Nkurenkuru
ECOLOGY & BIODIVERSITY
SACNASP REG: 400502/14

AVIFAUNAL SPECIALIST ASSESSMENT REPORT:

BASIC ASSESSMENT

PROPOSED MOEDING SOLAR PV FACILITY, VRYBURG, NORTH-WEST PROVINCE

DECEMBER 2018

Prepared by:

NKURENKURU ECOLOGY & BIODIVERSITY (PTY) LTD.

Gerhard Botha (Pri Sci Nat: Ecology & Botany)

PO Box 12500, Brandhof, 9324

Cell: 084 2073454

Email: gabotha11@gmail.com

TABLE OF CONTENTS

FIGURES

DECLARATION OF CONSULTANT'S INDEPENDENCE

I, Gerhard Botha, as the appointed specialist hereby declare that I:

- » act/ed as the independent specialist in this application;
- » 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;
- » have and will not have no vested interest in the proposed activity proceeding;
- » have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- » am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 326) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- » have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- » am aware that a false declaration is an offence in terms of regulation 48 of GN No. R. 326.

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)
December 2018

MOEDING SOLAR PV FACILITY, NEAR VRYBURG, NORTH WEST PROVINCE AVIFAUNAL IMPACT ASSESSMENT REPORT

1 INTRODUCTION

1.1 Applicant

Moeding Solar (Pty) Ltd.

1.2 Project

The project will be known as the Moeding Solar PV Facility (Moeding Solar).

1.3 Proposed Activity

The facility is proposed to include multiple arrays (static or tracking) of photovoltaic (PV) solar panels with a generating capacity of up to 100MW. The development footprint for the facility is anticipated to be approximately 300ha in extent.

Infrastructure associated with the solar energy facility will include:

» Arrays of PV panels (either a static or tracking PV system) with a capacity of up to 100MW.
» Mounting structures to support the PV panels.
» On-site inverters to convert the power from a direct current to an alternating current.
» An onsite substation to facilitate the connection between the solar energy facility and the Eskom electricity grid.
» A new 132kV power line between the on-site substation and the Eskom grid connection point.
» Battery storage with up to 6hours of storage capacity.
» Cabling between the project components, to be laid underground where practical.
» Offices and workshop areas for maintenance and storage.
» Temporary laydown areas.
» Permanent laydown area.
» Internal access roads and fencing.

Two power line alternatives are being considered:

» Direct connection to the existing Mookodi Substation located approximately 4.5km north of the project site.
» A turn-in turn-out connection into the Mookodi - Magopela 132kV power line (proposed to be constructed along the eastern boundary of the project site).

1.4 Terms of reference

The most important objective of this avifaunal impact assessment is to determine the impacts that the proposed activity may have on avifauna species. The following are the tasks/objectives of the study:

» Field visit to identify important avian habitats associated with the proposed development as well as avian micro-habitats and species that will potentially use these niches;
» A description of the current avifauna within the project site and the identification of Red Data Species potentially affected by the proposed development and associated infrastructure;
» Integration of the site data collected within avian atlases and counts within the area to develop a comprehensive avifaunal database likely to be present within the development footprint;
» Identify potential negative impacts on the avifaunal diversity and species composition at the site of the proposed development and assess the significance of these impacts;
» To provide recommended mitigation measures for the potential impacts in order to avert or lower the significance of the negative impacts on avifauna.

All avifaunal data was collected throughout all identified habitats using various methods including (see Section 2.2 for a description of methodology used):
» Walked-transects,
» Vehicles drive surveys,
» Power Line inspection, and
» Fixed point surveys

1.5 Conditions of this report

Findings, recommendations and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

1.6 Relevant legislation

The Convention on Biological Diversity:

The Convention on Biological Diversity (CBD) is an international convention (to which South Africa is a signatory) and represents a commitment to sustainable development. The Convention has three main objectives: the conservation of biological diversity, the sustainable use of its

components, and the fair and equitable sharing of the benefits from the use of genetic resources (http://cbd.int/convention/guide/). Although the convention does not include specific recommendations or guidelines pertaining to birds and energy infrastructure interactions and impacts, it does make provisions for keeping and restoring biodiversity.

The Convention on the Conservation of Migratory Species of Wild Animals:

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or the Bonn Convention) is an intergovernmental treaty and is the most appropriate instrument to deal with the conservation of terrestrial, aquatic and avian migratory species. The convention includes policy and guidelines with regards to the impact associated with man-made infrastructures. CMS requires that parties (South Africa is a signatory) take measures to avoid migratory species from becoming endangered (Art II, par. 1 and 2) and to make every effort to prevent the adverse effects of activities and obstacles that seriously impede or prevent the migration of migratory species i.e. power lines (Art 111, par. 4b and 4c).

The Agreement on the Convention of African-Eurasian Migratory Water Birds:

The Agreement on the Conservation of African-Eurasian Migratory Water birds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitat across Africa, Europe, the Middle East Central Asia, Greenland and the Canadian Archipelago. The AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle and is a legally binding agreement by all contracting parties (South Africa included) to guarantee the conservation of migratory waterbirds within their national boundaries through species and habitat protection and the management of human activities.

The National Environmental Management: Biodiversity Act:

The National Environmental Management: Biodiversity Act (No. 10 of 2004, NEMBA) regulations on Threatened and Protected Species (TOPS) provides for the consolidation of biodiversity legislation through establishing national norms and standards for the management of biodiversity across all sectors and by different management authorities. The national Act and several sets of provincial conservation legislation provide for among other things, the management and conservation of South Africa's biodiversity; protection of species and ecosystems that necessitate national protection and the sustainable use of indigenous biological resources.

Guidelines to minimise the impacts on birds of Solar Facilities and Associated Infrastructure in South Africa:

The "Guidelines to minimise the impact on birds of Solar Facilities and Associated Infrastructure in South Africa" (Smit, 2012) is perhaps the most important (although not legally binding) document from an avifaunal impact perspective currently applicable to solar development in

South Africa. The guidelines were published by BirdLife South Africa (BLSA) and detail their recommended procedure for conducting an avifaunal specialist study as well as list all of the potential impacts of interactions between birds and solar facilities and associated infrastructure. Even though, as mentioned, this is not a legally binding document, this document furthermore provide valuable insight on the methods and procedures followed by BLSA during the evaluation of avifaunal assessments and monitoring. Nkurenkuru Ecology and Biodiversity is aware of changes to the BirdLife South Africa best practise guidelines recently published at the Birds and Renewable Energy Forum in Johannesburg (2015) and although the revised requirements are still a work in progress and have not yet been ratified, they will inform this assessment where applicable.

2 METHODOLOGY

The main objective of the Avifauna Impact Assessment Report is to provide a description of the avifaunal, their interactions with their surrounding environment and how activities associated with the proposed development could potentially impact on the immediate as well as surrounding avifaunal character. Furthermore, following the identification of impacts, this report aims to provide effective potential mitigation and measures to aid in future decisions regarding the proposed project and to ultimately minimalize the significance of identified impacts. To obtain the achieved results the following methodology was implemented.

2.1 Data scouring and review

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

» Vegetation types and their conservation status were extracted from the South African National Vegetation Map (Mucina and Rutherford 2012) as well as the National List of Threatened Ecosystems (2011), where relevant.
» Bird distribution data of the Southern African Bird Atlas Project obtained from the Animal Demography Unit of the University of Cape Town, in order to ascertain species occurrence within the study area (Harrison et al. 1997).
» The Birds in Reserves Project database was used to augment bird counts data (Animal Demographic Unit 2015).
» The conservation status of all bird species occurring within the quarter degree square determined with the use of The Eskom Red Data book of birds of South Africa, Lesotho and Swaziland (Taylor 2014).
» The Important Bird Areas (IBA) programme according to BirdLife South Africa.
» The conservation status, endemism and biology of all species considered likely to occur within the study area was determined from Hockey et al. (2005) and Taylor et al. (2015).
» The BirdLife South Africa "Guidelines to minimise the impact on birds of Solar Facilities and Associated Infrastructure in South Africa" was incorporated into the report (Smit et al. 2012).

» A review of avian monitoring and mitigation information at existing utility scale solar facilities compiled by Watson et al. (2015) was used to determine the impacts of solar facilities on avian species.
» Appendix A5: Bird Scoping Assessment Report of The Strategic Environmental Assessment of Wind and Solar Photovoltaic Energy in South Africa.
» A review of available published and unpublished literature pertaining to bird interactions with SEFs and their associated power infrastructure, summarising the issues involved and the current level of knowledge in the field. Various information sources including data on the local avifauna of the area and previous studies of bird interactions with SEFs and their associated power infrastructure were be examined.

Data Sources Utilized

» The Southern African Bird Atlas Project 1 (SABAP 1; Harrison et al., 1997) quarter degree squares (QDC) 2724BA (7 cards) and 2724BB (6 cards) as well as the Southern African Bird Atlas Project 2 (SABAP 2; http://sabap2.adu.org.za/index.php) pentads 2655_2445 (1 card) and 2700_2445 (2 cards) were consulted to determine the bird species likely to occur within the project site and the broader impact zone of the development.
» The conservation status, endemism and biology of all species considered likely to occur within the project site was determined from Hockey et al. (2005) and Taylor et al. (2015).
» The South African National Vegetation Map (Mucina & Rutherford, 2012) was consulted in order to determine the vegetation types and their conservation status that occur within the project site.

2.2 Field sampling and assessment methodology

Prior to the site visit, a review of available published and unpublished literature pertaining to bird interactions with solar plants, substations and power lines was undertaken, summarising the issues involved and the current level of knowledge in the field. Various information sources including data on the local avifauna of the area and previous studies of bird interactions with plants, substations and power lines were examined.

A site visit of the project site was conducted from the 14^{h} to the 15th of May 2018 (Autumn) to determine the *in situ* local avifauna and avian habitats present on site. Walked transects, vehicle transects and vantage point surveys were conducted in various habitats across the site. Not only the development footprint area was surveyed, but a broader area was also inspected (the immediate surrounding environment). The project site was thoroughly surveyed to obtain a first-hand perspective of the proposed project and birdlife and to:

» Quantify aspects of the local avifauna (such as species diversity and abundance);
» Identify important avian features present on site (such as nesting and roosting sites);
» Confirm the presence, abundance, habitat preference and movements of priority species;

» Identify important flyways across the site; and
» Delineate any obvious, highly sensitive, no-go areas to be avoided by the development and associated infrastructure.

Data collection methods included the following:

» Vehicle drive surveys: Vehicle surveys were predominantly done along the farm dirt roads and twin tracks as well as the service road of the existing power line infrastructure and the Transnet Railway.
» Power Line inspection: A portion of the existing –Mercury - Mookodi 400kV power line was surveyed twice daily for the duration of the survey period for any possible raptors or other avifaunal species utilizing the line and pylons for perching. All nests located within the pylons were identified and monitored for a period of time during sunrise and sunset to determine if the nests are active and which species utilized these nests.
» Walked-transects: Walk-throughs were conducted within the project site as well as study area[1] (refer to Figure 1). These were done along pre-defined areas as well as along random selected areas.

The following equipment were utilized during field work:

» Canon EOS 450D Camera,
» Swarovski SLC 10X42 WB Binoculars,
» Roberts VII Multimedia Android Edition for Data Capturing and Bird Identification,
» Sasol's The Larger Illustrated Guide to Birds of Southern Africa (2005),
» Roberts Bird Guide (2016), and
» A simplified adaption of the Braun-Blanquet Data Form to capture habitat and other environmental data.

