 Spike-heeled Lark, Sabota Lark, Fawn-coloured Lark, Eastern Clapper Lark, Rufous-eared Warbler, Chat Flycatcher, and Black-chested Prinia. 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 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 *Rhinoptilus africanus*, 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, Martial Eagle, Tawny Eagle, Secretarybird and the Lanner Falcon, as well as the Near Threatened Kori. 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 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 Naledi PV Development

The following is an assessment of Naledi PV, 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

- 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 the habitat diversity.
- 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 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 residual impact even after mitigation and avoidance of more sensitive areas. The sensitivity of the affected habitat is however low and the overall residual impact on avifaunal habitat loss remains low.

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.
- The major drainage lines and pans should be avoided as far as possible.
- 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. • The major drainage lines and pans should be avoided as far as possible, but also the majority of the eastern boundary and the south eastern corner of the broader study area, which should serve as a buffer between the existing Khi Solar One CSP Facility and the wooded drainage line to the east. • 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 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. The sensitivity of the affected habitat is however low and the overall residual impact on avifaunal habitat loss remains low.

5.1.4 Cumulative Impacts

The following are the cumulative impacts that are assessed as being a likely consequence of the development of Naledi PV. 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 two seasons of detailed field assessment of the proposed development area. Consequently, the impact assessment and sensitivity map presented herein are based on detailed on-site information and as such have a relatively high degree of confidence and are considered reliable and comprehensive.

The broader study and development area lies within the Kalahari bioregion and supports a fairly typical avifaunal assemblage expected for the area. Eight (8) threatened and four (4) Near-Threatened species are known to occur within the surrounding environment, of which at least two terrestrial species (Karoo Korhaan, Kori Bustard) are common while others appear to occur more infrequently. The broader study area supports no known features of high sensitivity, such as nesting or roosting sites of red-listed species. Impacts on avifauna with the development of the dominant plains habitat will likely be medium-low though moderate post-mitigation impacts are likely, primarily due to the possible displacement of the Kori Bustard from the site.

The expected impacts of the proposed solar development area will include the following, 1) habitat loss and fragmentation associated with the Kalahari Karroid Shrubland, 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. 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. Although Karoo Korhaan were not recorded on the Naledi site, it is worth noting that they are present on the gravel plains habitat to the east and north of the broader study area and hence the long-term preservation of these areas is considered important. 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 Kalahari Karroid Shrubland vegetation type is still approximately 90% intact, while it has an extensive range within the bioregion. The transformation and loss of 276ha 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 likely to be low.

Avifaunal Impact Statement:

The proposed development area for Naledi PV 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, and that there are no known communal breeding or roosting sites of red-listed priority species, there are no impacts associated with the development that are considered to be of high residual significance and which cannot be mitigated to a low level. Consequently, the development can be supported from an avifaunal perspective. It is, therefore, the reasoned opinion of the specialist that the Naledi PV development be authorised, subject to 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 Naledi PV 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

<table>
<tr><th colspan="3">Objective: Limit disturbance and loss of avifaunal microhabitats during construction</th></tr>
<tr><td>Project component/s</td><td colspan="2">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.</td></tr>
<tr><td>Potential Impact</td><td colspan="2">Disturbance and loss of avifaunal microhabitats, leading to displacement and loss of resident avifaunal species.</td></tr>
<tr><td>Activity/risk source</td><td colspan="2">» 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.</td></tr>
<tr><td>Mitigation: Target/Objective</td><td colspan="2">» Low footprint and low impact on avifaunal habitats.
» Low disturbance of avifauna during construction.
» Low disturbance and impact on red-listed avifaunal species.</td></tr>
<tr><td>Mitigation: Action/control</td><td>Responsibility</td><td>Timeframe</td></tr>
<tr><td>» Pre-construction environmental induction for all construction personnel regarding basic environmental principles.</td><td>ECO</td><td>Pre-construction</td></tr>
<tr><td>» 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 electrified strands should be located on the inside of the fence and not the outside, while there should be</td><td>Contractor</td><td>Construction</td></tr>
</table>

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 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 (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 (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.		