The survey was primarily conducted by means of a Checklist survey supplemented with some notes on avifaunal movement (especially regarding the larger avifaunal species as well as identified nesting species and activities with the patches of higher tree covering). The surveys normally started just before sunrise and ended just after sunset in order to record all possible bird activities throughout the day.

Using the data collected during the desktop phase as well as during the site visit, avian micro-habitats and sensitive habitats for avifaunal communities were identified and mapped.

The methodology used during the survey was deemed sufficient as this area was identified (and confirmed on site) as a low sensitive or low risk area within the REDZ map (Avian Impact

[1] Study area refers to the area including the project site and surroundings which provides the most accurate representation of available avifaunal habitats as well as diversity of the region whilst taking into account accessibility and time constraint.

Sensitivity Map for Solar Developments within Vryburg FA 6; refer to Figure 6). During the site visit sufficient first-hand knowledge of the avian habitats as well avian species present were obtained as well as information regarding the potential impacts that the development will have on the avifaunal character of the area.

2.3 Criteria used to assess site sensitivity

The Avian sensitivity map of the project site and power line corridor was produced by integrating avian microhabitats present on site and avifaunal information collected during the site visit. The avian sensitivity of the different units identified in the mapping procedure were rated according to the following scale:

Table 1: Explanation of sensitivity rating

Sensitivity	Factors contributing to sensitivity
VERY HIGH	Critical and unique habitats that serve as habitat for rare, threatened, endemic or range-restricted species and/or perform critical ecological roles. These areas are essentially no-go areas from a development perspective and should be avoided as much as possible.
HIGH	Areas of natural or transformed land where a high impact is anticipated due to the high biodiversity, sensitivity or important ecological role of the area. Development within these areas is undesirable and should only proceed with caution as it may not be possible to mitigate all impacts appropriately.
MEDIUM	Areas of natural or previously transformed land where the impacts are likely to be largely local. These areas usually comprise the bulk of habitats within an area. Development within these areas can proceed with relatively little ecological and avian impacts provided that appropriate mitigation measures are taken.
LOW	Areas of natural or transformed habitat with a low sensitivity where there is likely to be a negligible impact on ecological processes and avifauna. Most types of development can proceed within these areas with little ecological impact.

* In some situations, areas may also be classified between the above categories, such as *Medium-High,* where it was deemed that an area did not fit well into a certain category but rather fell most appropriately between two sensitivity categories.

3 STUDY AREA

3.1 Locality

The project site is 642ha in extent and is located approximately 8 km south of the town of Vryburg which is situated within the Naledi Local Municipality and Dr Ruth Segomotsi Mompati District Municipality. Furthermore, the project site falls within the 2724BA quarter degree square (QDGS). The following properties form part of the project site and power line corridor:

» Portion 1 of the farm Champions Kloof 731,
» Portion 4 of the farm Waterloo 730,

» Farm Rosendal 673/RE (does not form part of the project site for the proposed solar development but a section of the proposed power line corridor traverses this property), and
» Remaining Extent of Portion 3 of the farm Waterloo 730.

The project site is located within Zone 6 of the Renewable Energy Development Zones (REDZ), which is otherwise known as the Vryburg REDZ as well as the Northern Transmission Corridor.

The surrounding landscape is utilized for agricultural purposes, predominantly grazing land for livestock (mostly cattle and to a lesser extent sheep). In some areas game have been re-introduced and should also be seen as part of the agricultural environment. Most of the grazing is unimproved vegetation with some small, scattered patches of secondary grassland, which was historically cultivated. Currently very little of the surrounding environment is under cultivation, with relative small, isolated areas scattered throughout the receiving environment. Access to the project site can be obtained via the N18 which runs in a north to south direction, adjacent-east of the project site. The closest built-up areas are the agricultural town of Vryburg, which is located some 8 km north of the project site and the Huhudi informal/semi-formal settlement which is located approximately 6.3 km north of the project site and adjacent to the N18. Within this part of the receiving environment, anthropogenic influence is also visible in the form of the N18 national route and a railway line which both traverse the project site in a north-south direction as well as electricity transmission infrastructure comprising a 400kV power line and the Mookodi Transmission substation. In addition, there are some small quarries in the area as well as the Arthington Memorial Church and the Tiger Kloof Educational Institution along the N18.

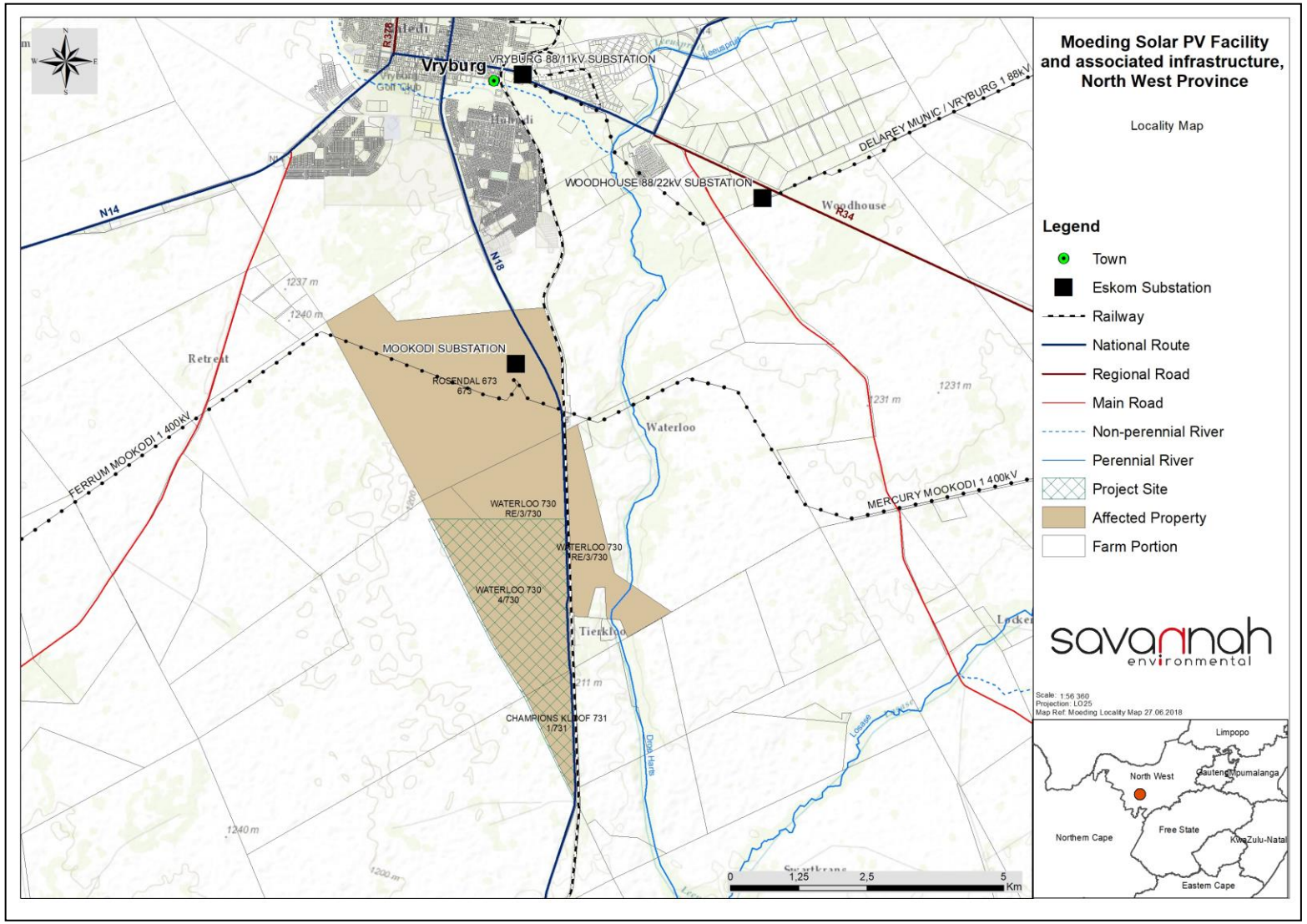

Figure 1: Locality map of the proposed Moeding Solar PV Facility, North-West Province (map provided by Savannah Environmental).

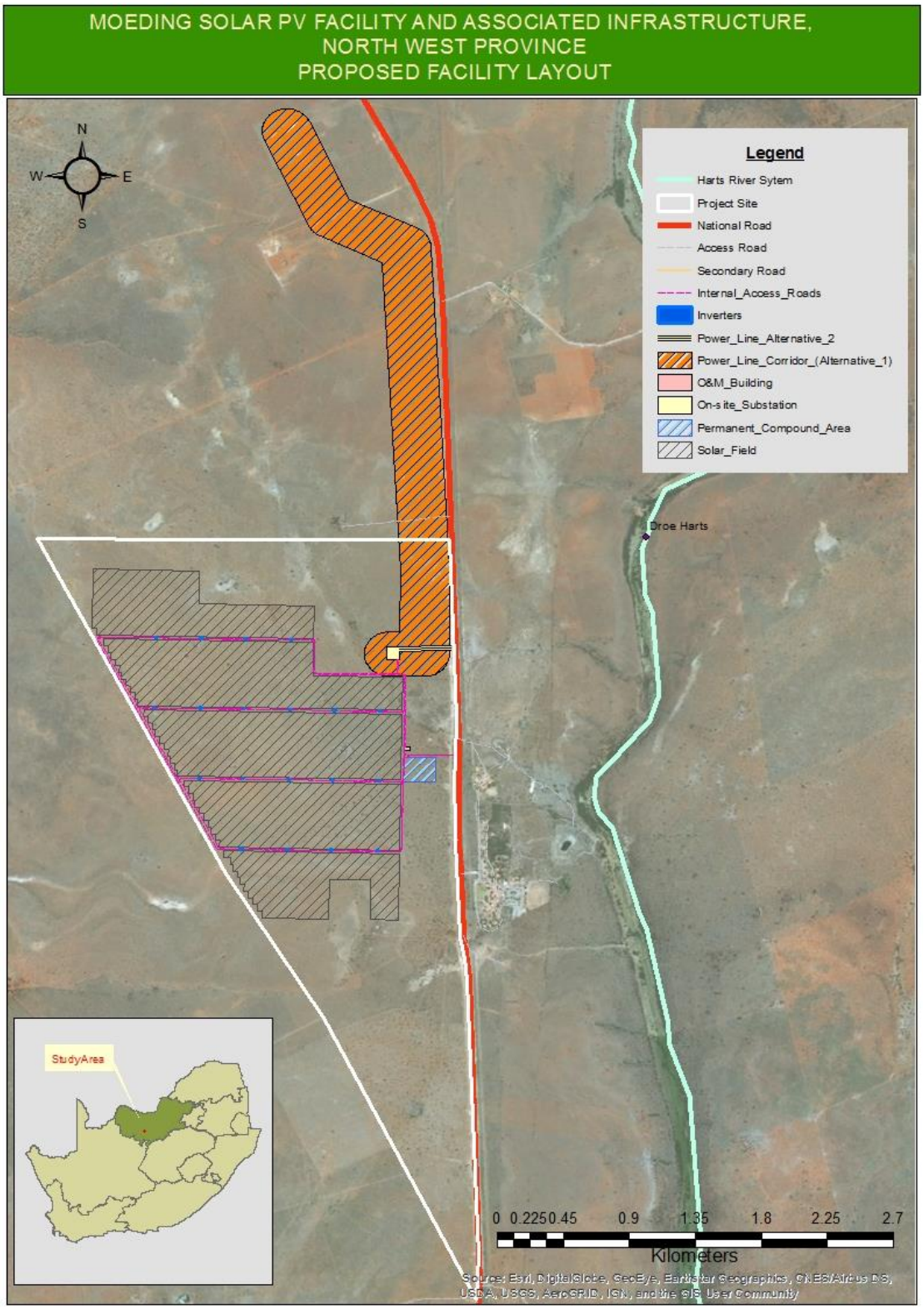

Figure 2: Proposed Moeding Solar PV Facility Layout near Vryburg, North West Province.

3.2 Climate and rainfall

The climate associated with the study area has been derived from recorded and extrapolated climatic data (http://en.climate-data.org/location/10658/) for Vryburg (Figures 3 and 4). Rainfall occurs mainly in summer and autumn with very dry winters. Mean annual rainfall is about 477mm with January being the wettest month, averaging about 89mm, and July being the driest, with an average of only 4mm. The average annual temperature in Vryburg is 17.9°C with January being the warmest (Ave. 24.8°C) and July being the coldest (Ave 9.3°C). Frost is frequent to very frequent in winter (mean frost days: 40).

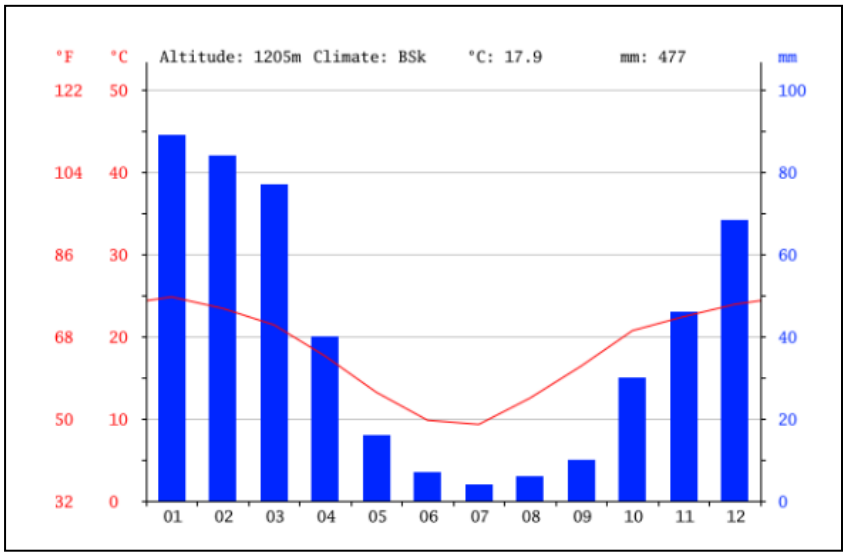

Figure 3: Climate graph of Vryburg (http://en.climate-data.org/location/10658/).

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	89	84	77	40	16	7	4	6	10	30	46	68
°C	24.8	23.4	21.4	17.6	13.2	9.8	9.3	12.5	16.4	20.7	22.4	23.9
°C (min)	17.2	16.3	14.3	9.8	4.4	0.4	-0.3	2.6	7.0	12.0	14.3	16.1
°C (max)	32.4	30.5	28.5	25.5	22.1	19.3	19.0	22.5	25.9	29.5	30.5	31.8
°F	76.6	74.1	70.5	63.7	55.8	49.6	48.7	54.5	61.5	69.3	72.3	75.0
°F (min)	63.0	61.3	57.7	49.6	39.9	32.7	31.5	36.7	44.6	53.6	57.7	61.0
°F (max)	90.3	86.9	83.3	77.9	71.8	66.7	66.2	72.5	78.6	85.1	86.9	89.2

Figure 4: Climate table of Vryburg (http://en.climate-data.org/location/10658/).

3.3 Topography and drainage

The study area can be described as largely flat to slightly undulating with an average slope of only 0.2% and a maximum slope of 0.8%. The position of the project site within the greater landscape can be described as a relative flat (gradual westward sloping) bench or isolated plain, within a footslope region of a mostly concave landscape. This area furthermore, is situated right at the edge of the

valley rim of the Droë Harts River valley which is characterised by steep, narrow inner slopes and a relative narrow valley floor.

The topography of the project site itself can be described as a plain with a slight east to south-eastern inclination with the north-western portion forming the highest lying section and the south-eastern corner the lowest lying section of the project site. Furthermore, the entire project site is characterised by small micro-typographical variations, mostly due to small geological variations (e.g. low scattered bedrock exposures, depression features (pan wetlands), overlying calcretes.

The project site is situated at elevations of between 1 220 m and 1 191 m above sea level, with an elevation gain/loss of only 19 m. The average elevation of the project site is 1 209 m above sea level.

A unique feature of the project site is the palaeo-valley (fossil river) running in a West to East direction within the central portion of the project site and is fringed along the southern bank by a very low, cherty-dolomite ridge line. The palaeo-channel is mostly flat or very gradual sloping. Although there is still a very slight incision of the channel, it is mostly filled with a moderately thin layer of sand and/ or silt and clay. For most part of this channel surface drainage functionality has been lost. Some moisture within the soil may however be retained for longer periods of time, following rainfall events (higher than the surrounding area), but most of these areas seldom exhibit saturated soil conditions. These areas of higher moisture content will likely be characterized by a plant species composition different from the surrounding dryer areas.

Another landscape feature within the project site is the calcareous bed or mantle, located in the north-western corner and south of the larger pan wetland, which is slightly elevated above the lower lying dolomitic dominated areas.

Furthermore, within the project site, five pan wetlands and a small drainage line providing some connection between two of the pan wetlands were identified. These wetland types are shallow depressions or basin which are usually closed-systems (endorheic). Overall, pans are principally viewed as ephemeral and sporadic. Pans are also regularly restricted to lowlands or plains and can become very turbid after rainfall events and saline throughout time. In terms of pan wetland geomorphology, the influx of silt and clay due to inward depositional processes results in the accumulation of sediment. This sediment forms a layer that is relatively impermeable and is found near the surface in the subsoil of a pan basin. However, soil composition (for example, degree of sand, silt and clay) may vary between the pans.

Aside from these surface water features, no rivers and other forms of watercourses were identified on site.

3.4 Existing Land Use

The open Savannah Grassland and shrublands is mostly used as grazing for livestock, especially cattle, with some presence of small game species. Most of the grazing is unimproved vegetation (natural to semi-natural), apart from the southern corner which is covered by a secondary open tree Savannah, covering historically cultivated areas.

Built form within the project site, is minimal and mostly restructured to infrastructure associated with the general land use activity (livestock rearing) which include:

- a cattle kraal (pens);
- artificial watering points, windmills and cement dams;
- cattle feeding points;
- fences;
- farmstead;
- gravel access roads;
- ancillary farm buildings; and
- remnants of old worker's dwellings.

Other infrastructure includes:

- cell phone mast;
- the N18 road (site access will be gained from this road);
- Mookodi - Magopela 132kV power line (to be constructed); and
- 400kV Overhead Power Line (adjacent and parallel with the N18 road).

Other notable infrastructure located in relative close proximity to the project site includes:

- the Mookodi Main Transmission Substation (MTS) (north of the project site);
- the Tierkloof railway station and railway line (running adjacent-east and parallel with the N18); and
- the Tiger Koof Education Institution and Arthington Memorial Church (east of the railway line.

3.5 Strategic Environmental Assessment for wind and solar PV energy in South Africa – Renewable Energy Development Zones (REDZs)

The DEA has been mandated to undertake a Strategic Environmental Assessment (SEA) process. The wind and solar photovoltaic SEAs are being undertaken in order to identify geographical areas most suitable for the rollout of wind and solar photovoltaic energy projects and the supporting electricity grid network. The DEA and Council for Scientific and Industrial Research (CSIR) have released a map with focus areas (FA) best suited for the roll-out of wind and solar photovoltaic energy projects in South Africa. The aim of the assessment is to designate renewable energy development zones (REDZs) within which such development will be incentivised and streamlined. The proposed solar facility falls within the identified geographical areas / focus area most suitable for the rollout of the development of solar energy projects (called "Vryburg Solar priority area") within the North-West Province. The proposed Vryburg REDZ 6 landscape sensitivity of remaining areas after the elimination of combined very high sensitivities is shown in Figure 6. The Moeding Solar PV Facility site falls within an area of lower sensitivity.

Appendix A5 (Bird Scoping Assessment Report and Development Protocols) of the Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy in South Africa.

The second stage of the SEA comprises a scoping-level assessment of the Renewable Energy (RE) development sensitivities within each of the identified FAs, in order to identify those areas of lowest sensitivities, where development applications can be fast-tracked without compromising the environmental sustainability of the RE industry.

According to this report the most significant impacts causing a concern about the implications for avifauna of large-scale solar PV developments include the tendency of these developments to destroy, degrade, fragment or otherwise displace birds from large areas of natural habitats. This is especially of significance for species with restricted ranges and very specific habitat requirements. Other possible impacts of solar PV facilities as identified within this report include noise and disturbance generated by construction and maintenance activities, collision and electrocution mortality associated with newly installed power infrastructure, the attraction of novel species to an area by the artificial provision of otherwise scarce resources (perches, nest sites and shade etc.) and potential chemical pollution.

Furthermore, according to this report the following activities relating to infrastructure associated with solar PV developments, may potentially have significant impact on local avifauna:

- The construction and maintenance of substations, power lines, servitudes and roadways cause both temporary and permanent habitat destruction and disturbance,
- Overhead power lines pose a collision and possibly an electrocution threat to certain species (Van Rooyen 2004, Lehman et al. 2007, Jenkins et al. 2010). Some habitat destruction and alteration inevitably take place during the construction of power lines, substations and associated roadways.
- Also, power line service roads or servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, and to prevent vegetation from intruding into the legally prescribed clearance gaps between the ground and the conductors.

Impacts associated with the above described activities may include the following:

- These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the power line corridor, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any given power line (e.g. King & Byers 2002).
- Power line collision risk affects a particular suite of susceptible species, mainly comprising large, heavy birds (such as bustards, cranes and large raptors), and smaller, fast-flying birds (such as gamebirds, waterfowl and small raptors - Bevanger 1994, 1998, Janss 2000, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins et al. 2010).
- Electrocution risk is strongly influenced by the voltage and design of the power lines erected (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energised components (Lehman et al. 2007).

The main objective of this present study was to examine and map avian impact sensitivity within the eight FAs and to look for areas within each FA where these sensitivities are low enough to allow some abbreviation or streamlining of the baseline monitoring requirements.

The following description has been provided for the Vryburg Focus Area following the scoping assessment:

> *"The Vryburg FA (9 204 km2) falls within the Savannah Biome and is dominated by the Eastern Kalahari Bushveld Bioregion (Mucina & Rutherford 2006). Open Savannah or bushveld vegetation covers the majority of the FA, which features very little topographic relief. The northwestern section includes a number of salt pans that form a unique feature in the open landscape. The FA is not*

located close to any registered national Important Bird Areas, but is located about 30 km north-east of Barberspan, an acknowledged and registered RAMSAR site since 1975, and one of the few wetlands in the area that contains water throughout the year, attracting large numbers of wetland and water-dependant bird species.

The FA supports up to 337 bird species, of which 23 are red-listed species, and two are red-listed endemics (Melodious Lark and Short-clawed Lark Certhilauda chuana).

The avifauna of this area is poorly known and virtually undocumented. Levels of rural and agricultural development appear to be high, but in areas where the open Savannah is at least partially intact, and especially where sizable trees still remain, large Savannah raptor species such as Tawny Eagle, Lappet-faced Vulture, White-backed Vulture, and even Bateleur Terathopius ecaudatus may still be present. Otherwise, the open plains are likely to hold numbers of threatened large terrestrial birds (e.g. Secretarybird, Blue Crane and Kori Bustard, the town of Stella is a summer roost site for >3000 Lesser Kestrels, and the wetlands areas are likely to attract both Greater and Lesser Flamingos and a variety of other waterbirds (particularly in wet years).