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9 Annex 1. List of Avifauna

A consolidated avifaunal list for the broader Naledi PV project site and surrounds, including records from SABAP1, SABAP2 and the two site visits, and includes red-list status (Taylor *et al.*, 2015), regional endemism (BLSA, 2018), and SABAP2 reporting rates (based on nine cards). Species with a zero reporting rate were only recorded during SABAP1 and not SABAP2. Species highlighted in bold text were recorded during the site visit in spring (4 to 8 October 2018) and late summer (9 to 12 April 2019). 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***			**44.4**
Batis, Pririt	***Batis pririt***			**22.2**
Bee-eater, European	*Merops apiaster*			22.2
Bee-eater, Swallow-tailed	*Merops hirundineus*			0.0
Bishop, Southern Red	***Euplectes orix***			**77.8**
Bokmakierie	***Telophorus zeylonus***			**77.8**
Brubru	*Nilaus afer*			0.0
Bulbul, African Red-eyed	*Pycnonotus nigricans*			11.1
Bunting, Lark-like	***Emberiza impetuani***			**88.9**
Bustard, Kori	***Ardeotis kori***	**Near-Threatened**		**22.2**
Bustard, Ludwig's*	***Neotis ludwigii***	**Endangered**		
Buzzard, Jackal	*Buteo rufofuscus*		Near-endemic	0.0
Buzzard, Steppe	*Buteo vulpinus*			11.1
Canary, Black-headed*	*Serinus alario*		Near-endemic	0.0
Canary, Black-throated	*Crithagra atrogularis*			0.0
Canary, White-throated	*Crithagra albogularis*			22.2
Canary, Yellow	***Crithagra flaviventris***			**66.7**
Chat, Anteating	***Myrmecocichla formicivora***			**55.6**
Chat, Familiar	***Cercomela familiaris***			**55.6**
Chat, Karoo*	***Cercomela schlegelii***			**11.1**
Chat, Sickle-winged*	*Cercomela sinuata*		Near-endemic	0.0
Chat, Tractrac*	***Cercomela tractrac***			**0.0**
Cisticola, Desert	***Cisticola aridulus***			**44.4**
Cisticola, Grey-backed	*Cisticola subruficapilla*			0.0
Cisticola, Zitting	*Cisticola juncidis*			11.1
Courser, Double-banded	***Rhinoptilus africanus***			**55.6**
Crombec, Long-billed	***Sylvietta rufescens***			**22.2**

Crow, Pied	***Corvus albus***			**88.9**
Cuckoo, Diderick	*Chrysococcyx caprius*			11.1
Dove, Ringed-necked	***Streptopelia capicola***			**44.4**
Dove, Laughing	***Streptopelia senegalensis***			**55.6**
Dove, Namaqua	***Oena capensis***			**88.9**
Dove, Red-eyed	*Streptopelia semitorquata*			0.0
Drongo, Fork-tailed	*Dicrurus adsimilis*			0.0
Eagle, African Fish	*Haliaeetus vocifer*			11.1
Eagle, Booted	*Aquila pennatus*			11.1
Eagle, Martial	***Polemaetus bellicosus***	**Endangered**		**0.0**
Egret, Western Cattle	*Bubulcus ibis*			11.1
Eremomela, Yellow-bellied	***Eremomela icteropygialis***			**55.6**
Falcon, Lanner	***Falco biarmicus***	**Vulnerable**		**22.2**
Falcon, Pygmy	*Polihierax semitorquatus*			11.1
Finch, Red-headed	***Amadina erythrocephala***			**11.1**
Finch, Scaly-feathered	***Sporopipes squamifrons***			**66.7**
Firefinch, Red-billed	*Lagonosticta senegala*			0.0
Fiscal, Southern	***Lanius collaris***			**66.7**
Flycatcher, Chat	***Bradornis infuscatus***			**66.7**
Flycatcher, Fairy	*Stenostira scita*		Near-endemic	0.0
Flycatcher, Fiscal	*Sigelus silens*		Near-endemic	0.0
Flycatcher, Spotted	*Muscicapa striata*			0.0
Goose, Egyptian	***Alopochen aegyptiacus***			**66.7**
Goshawk, Pale Chanting	***Melierax canorus***			**77.8**
Greenshank, Common	*Tringa nebularia*			0.0
Guineafowl, Helmeted	*Numida meleagris*			0.0
Harrier, Pallid	*Circus macrourus*	Near-Threatened		11.1
Heron, Black-headed	*Ardea melanocephala*			11.1
Honeyguide, Lesser	*Indicator minor*			0.0
Hoopoe, African	*Upupa africana*			0.0
Ibis, African Sacred	*Threskiornis aethiopicus*			0.0
Ibis, Hadeda	***Bostrychia hagedash***			**44.4**
Kestrel, Greater	*Falco rupicoloides*			33.3
Kestrel, Rock	***Falco rupicolus***			**33.3**
Kingfisher, Striped	*Halcyon chelicuti*			0.0
Kite, Black-shouldered	*Elanus caeruleus*			0.0
Kite, Yellow-billed	*Milvus aegyptius*			0.0
Korhaan, Karoo*	***Eupodotis vigorsii***	**Near-Threatened**		**88.9**
Korhaan, Northern Black	***Afrotis afraoides***			**100.0**