We identified a short-list of 18 threatened and/or impact susceptible priority species to inform the sensitivity mapping for this FA (Table 3). A suite of large Savannah raptors, Lesser Kestrel and Greater Flamingo were the most influential species in shaping the sensitivity maps for this area."

Within the Bird Scoping Assessment Report (desktop integration and interpretation of existing data) of the SEA, avian impact sensitivities were generated and mapped (Figures 5 - 7) based on the interpretation of spatial data known as absolute sensitivity criteria (refer to Table 2).

According to the Figures 6 and 7, Moeding Solar PV Facility is located within a green zone which is defined within the Bird Scoping Assessment Report as:

A low sensitivity area which possibly does not support important populations of threatened species that is susceptible to impacts. These areas are probably suitable for development, but present levels of knowledge preclude confident predictions on the sustainability of impacts.

Table 2: The absolute sensitivity criteria applied for solar developments within the Vryburg FA 6.

Site	Description of criteria	Application Sensitivity: Buffer Distance

Relevant to all Focus Areas	All wetlands with a surface area >20 000 m^2	Medium: 1 km from edge
	All protected areas	Very High: 1 km from edge
	From DEM slopes >75°, that probably constitute sheer cliffs that may be used by cliff-nesting/slope soaring birds.	High: 1 km
Upington Focus Area 7	Power lines ≥88 kV possibly used by nesting White-backed Vultures or other raptors.	Medium: 2 km
	Known migrating kestrel roost site	Very High: 1 km
	Unknown area with some data to suggest preferential use by large Savannah raptors, broadly located in the arc bordered by the R378 and the N14, and based loosely on the SABAP2 data above	Medium: No buffer
	Presence data for a suite of threatened, impact susceptible large Savannah raptors.	High: No buffer

Table 3: Listed priority species identified for the Vryburg FA 6. Key species in the sensitivity mapping process are highlighted in bold. NT = Near Threatened; VU = Vulnerable; EN = Endangered; LC = Least Concern.

Name	Threat Status		SA Endemic	SABAP2 Rep Rate (%)	FA-specific predicted susceptibility to Solar
	Regional	Global			
Secretary Birds *Sagittaraius serpentarius*	VU	VU		3.24	Moderate
Martial Eagle *Polemaetus bellicosus*	EN	VU		0.00	Moderate
Korri Bustard *Ardeotis kori*	NT	NT		0.00	Moderate
Blue Crane *Anthropoides paradiseus*	NT	VU	Near-Endemic	0.00	Modetate
African Fish-Eagle *Haliaeetus vocifer*	-	-		3.24	Low
White-backed Vulture *Gyps africanus*	EN	EN		7.03	Moderate
Lappet-faced Vulture *Aegypius tracheliotus*	EN	VU		1.62	Moderate
Bateleur *Terathopius escaudatus*	EN	NT		0.54	Moderate
Tawny Eagle *Aquila rapaxs*	EN	LC		0.00	Moderate
Booted Eagle *Aquila pennatus*	-	-		2.39	Low
Lesser Kestrel *Falco naumanni*	-	-		9.19	Moderate
Red-footed Falcon *Falco vepertinus*	-	-		1.08	Moderate
Amur Falcon Falco amurensis	-	-		1.08	Moderate

Greater Flamingo ***Phoenicopterus ruber***	NT	LC		4.86	Moderate
Great White Pelican Peliecanus onocrotalus	VU	LC		0.00	Low
Pink-backed Pelican Peleacanus rufescens	VU	LC		0.00	Low
Lesser Flamingo *Phoeniconaias minor*	NT	NT		1.08	Moderate
Black Stork *Ciconia nigra*	VU	LC		1.08	Low
Melodious Lark *Mirafra cheniana*	LC	NT	Near-Endemic	0.54	High

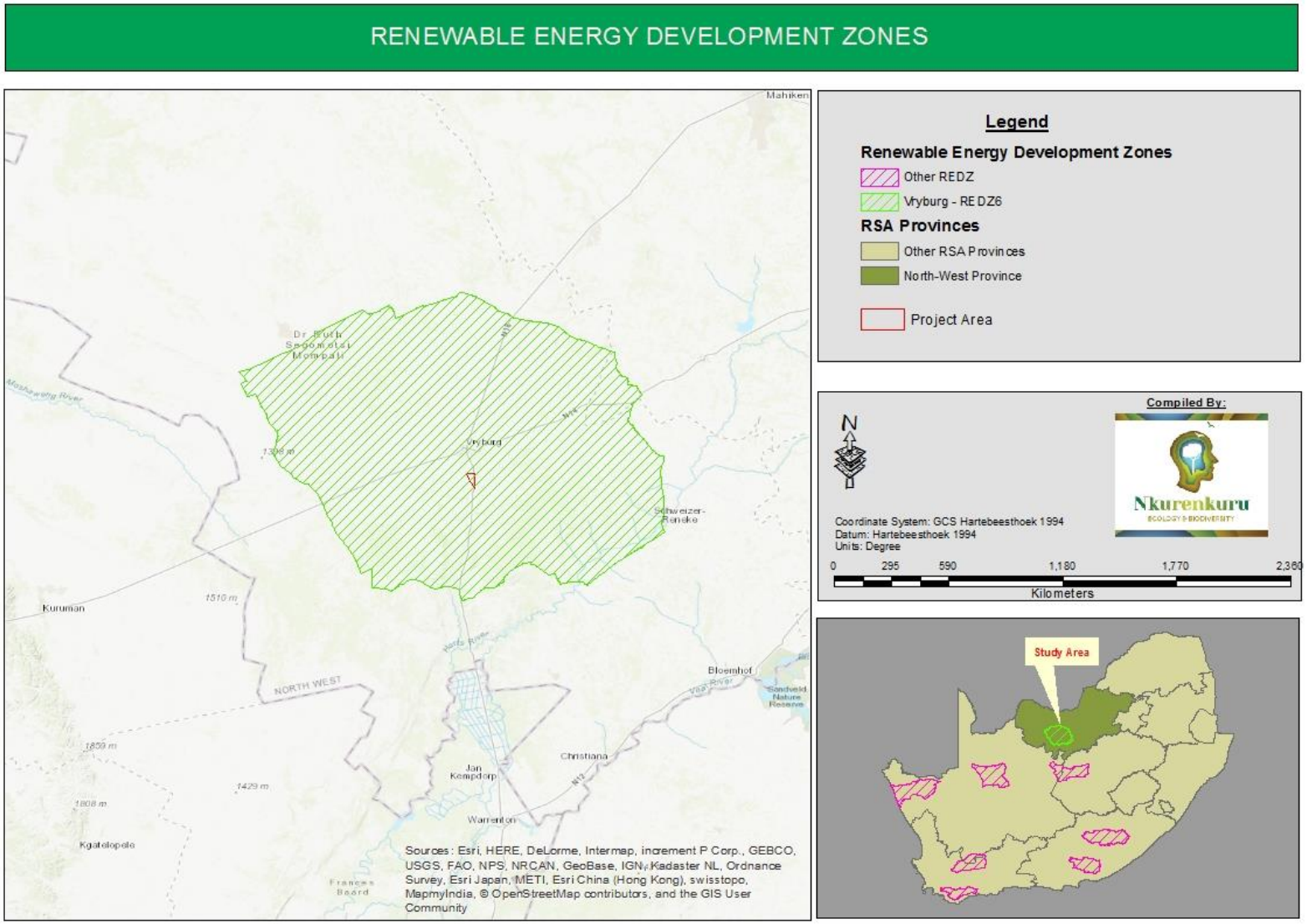

Figure 5: The project site's location within the REDZ6: Vryburg.

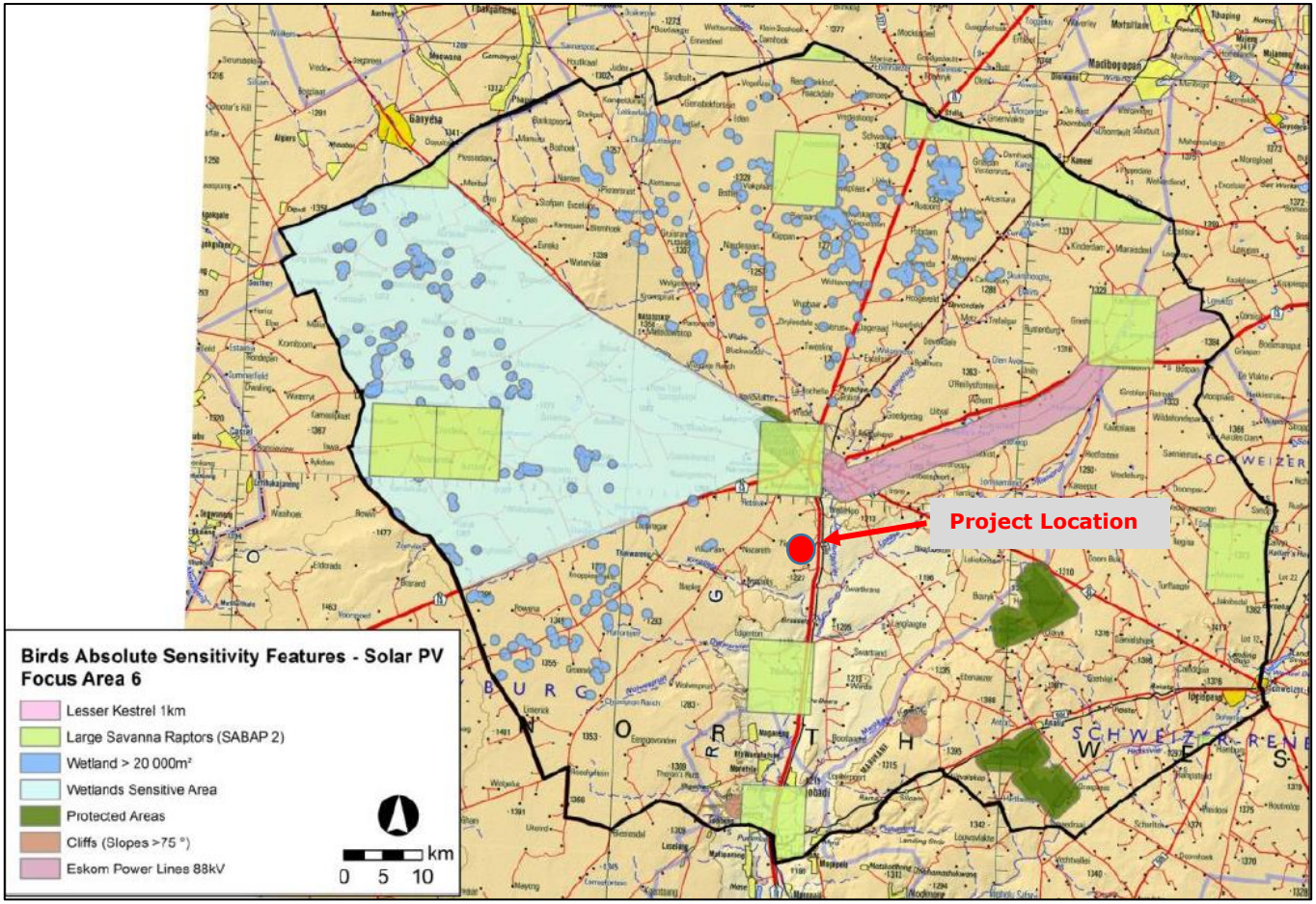

Figure 6: Avian Sensitivity Features Map (copied from DEA, 2015) indicating that the proposed Moeding Solar PV Facility (red dot) is located outside any sensitive feature.

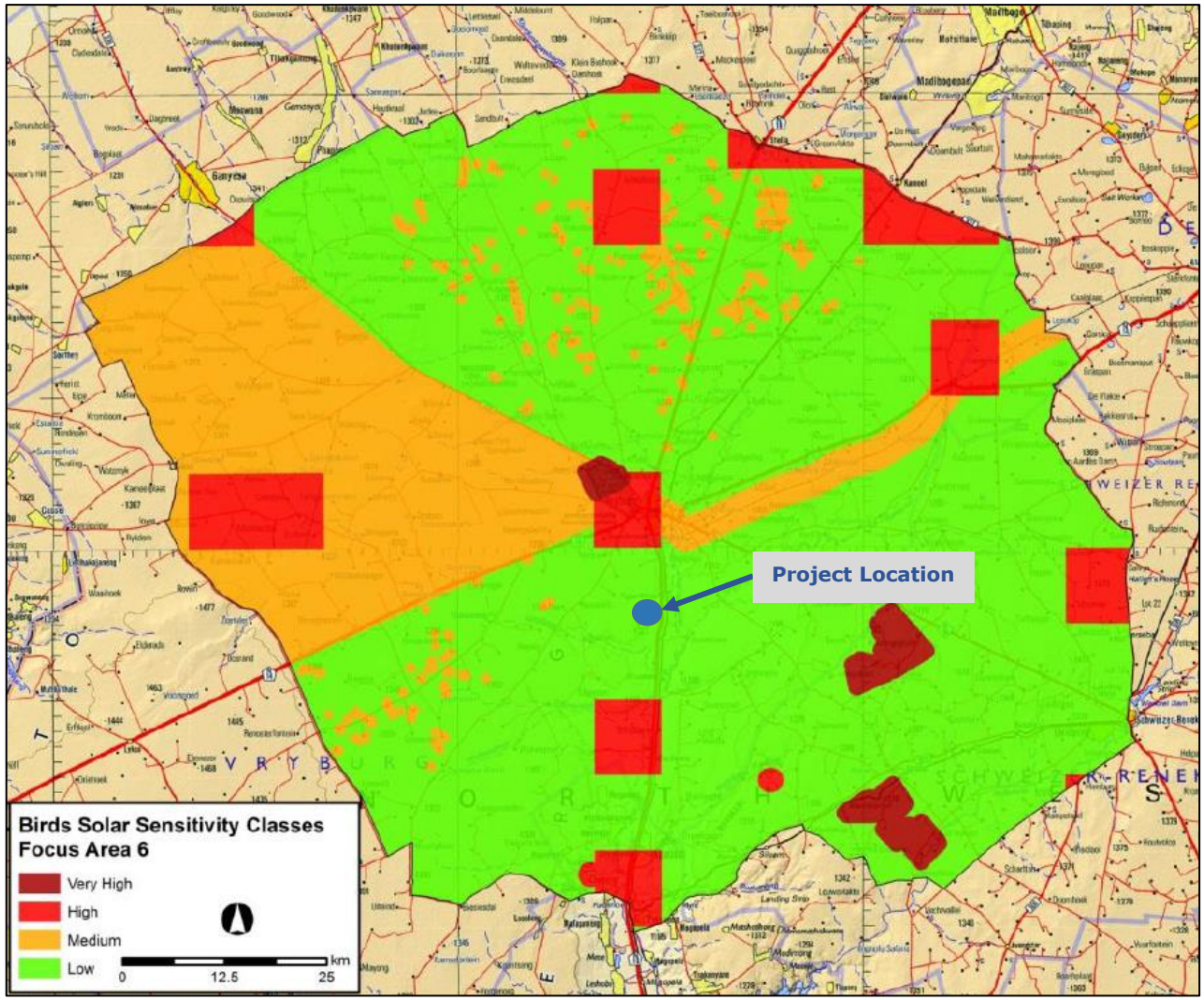

Figure 7: Avian Impact Sensitivity Map (copied from DEA, 2015) indicating that the proposed Moeding Solar PV Facility (dark blue dot) and power line alternatives are located within a Green Zone or a Low Landscape Sensitivity Area.

3.6 Vegetation Overview

The project site and power line corridor is situated in the Savannah biome and Eastern Kalahari Bushveld Bioregion. The vegetation in and surrounding the project site is Ghaap Plateau Vaalbosveld (SVk 7).

The distribution of the vegetation type is spread across the Northern Cape and North West Province, from about Campbell in the south east of Danielskuil through Reivilo to around Vryburg in the north. This vegetation type has been described by Mucina and Rutherford (2006) as a flat plateau with well-developed shrub layer with *Tarchonanthus camphoratus* and *Acacia karroo*. Open tree layer has *Olea europaea* subsp. *africana*, *A. tortilis*, *Ziziphus mucronata* and *Searsia lanceae*. *Olea* is more important in the southern parts of the unit, while *A. tortilis*, *A. hebeclada* and *A. mellifera* are more important in the north and part of the west of the unit. Much of the south-central part of this unit has remarkably low cover of Acacia species for an arid Savannah and is dominated by the non-thorny *T. camphoratus, R. lanceae* and *O. europaea* subsp. *africana.*

This vegetation type is regarded as Least Threatened by Mucina and Rutherford (2006) and is not listed within The National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environment Management: Biodiversity Act (Act No. 10 of 2004) (NEM:BA). According to Mucina and Rutherford (2006) transformations within this unit is very limited with only 1% being transformed. This vegetation unit is furthermore poorly conserved, with 0% conserved within statutory reserves as well as private conservation areas.

3.7 Avian micro-habitats

Most of the abundance and distribution of avian species can usually be attributed to the vegetation types and bioregions within an area. In determining the suitability of the project site for avian species, it is necessary to look at the habitats available to determine where the relevant species will most likely occur within the project site. These "micro habitats" do not always correspond to vegetation types and are determined by a combination of vegetation type, topography, land use, food sources and other various intrinsic factors.

During investigation of the project site (including the power line corridor), five important avian micro-habitats were identified. The project site was mostly consistent with the description of the Ghaap Plateau Vaalbosveld with some variations occurring between the grass and tree layer. This variation in vegetation structure species composition formed the basis identification of the different habitat

types. Four of the habitat types are variations of Savanah habitats whilst the fifth habitat type represent the pan wetlands and their wooded fringes.

The micro-habitats identified are as follows:

- Savannah Variations:
  - Savannah Grassland with some characteristics of Savannah Parklands
  - Savannah Shrubland
  - Tree Savannah
    - Natural
    - Transformed
  - Savannah Woodland
- Grassy pan wetlands with woody/shrubby peripheries.

3.7.1 Savannah Grassland

This Savannah type comprises of a dominant open grassland with some scattered shrubs and trees (mainly *Trachonanthus camphoratus, Grewia flava* and *Searsia tridactyla*). Tall trees are scarce and usually clumped together. This features of circular clumped and/or "mottles" of woody plants is also consistent of a Parkland Savannah type (two-phase mosaic landscape) but due to the fact that such clumps are quite scarce and the grass layer form such a prominent feature within this area, the former Savannah type is preferred. Such clumps typically comprise of *Searsia lanceae, Ziziphus mucronata* and *Trachonanthus camphoratus*. Variations within this habitat type occur and include areas where *T. camphoratus* and other taller tree/shrub species are less prominent with the low growing shrub; *Searsia tridactyla* forming the diagnostic shrub species. This variation mostly covers the low, almost inconspicuous chert ridge. The palaeo-channel on the other hand contains very little trees and shrubs which occasionally occurs along the channel. Key grass species includes; *Aristida congesta*, *Eragrostis lehmanniana, E. superba, Anthephora pubescens, Centropodia glauca, Schmidtia pappophoroides, Brachiaria nigropedata* and *Cymbopogon pospischilli*.

This habitat represents the majority of the vegetation in the project site and comprise most of the habitat that is located within the proposed power line corridor. This habitat has been subjected to historical and long-term overgrazing and has subsequently altered the vegetation structure, especially within the grass/forb layer. However, the grass – tree interactions, especially where tree clumps are surrounded by open portions of grassland contribute to variation within this habitat, and subsequently niche habitats.

Avian diversity within this habitat is regarded as moderate with 35 species recorded. The larger tree clumps may provide roosting and nesting from many bird

species (no important roosting or nesting sites were however recorded in the project site i.e. project site and 300m corridor). The open grassy areas represent foraging and/or hunting areas for many insectivorous and granivorous bird species, including species such as Helmeted Guineafowl, Common Quail, Kori Bustard, Northern Black Korhaan, Eastern Clapper Lark, Spike-heeled Lark, Desert Cisticola, Ant-eating Chat, Red-billed Quelea and African Pipit. Taller shrubs and tree species provide perching for especially insectivorous species such as; Southern Fiscal, Bokmakierie, Black-chested Prinia and Kalahari Scrub Robin. Avifaunal species typically recorded within and in close proximity to the tree clumps include; Ring-neck Dove, Cape penduline Tit, Black-chested Prinia, Yellow-bellied Eremomela, Kalahari Scrub Robin and Chestnut-vented Warbler.

Artificial features also contribute to the diversity within this habitat and include structures such watering points, cement dams, transmission power line and short grasslands and bare areas on severely trampled and grazed patches. The artificial watering points and cement dams regularly attracted species such as; Laughing Dove, Namaqua Dove, Lefaillant's Cisticola, Southern Grey-headed Sparrow, Red-billed Quelea, Black-throated Canary and Yellow Canary. Crowned Lapwing, Laughing Dove and Spike-heeled Lark were typically associated with the trampled and severely overgrazed patches. Few species were recorded, utilizing the power line (Mercury Mookodi 400kV Power Line) as a perched and included Ring-necked Dove, Laughing Dove, Red-billed Quelea, Pied Crow and Cape Sparrow

The only Conservation Important Avifaunal species recorded within this habitat type was a single Kori Bustard (*Ardeotis kori*) – Near Threatened.

3.7.2 Savannah Shrubland

This habitat predominantly occurs on the calcareous beds within the project site and is fairly plant species poor. *T. camphoratus* and *G. flava* are the most dominant species within this unit and cover approximately 60% - 70% of the project site, creating a fairly dense, medium tall shrub layer. The proposed power line corridor contains a fairly large portion of this habitat type. The grass layer below these shrubs comprise predominantly of A*nthephora pubescens, Eragrostis lehmanniana, Cymbopogon pospischilli, Enneapogon desvauxii* and *Themeda triandra.* Forbs such as *Felicia muricata*, *Hertia pallens, Barleria macrostegia, Pentzia incanum, Geigeria burkei,* and *Blepharis integrifolia* are also relative dominant. It is likely that this shrub layer may have densified and somewhat encroached over this calcareous layer due to overgrazing over a long period of time.

Avian diversity within this habitat is regarded as low with only 13 species recorded. This is likely due to the largely homogenous and dense plant composition and

structure. Prominent avifaunal species within this habitat includes; Southern Fiscal, Cape Penduline Tit, Black-chested Prinia, Chestnut-vented Warbler and Kalahari Scrub Robin.

No Conservation Important Avifaunal species were recorded within this habitat type.