Lapwing, Blacksmith	***Vanellus armatus***		**55.6**
Lapwing, Crowned	***Vanellus coronatus***		**22.2**
Lark, Black-eared Sparrow-*	***Eremopterix australis***	**Near-endemic**	**33.3**
Lark, Grey-backed Sparrow-	***Eremopterix verticalis***		**66.7**
Lark, Eastern Clapper	***Mirafra fasciolata***		**66.7**
Lark, Fawn-coloured	***Calendulauda africanoides***		**88.9**
Lark, Karoo Long-billed*	*Certhilauda subcoronata*		0.0
Lark, Red-capped	*Calandrella cinerea*		0.0
Lark, Sabota	***Calendulauda sabota***		**66.7**
Lark, Spike-heeled	***Chersomanes albofasciata***		**100.0**
Lark, Stark's*	***Spizocorys starki***		**22.2**
Lovebird, Rosy-faced	*Agapornis roseicollis*		0.0
Martin, Brown-throated	*Riparia paludicola*		0.0
Martin, Rock	***Hirundo fuligula***		**44.4**
Mousebird, Red-faced	***Urocolius indicus***		**33.3**
Mousebird, White-backed	***Colius colius***		**11.1**
Oriole, Eurasian Golden	*Oriolus oriolus*		0.0
Owl, Spotted Eagle-	*Bubo africanus*		11.1
Owl, Western Barn	*Tyto alba*		0.0
Owlet, Pearl-spotted	*Glaucidium perlatum*		0.0
Penduline-tit, Cape	***Anthoscopus minutus***		**11.1**
Pigeon, Speckled	***Columba guinea***		**33.3**
Pipit, African	*Anthus cinnamomeus*		11.1
Plover, Kittlitz's	*Charadrius pecuarius*		0.0
Plover, Three-banded	*Charadrius tricollaris*		22.2
Prinia, Black-chested	***Prinia flavicans***		**100.0**
Quail, Common	*Coturnix coturnix*		11.1
Quelea, Red-billed	***Quelea quelea***		**100.0**
Reed-warbler, African	*Acrocephalus baeticatus*		0.0
Robin, Kalahari Shrub*	***Cercotrichas paena***		**66.7**
Robin, Karoo Scrub	***Cercotrichas coryphoeus***		**22.2**
Robin-chat, Cape	*Cossypha caffra*		0.0
Rock-thrush, Short-toed	*Monticola brevipes*		0.0
Ruff	*Philomachus pugnax*		0.0
Sandgrouse, Namaqua	***Pterocles namaqua***		**100.0**
Sandpiper, Common	*Actitis hypoleucos*		0.0
Sandpiper, Curlew	*Calidris ferruginea*		0.0
Sandpiper, Marsh	*Tringa stagnatilis*		0.0
Sandpiper, Wood	*Tringa glareola*		0.0

Scimitarbill, Common	*Rhinopomastus cyanomelas*			0.0
Secretarybird	*Sagittarius serpentarius*	Vulnerable		22.2
Shelduck, South African	***Tadorna cana***			**33.3**
Shikra	*Accipiter badius*			0.0
Shrike, Lesser Grey	*Lanius minor*			11.1
Shrike, Red-backed	*Lanius collurio*			0.0
Sparrow, Cape	***Passer melanurus***			**66.7**
Sparrow, House	*Passer domesticus*			11.1
Sparrow-weaver, White-browed	***Plocepasser mahali***			**33.3**
Starling, Cape Glossy	*Lamprotornis nitens*			0.0
Starling, Pale-winged*	*Onychognathus nabouroup*			0.0
Starling, Wattled	*Creatophora cinerea*			0.0
Stilt, Black-winged	*Himantopus himantopus*			33.3
Stint, Little	*Calidris minuta*			0.0
Stork, Abdim's	*Ciconia abdimii*	Near-Threatened		0.0
Stork, Black	*Ciconia nigra*	Vulnerable		0.0
Sunbird, Dusky	***Cinnyris fuscus***			**77.8**
Swallow, Barn	***Hirundo rustica***			**33.3**
Swallow, Greater Striped	***Cecropis cucullata***			**11.1**
Swallow, Pearl-breasted	***Hirundo dimidiate***			
Swallow, White-throated	*Hirundo albigularis*			11.1
Swift, African Palm	***Cypsiurus parvus***			**11.1**
Swift, Alpine	***Tachymarptis melba***			**0.0**
Swift, Common	*Apus apus*			11.1
Swift, Little	***Apus affinis***			**66.7**
Swift, White-rumped	*Apus caffer*			0.0
Teal, Cape	*Anas capensis*			0.0
Teal, Red-billed	*Anas erythrorhyncha*			11.1
Thick-knee, Spotted	*Burhinus capensis*			0.0
Thrush, Karoo	*Turdus smithi*		Near-endemic	0.0
Tit-Babbler, Chestnut-vented	***Sylvia subcaerulea***			**66.7**
Tit, Ashy	*Parus cinerascens*			0.0
Vulture, White-backed	***Gyps africanus***	**Critically Endangered**		
Wagtail, Cape	*Motacilla capensis*			22.2
Warbler, Icterine	*Hippolais icterina*			0.0
Warbler, Rufous-eared	***Malcorus pectoralis***			**100.0**
Waxbill, Common	*Estrilda astrild*			0.0
Weaver, Sociable*	***Philetairus socius***			**100.0**
Weaver, Southern Masked	***Ploceus velatus***			**55.6**

Wheatear, Capped	***Oenanthe pileata***	**44.4**
Wheatear, Mountain	***Oenanthe monticola***	**0.0**
White-eye, Orange River	*Zosterops pallidus*	0.0
Whydah, Pin-tailed	*Vidua macroura*	0.0
Woodpecker, Cardinal	*Dendropicos fuscescens*	0.0
Woodpecker, Golden-tailed	*Campethera abingoni*	0.0