3.7.3 Tree Savannah (Open tree layer with moderate dense grass layer)

This Savannah type comprises of an open tree Savannah characterised by medium size trees and a well-developed and moderate to dense grass layer. This vegetation unit may show some resemblance to portions of the Open Vaalbos Shrubland in terms of species composition and diversity, with differences occurring in the form of the structure and relationship between the different plant strata. The tree Savannah contains a denser (although still open) tree layer whilst the shrub layer is much more open. As within the Open Vaalbos Shrubland, clustering of trees may occur. Dominant tree species include; *Searsia lancea*, *Acacia karoo, Acacia tortilis* and *Ziziphus mucronata*. *T. camphoratus* and *G. flava*, even though still constant throughout the area, are much lower in density. Within the tree Savannah two distinctions (forms) could be made based on the degree of transformation and are:

- a near-natural to natural tree Savannah dominated by *S. lancea* and *Z. mucronata* and a dense, well developed grass cover; and
- a transformed form of tree Savannah occurring on historically cultivated areas, dominated by *S. lancea* and A*. karroo*. The grass layer is much sparser and dominated by mostly wiry unpalatable species.

Avian diversity within this habitat varied between the two forms with the natural form being moderate with 26 species recorded whilst the transformed form was relatively poor (16 species recorded).

The following remarks have relevance to the natural form of Tree Savannah habitat:

The higher biomass and structural and compositional variation in the vegetation (Natural form) supports a higher diversity and abundance of bird species, with large trees potentially providing roosting and nesting for many bird species (no important roosting or nesting sites were however recorded in the project site). Furthermore, this natural form of tree Savannah is relatively small in extent when compared to the Savannah grassland but provide, within the limited space, a high diversity of niches, and the abundance (density) of species within this unit per size was much higher than the Savannah grassland. The denser woody areas provided niche and habitat for species such as Golden-breasted Bunting, Yellow Canary, Violet-eared

Waxbill, Red-billed Firefinch, Ring-neck Dove, Cape penduline Tit, Black-chested Prinia, Yellow-bellied Eremomela, Kalahari Scrub Robin and Chestnut-vented Warbler. Within the more open grassy areas the following species were regularly recorded; Helmeted Guineafowl, Northern Black Korhaan, Eastern Clapper Lark, Sabota Lark, Desert Cisticola, Ant-eating Chat and Red-billed Quelea.

No Conservation Important Avifaunal species were recorded within this habitat type.

3.7.4 Tree Savannah (Dense shrub/tree cover)

This Savannah type, within the project site is very small and limited in extent and comprises a dense tall shrub / tree cover, forming an almost closed canopy in some areas. Open patches and peripheries of these woodlands contain shade loving grasses whilst the deeper shaded areas contain forbs with some possessing the ability to climb. This patch is dominated by a tall dense tree cover comprising of a mixture of broad- and compound leaved tree species (*Acacia karroo, Searsia lancea and Ziziphus mucronata*). The lower shrub stratum is characterized by *Diospyros lycioides, Gymnosporia buxifolia* and *Searsia leptidictya.* The lower stratum comprises predominantly of shade tolerating forbs such as *Pergularia daemia, Sida chrysantha* and *Pavonia burchelii*. The nitrogen enriched areas around *A. karroo* trees are dominated by a dense sward of *Setaria verticilata*.

Avian diversity within this habitat was relatively poor (13 species recorded) and is most likely due to the location of this habitat in close proximity to infrastructure. However, this unit is unique in terms of species composition and vegetation structure and subsequently contribute to habitat niche diversity. Species that was recorded within this habitat type included; Golden-breasted Bunting, Violet-eared Waxbill, White-bellied Sunbird, Cape Starling, Chestnut-vented Warbler, Black-chested Prinia, Red-faced Mousebird, Acacia Pied Barbet and Barred Wren-Warbler

No Conservation Important Avifaunal species were recorded within this habitat type.

3.7.5 Grassy pan wetlands with woody/shrubby peripheries

There are five ephemeral pans (which will only hold water after heavy rains with larger wetlands being inundated for some time) within the project site. These areas are also usually characterized by soils with a higher clay content due to the accumulation of such textures in these low-lying areas. These pans comprise of a low to tall moisture loving grassland which may be replaced by forbs when regularly trampled and grazed. Key species include; *Panicum coloratum, Cynodon dactylon, Eragrostis cilianensis, Echinochloa holubii, Brachiaria marlothii, Schkuria pinnata*

and *Persicaria serrulata*. The composition of dominant species typically varies along a moisture gradient. Woody patches are found as small, dense patches at the peripheries of some of the pan wetlands, where the soils are slightly clayey and relatively shallow with surface rock typically present. These patches comprise a combination of small to moderately sized trees and shrubs with a moderate ground cover, predominantly forbs and shade loving graminoids. Key species include *Searsia lancea, Ziziphus mucronate, Searsia pyroides, Diospyros lycioides, Grewia flava*, *Asparagus laricinus* and *A. suaveolens* with the occasional *Acacia erioloba* species. This habitat unit is important for numerous species, as it is a reliable source of surface water in the area and because the vegetation potentially supports numerous wetland bird species especially during periods of inundation.

Avian diversity within this habitat is regarded as moderate with 26 species recorded. The larger tree clumps at the peripheries may provide roosting and nesting for many bird species (no important roosting or nesting sites where however recorded in the project site). The open grassy areas represent foraging and/or hunting areas for many insectivorous and granivorous bird species, including species such as Common Quail, Crowned Lapwing, Namaqua Sandgrouse, Spike-heeled Lark, Red-capped Lark, Lefaillant's Cisticola, Red-billed Quelea, Red-headed Finch, Grey-backed Sparrow Lark, Black-faced Waxbill, Yellow Canary and African Pipit. Taller shrubs and tree species provide perching for especially insectivorous species and smaller raptor species (especially taller *Acacia erioloba* trees associated with pan fringes) with the following recorded species; Greater Kestrel, Lanner Falcon, Black-winged Kite, Sabota Lark, Familiar Chat, Chat Flycatcher, Southern Fiscal, Black-chested Prinia and Kalahari Scrub Robin. Other avifaunal species typically recorded within and in close proximity to the tree clumps furthermore include; Red-eyed Dove, Ring-neck Dove, Cape penduline Tit, Yellow-bellied Eremomela, Violet-eared Waxbill and Chestnut-vented Warbler. Especially the larger specimens of *Acacia erioloba* are regarded as important avifaunal features within this habitat unit and are preferential perching sites for especially raptor species.

During periods of inundation waterfowl, herons and waders may frequent these pans and likely include Spur-winged Goose, Egyptian Goose, South African Shelduck, Yellow-billed duck, Hadada Ibis, Black-headed Heron, Pied Avocet, Three-banded Plover, Common Greenshank and sanpiper species etc.

The only Conservation Important Avifaunal species recorded within this habitat type was a single Lanner Falcon (*Falco biarmicus*) – Vulnerable.

3.8 Important Bird Areas (IBA)

The proposed PV Facility and associated power line infrastructure is not located within or in close proximity to any Bird Area and will thus have no impact in this regard.

3.9 Avifauna species composition

A total of 221 species were recorded within the study area and broader impact zone of the development (SABAP1 & 2) with 17 species classified as Red Data species (Barnes 2014), 12 endemic species and 28 near-endemic species. Of these, 55 species were recorded during the site visit, most notable of which being sightings of Kori Bustard (Near Threatened) and Lanner Falcon (Vulnerable). Also notable, despite being recorded outside of the project site (but included due to their transient nature which could bring them into contact with the development), being the sightings of White-backed Vulture (Critically Endangered) and Greater Flamingo (Near Threatened).

The birds of greatest potential relevance and importance in terms of the possible impacts of the Solar PV Project and its associated power infrastructure are likely to be local populations of threatened or endemic passerines (Ant-eating Chat *Myrmecocichla formicivora* and Cape Longclaw *Macronyx capensis*), shy ground-nesting species (Burchell's Courser *Cursorius rufus* and Double-banded Courser *Rhinoptilus africanus*), resident or visiting large terrestrial birds (Secretarybird *Sagittarius serpentarius*, Abdim's Stork *Ciconia abdimii*, Black Stork *Ciconia nigra* and Blue Crane *Anthropoides paradieus*), resident or passing raptors (Martial Eagle *Polemaetus bellicosus,* Tawny Eagle *Aquila rapax,* Lanner Falcon *Falco biarmicus* and Red-footed Falcon *Falco vespertinus* and White-back Vulture) and transient waterbirds (Greater Flamingo*,* Lesser Flamingo *Phoenicopterus minor,* South African Shelduck *Tadorna cana* and Yellow-billed Stork *Mycteria ibis*).

Southern Africa contains 13 avifaunal endemic regions, namely Western Arid, Woodland, Evergreen Forest, Grassland, Montane, Rocky slopes and cliffs, Fynbos, Marine and Inland Waters (MacLean 1999). Of these regions, Grassland, where the project site is located, contains the fourth highest number of endemics. Overall, the core study area and immediate surroundings potentially contains a total of 40 endemics and near-endemics, which is 24% of the 167 southern African endemics and near-endemics (Hockey et al. 2005).

At the time of the site visit (14 - 15 May 2018) bird species diversity and abundance were moderate to low across the entire project site and corridor with a total of 55 species recorded. The Savannah Grassland habitat unit supported the highest species diversity due to the structural variation provided by the composition of trees, shrubs and grass patches. However, the natural Tree Savanah habitat type

was regarded as the most significant habitat type as this habitat type contained a high species diversity and abundance relative to its size. Abundance of species recorded within this unit was much higher than within the Savannah Grassland even though total diversity was a little bit lower. This diversity and abundance could also be attributed to the structural variation provided by the composition of trees, shrubs and grass patches.

The most commonly recorded species within the project site were passerine of which Scaly-feathered Weaver, Bokmakierie, Southern Fiscal, Desert Cisticola, Eastern Clapper Lark, Red-billed Quelea, Black-chested Prinia, Cape Penduline Tit, Chestnut-vented Warbler, Kalahari Scrub Robin and Yellow Canary. Non-passerines commonly recorded included Ring-necked Dove, Namaqua Dove, Northern Black Korhaan and Crowned Lapwing. Raptor species were not common within the project site and were mostly associated with the taller *Acacia erioloba* species located within the woodland fringes of some of the pan wetlands. Raptor species that were recorded included, Black-winged Kite, Southern Pale Chanting Goshawk, Greater Kestrel and Lanner Falcon. Sixteen Endemic and Near-Endemic species were recorded during the site survey and includes; Southern Pale Chanting Goshawk, Northern Black Korhaan, Namaqua Sandgrouse, Acacia Pied Barbet, Bokmakierie, Sabota Lark, Spike-heeled Lark, Grey-backed Sparrow Lark, African Red-eyed Bulbul, Barred Wren-Warbler, Chestnut-vented Warbler, Kalahari Scrub Robin, Ant-eating Chat, Chat Flycatcher, Scaly-feathered Weaver and Yellow Canary. Two Red listed species were recorded within the project site namely; Kori Bustard (Near Threatened) and Lanner Falcon (Vulnerable).

On the basis of the observations recorded during the field visit, and in combination with already documented information on the avifauna of the project site, 17 priority species are considered central in this avifaunal impact study (Table 5). These are mostly threatened species which are known to occur, or could occur, in relatively high numbers in the project site and the broader impact zone of the development and which are likely to be, or could be, negatively affected by the Solar PV Facility.

Overall, the avifauna of the project site and the broader impact zone of the Solar PV Facility is not considered unique and is typical of what occurs across large areas of the Savannah Biome, which therefore suggests that the sensitivity of the site, from an avian perspective, will not be of any great significance.

Table 4: Red listed species that may potentially occur within the project site and surroundings (surveyed area). Species that have been confirmed within the project site have been highlighted in **Green** font. (NT = Near Threatened; VU = Vulnerable; EN = Endangered; LC = Least Concern; CR = Critically Endangered)

Taxonomic name	Common Name	Red Data (Regional, Global)	Endemism	Habitat	Likelihood of occurrence	Susceptible to
Ciconia nigra	Stork, Black	VU, LC		Forages singly, occasionally in pairs/small groups in wetland habitats, dried up watercourses and small isolated pools. Roosts on cliff, tree or pylon.	Moderate	Collision / Electrocution
Ciconia abdimii	Stork, Abdim's	NT, LC		Gregarious and usually in flocks. Grassland, Savannah woodland, pan edges, pastures and cultivated areas. Regularly found foraging on irrigated lands, pastures and ploughed fields. Roost in large trees (incl. *Eucalyptus*), or cliffs.	Moderate	Habitat Loss / Disturbance / Collision / Electrocution
Mycteria ibis	Stork, Yellow-billed	EN, LC		Often in pairs or groups. Wide variety of wetland and aquatic habitats. Forages in shallow water free of emergent vegetation. Roosts communally on sandbanks, lake margins and large trees.	Moderate	Habitat loss / Disturbance
Phoenicopterus ruber	**Flamingo, Greater**	**NT, LC**		**Flocks greatly variable in size. Open water bodies (e.g. dams, sewage treatment works, ephemeral pans, river mouths and coastal mudflats). Breeds at recently flooded, large, eutrophic, shallow salt pans**	**Moderate**	**Collision**
Phoenicopterus minor	Flamingo, Lesser	NT, NT		Flocks greatly variable in size. Open, eutrophic, shallow wetlands. Small, ephemeral freshwater wetlands important for smaller flocks. Colonial nester. Breeds on saline lakes and saltpans	Moderate	Collision
Oxyura maccoa	Duck, Maccoa	NT, NT		Permanent wetlands in open grassland. Breeding habitat comprise of dense stands of emergent vegetation especially reeds, rushes and tall sedges.	Low	Habitat loss / Disturbance / Collision

Sagittarius serpentarius	Secretarybird	VU, VU		Pairs or sometimes solitary. Open grassland with scattered trees and shrubs. Roosts in crown of trees (mostly *Acacia* spp.).	High	Habitat loss / Disturbance / Collision
Gyps coprotheres	Vulture, Cape	EN, VU	E	Roosts mostly in mountainous area but may utilize large trees and pylons. Very wide and varying foraging range (up to 121,655 km^2). Colonial nester.	Low	Collision / Habitat loss / Disturbance / Electrocution
Gyps africanus	Vulture, White-backed	CR, CR		Savannah woodland and bushveld	Low	Habitat loss / disturbance / collisions / electrocutions
Polemaetus bellicosus	Eagle, Martial	EN, VU		Open woodland in fairly flat country, also open shrubland with drainage line woodland or high-tension pylons, and open farmland with clumps of trees.	Moderate	Collision / Electrocution
Coracias garrulus	Roller, European	NT, LC		Open woodlands	Moderate	Habitat loss / Disturbance
Aquila rapax	Eagle, Tawny	EN, LC		Open Savannah woodland	Moderate	Habitat loss / disturbance / Electrocution
Falco biarmicus	Falcon, Lanner	VU, LC		Singly or in pairs. Open grassland, open or cleared woodland, and agricultural areas. Nesting sites includes; cliffs (normally), large trees, electricity pylons and buildings). May utilize existing nests of other species, e.g. crows and other raptor species.	Confirmed	Collision/ Disturbance / Habitat loss / Electrocution
Falco vespertinus	Falcon, Red-footed	NT, NT		Gregarious. Open habitat with some trees, including semi-forested areas, forest fringes, croplands and wetlands. Mostly associated with open, grassy, arid woodland. Often utilizes dead trees, telephone poles and wire and fence lines as perches. Roosts in small tree clumps (often *Eucalyptus* stands). Non-breeding migrant.	High	Collision/ Disturbance / Habitat loss / Electrocution
Anthropoides paradiseus	Crane, Blue	NT, VU	E	Flocks of varying size. Open grassland but also wetlands, pastures and croplands. Frequently observed in cultivated fields. Roosts in shallow water bodies. Breeds in varies habitats including marshes, wet ground and	Low	Collision

				grassland with a clear all-round visibility as the most important requirement.		
Ardeotis kori	Bustard, Kori	NT, NT		Dry open Savannah woodland, dwarf shrubland and occasionally grassland	Confirmed	Habitat loss / Disturbance / Collision
Cursorius rufus	Courser, Burchell's	VU, LC	NE	Sparsely vegetated arid regions	Moderate	Habitat loss / Disturbance

4 SENSITVITY ASSESSMENT

It is important to delineate sensitive avian habitats within the project site in order to ensure the development does not have a long-term negative impact on these habitats. Important avian habitats play an integral role in their persistence within a landscape providing nesting, foraging and reproductive benefits.

A sensitivity map was compiled for the project site by making use of the results of the avifaunal micro-habitat assessment (refer to Figure 8).

The majority of the project site and surrounding surveyed area (including the power line corridor area) has been assessed as being of **Medium-Low** sensitivity from an avifaunal perspective. This Medium-Low sensitive area includes the Savannah Grassland, Savannah Shrubland and the Tree Savannah Habitat occurring on historically cultivated areas (Secondary Savannah). Both the Savannah Shrubland and Secondary Tree Savannah has been subjected to disturbances and habitat transformation and is characterised by a low diversity and abundance of bird species. The Savannah Grassland habitat unit supported the highest species diversity within the project site, due to the structural variation provided by the composition of trees, shrubs and grass patches. However, this habitat type has a very broad distribution throughout the region and from a broad geographical perspective are more homogenous and subsequently this habitat type is Medium to Low sensitive to the proposed development as a large area of this habitat type outside of the development area will remain intact allowing for suitable and sufficient habitat for local avifaunal species outside of the project site.

The relatively small natural Tree Savannah and Savannah Woodland has been assessed as being **Medium-Sensitive**. Both of these habitat units are fairly limited in extent with the Savannah Woodland forming a small isolated patch within the project site. These two habitat types combined, contributed to the area's general habitat and niche diversity and relative to its size, contained a significant species diversity and abundance (higher density of avifaunal species than the Savannah Grassland). This diversity and abundance are due to the structural and compositional variation in the vegetation. According to the proposed development footprint a portion of the solar field will expand into this habitat type as well as the compound area. These activities and the extent of their impacts within the above mentioned Medium-Sensitive habitat types are regarded as acceptable.

The ephemeral pans with the woody peripheries was assessed as being of **High sensitivity**. These habitats provide a source of surface water in the area and support a number of large trees, which could potentially be important for roosting and nesting.

The following areas have been classified as **Low** Sensitive due to general absence of suitable habitat for avifauna:

» Highly trampled and severely overgrazed areas;
» All areas containing infrastructure such as buildings, cattle kraals, cement dams and buildings etc.;
» The existing power line and water pipeline servitude;
» Sand and gravel quarries.

From the described sensitive areas and the location of the proposed development footprint area (according to the proposed facility layout) relative to these areas, it can be concluded that the majority of the proposed development will occur within a **Medium-Low** sensitivity avifaunal area with some encroachment into Medium sensitive areas. However, the development within these Medium areas are regarded as acceptable as this will not have a significant impact on local habitat diversity and avifaunal populations with most of these species, encountered within these Medium Sensitive Areas, moving into adjacent similar habitats. No **High Sensitive** areas will be impacted by the proposed development.

Overall, it was concluded that with the necessary mitigation measures implemented this **development will have little impact on the avifaunal character of the area with minimal loss due to habitat destruction, disturbance and collision.**

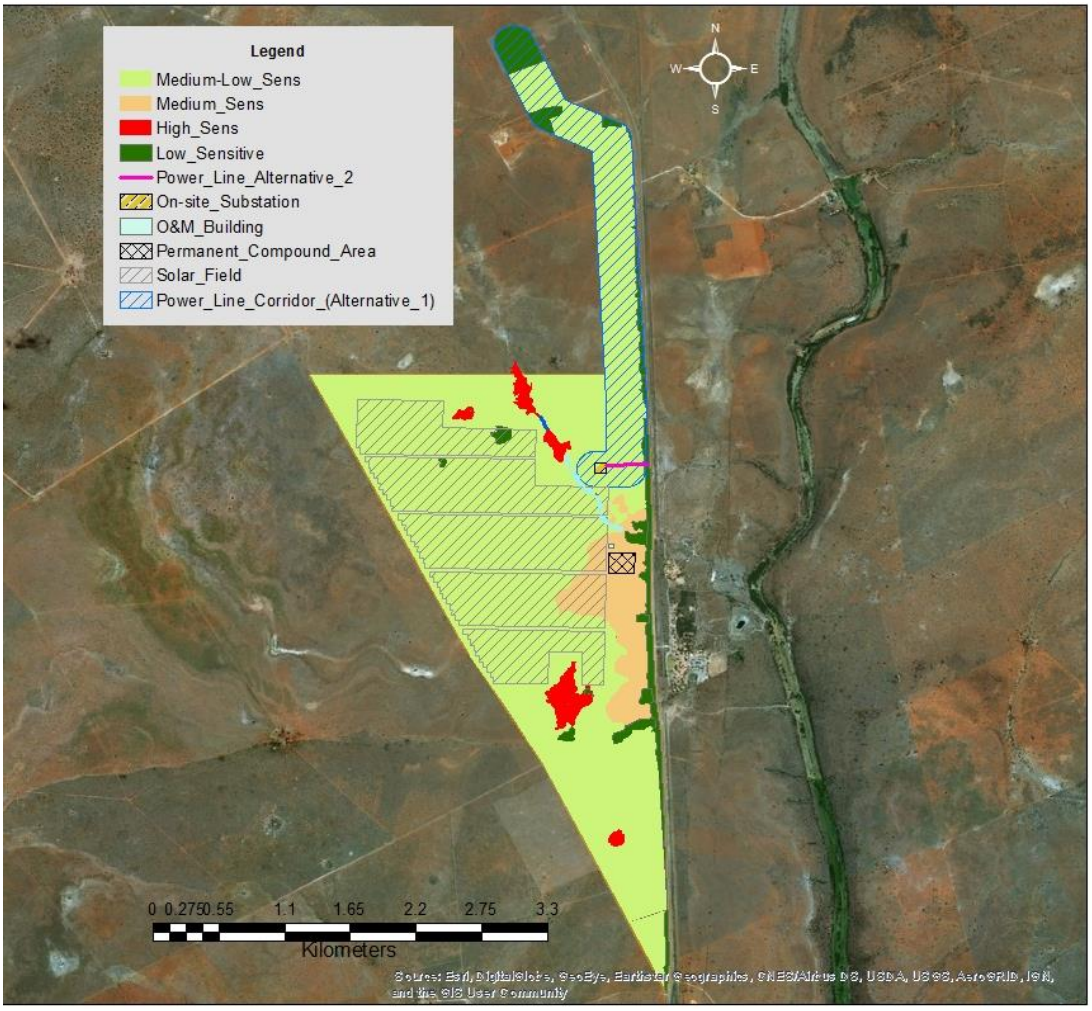

Figure 8: Avifaunal Sensitivity Map

5 ASSESSMENT OF PROPOSED IMPACTS THE PROJECT SITE

5.1 Methodology used to assess the potential impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

- The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value

between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high).

» The **duration**, wherein it was indicated whether:
  - the lifetime of the impact will be of a very short duration (0 – 1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2 – 5 years) – assigned a score of 2;
  - medium-term (5 -15 years) – assigned a score of 3;
  - long term (> 15 years) – assigned a score of 4; or
  - permanent – assigned a score of 5;

» The **magnitude**, quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

» The **probability** *of occurrence*, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1 -5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).

» The **significance**, was determined through a synthesis of the characteristics described above and can be assessed as **LOW**, **MEDIUM** or **HIGH**; and

» the **status**, which was described as either positive, negative or neutral.

» the degree of which the impact can be reversed,

» the degree to which the impact may cause irreplaceable loss of resources,

» the degree to which the impact can be mitigated.

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

S=(E+D+M)P where;

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

The significance weightings for each potential impact are as follows;

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

5.2 Impact Statement

The implications of the proposed Moeding Solar PV Facility and associated power line on avifauna are as follows:

- » An area of approximately 300 hectares of Ghaap Plateau Vaalbosveld vegetation will be altered and considered artificial, and largely unsuitable to various avian species.
- » During the construction phase, disturbance levels will be significantly higher in the immediate vicinity than previously. This disturbance will consist of machinery and vehicle disturbance as well as other construction activities.
- » During the operational phase, there will be some vehicle activity resulting in disturbance, particularly within the road access corridor and during maintenance of the facility.
- » The associated power line will potentially pose a collision risk to avifauna, particularly heavier birds with low manoeuvrability (specifically potential resident Bustard species).
- » The PV panel support structures, power line towers and the substation infrastructure provides perching and nesting substrate for various avifauna.
- » There is a possibility that species such as crows/owls could be electrocuted on substation infrastructure.

5.3 General Description of Bird Interactions with Solar Energy Facilities and their Associated Power Infrastructure

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 their 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 functioning. 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.

5.3.1 Impacts of solar energy facilities

Habitat loss

Although the degree of this impact is dependent on the location and scale of the development, this is potentially the most significant impact associated with the construction and operation (maintenance) of Solar Energy Facilities (SEFs). Extensive areas of vegetation (habitat) are cleared to accommodate the considerable amount of infrastructure required at these facilities, reducing the amount of habitat available to birds for foraging, roosting and breeding (Smallie, 2013). Given the considerable space requirements of commercially viable facilities (> 200 ha), this effect could be significant in some instances, particularly given the possibility that the initial footprint of successful facilities may be expanded over time, and allowing for the possible cumulative effects of multiple facilities in one area. This impact is likely to affect smaller bird species (i.e. larks and pipits) with small home ranges, as entire territories could be removed during construction activities.

Disturbance and displacement

Construction of SEFs requires a significant amount of machinery and labour to be present on site for a period of time. For shy, sensitive species or ground-nesting birds resident in the area, construction activities are likely to cause a temporary disturbance or even result in displacement from the site entirely. In addition, species commuting around the site may become disorientated by the reflected light and consequently fly longer distances to avoid the area, potentially resulting in displacement and energy implications (Smallie, 2013). Similarly, but to a lesser extent, ongoing maintenance activities at the operational facility are likely to cause some degree of disturbance to birds in the general vicinity.

Mortality

Bird mortality has been shown to occur due to direct collisions with solar panels. Species affected include waterbirds, small raptors, doves, sparrows and warblers (Kagan et al., 2014). The reflective surfaces of PV panels may confuse approaching birds and in some cases act as an attractant, being mistaken for large water bodies, resulting in injuries and/or mortalities when birds attempt to land on the installations.

Human conflict

Certain bird species may seek to benefit from the installations, using the erected structures as prominent perches, sheltered roost sites or even nesting sites, and possibly foraging around the infrastructure in response to changes in the distribution of preferred foods (i.e. plants growing under the paneling and other animals attracted to the facility). This may result in the fouling of critical components in the solar array, bringing local bird populations into conflict with facility operators.

5.3.2 Impacts of associated power infrastructure

Collisions with power infrastructure

Power lines pose a significant collision risk to birds, affecting a particular suite of collision prone species. These are mostly heavy-bodied birds such as bustards, cranes, storks, large eagles and various species of waterbirds that have limited maneuverability in flight, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (Anderson, 2001; van Rooyen 2004a; Jenkins *et al.,* 2010).

Electrocution on power line and power infrastructure

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the gap between live components and/or live and earthed components (van Rooyen, 2004b; Lehman *et al.,* 2007). Electrocution risk is strongly influenced by the power line voltage and the design of the pole structure and mainly affects larger, perching species such as vultures, eagles and storks that are capable of spanning the spaces between energized components.

5.4 Assessment of Impacts

The impacts identified above are assessed below, during the construction and operation phases of the facility as well as before and after mitigation.

5.4.1 For the SOLAR PV FACILITY (excluding the Power Line Alternatives)

Construction Phase

Construction Impact 1: *Habitat Loss Due to Construction*

Impact Nature: Habitat destruction and the subsequent displacement and exclusion of threatened, endemic or range restricted species are impacts associated with solar energy facilities (Smit 2012). The extensive space requirements of the proposed photovoltaic solar facility (300 ha) will result in the loss of avian micro-habitats located within the

development footprint. Due to the nature of the development, the majority of the site will be transformed. This impact will be amplified as more solar facilities are developed in the area, resulting in cumulative effects of multiple facilities within the area.

It is envisaged that the only Red Data species that will be displaced by the habitat transformation that will take place as a result of the construction of the proposed solar facility are, Kori bustard (*Ardeotis kori*). The impact on smaller, non-Red Data species that are potentially breeding in the area will be local in extent, and will not have a significant effect on regional or national populations.

The area proposed for the PV facility is not a unique habitat within the landscape.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (44)**	**Low (27)**
Status	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources	Highly Probable	Moderate Probability
Can impacts be mitigated?	Yes. However, due to the extensive space requirements, some land and avian microhabitats will be impacted.	
Mitigation	• The temporal and spatial footprint of the development should be kept to a minimum. • The boundaries of the development footprint areas must be clearly demarcated and it must be ensured that all activities remain within the demarcated footprint area. • Any bird nests that are found during the construction period must be reported to the Environmental Officer (EO) and where deemed necessary an appropriate buffer should be placed around the nest. If uncertain on the size of such a buffer, the ECO may contact an avifaunal specialist for advice. » The above measures must be included in a site specific EMPr and monitored by an ECO.	
Cumulative Impacts	Potentially Moderate. The Moeding Solar PV Facility falls within an area earmarked for the development of a number of solar facilities. This project will contribute to the loss of natural habitat within the area. However, as the wider landscape is already somewhat degraded due to agricultural practices in the area and the proximity to the	

	town of Vryburg, the contribution would be small and the overall significance low.
Residual Impacts	Moderate. The vegetation within the development footprint can be rehabilitated after the life time of the project if proposed mitigation measures are put in place.

Construction Impact 2. *Disturbance During Construction.*

Impact Nature: The disturbance of avifauna during the construction of the solar facility may occur. Species sensitive to disturbance include ground-nesting species (e.g. bustards and korhaans) resident within the development footprint. Disturbance can also influence the community structure of avifauna within close proximity to the development although this may only occur to a very limited extent.

Disturbance could have a negative impact on the breeding activities of various species, particularly if this occurs during a sensitive period in the breeding cycle.

Species of concern are predominantly Kori Bustard. Other small avian species do occur within the development footprint but these species are non-Red Data species.

The proposed development is located within an agricultural habitat close to National and Domestic roads. Therefore, species within this landscape often experience disturbance. As a result, disturbance of birds by the proposed solar facility is anticipated to be of moderate significance as birds will move away from the area temporarily during construction activities. However, species are particularly sensitive to disturbance during the breeding season and this must be borne in mind during both the construction and operational (maintenance) phases.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (7)	Minor (3)
Probability	Highly Probable (3)	Probable (3)
Significance	**Medium (30)**	**Low (18)**
Status	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Noise and disturbance during the construction phase cannot be avoided but would be transient in nature and with appropriate mitigation; no long-term impacts from the construction phase can be expected.	
Mitigation	• Strict control must be maintained over all activities during construction, in line with an approved construction EMPr.	

	• During construction, if any of the Red Data species identified in this report are observed to be roosting and/or breeding in the vicinity of the development footprint, the EO must be notified and where deemed necessary an appropriate buffer should be placed around the nests and/or roosting areas. If uncertain on the size of such buffer the ECO may contact an avifaunal specialist for advice. • Contractors and working staff should stay within the development area and movement outside these areas especially into avian micro-habitats must be restricted. » Driving must take place on existing and new access roads and a speed limit of 30km/h must be implemented on all roads traversing the project site during the construction phase. » Breeding, egg lying and incubation occur typically between October and February for Kori bustard and most of the sensitive ground nesting avifaunal species. During these months disturbances within natural and near-natural habitats should be limited as far as possible.
Cumulative Impacts	Potentially Moderate. The Moeding Solar PV Facility falls within an area earmarked for the development of a number of solar facilities which will also contribute to the disturbance of avifauna within the area. However, as the wider landscape is already somewhat disturbed due to agricultural practises in the area and the proximity to the town of Vryburg, the contribution would be small and the overall significance low.
Residual Impacts	Moderate. Some disturbance during the construction phase is inevitable. It is likely that some species will be disturbed and potentially displaced by the development.

Operation Phase

Operation Impact 1. *Disturbance During Operation.*

Impact Nature: The disturbance of avifauna during the operation of the solar facility may occur. Species sensitive to disturbance include are ground-nesting species resident within the development footprint. It may be likely that nesting and incubation may occur throughout the operation phase especially where some vegetation have re-established however the degree of likelihood is low. Disturbance can also influence the community structure of avifauna within close proximity to the development although this may only occur to a very limited extent. Disturbance could have a negative impact on the breeding activities of various species, particularly if this occurs during a sensitive period in the breeding cycle.

Species of concern are predominantly Kori Bustard. Other small avian species do occur within the development footprint but these species are non-Red Data species.

The proposed development is located within an agricultural habitat close to National and Domestic roads. Therefore, species within this landscape often experience disturbance. As a result, disturbance of birds by the proposed solar facility is anticipated to be of moderate significance as birds will move away from the area temporarily during maintenance activities (through the noise and movement of maintenance equipment and personnel). However, species are particularly sensitive to disturbance during the breeding season and this must be borne in mind during the operational (maintenance) phase.

	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Minor (2)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (40)**	**Low (24)**
Status	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Noise and disturbance during maintenance activities cannot be avoided but would be transient in nature and with appropriate mitigation; no long-term impacts from the construction phase can be expected.	
Mitigation	• If birds are nesting on the infrastructure of the facility and cannot be tolerated due to operational risks of fire, electrical short, soiling of panels or other problems, birds must be prevented from accessing nesting sites by using mesh or other manner of excluding them. Birds must not be shot, poisoned or harmed as this is not an effective control method and has negative ecological consequences. Birds already with eggs and chicks must be allowed to fledge their chicks before nests are removed. • If there are any persistent problems with avifauna, then an avifaunal specialist should be consulted for advice on further mitigation. • Working staff must stay within the development area and movement outside these areas especially into avian micro-habitats must be restricted. • Driving must take place on existing and new access roads and a speed limit of 30km/h must be implemented	

	on all roads running through the project site during the operation phase. • Breeding, egg lying and incubation occur typically between October and February for Kori bustard and most of the sensitive ground nesting avifaunal species. During these months disturbances should be limited as far as possible.
Cumulative Impacts	Potentially Low. The Moeding Solar PV Facility falls within an area earmarked for the development of a number of solar facilities which will also contribute to the disturbance of avifauna within the area.
Residual Impacts	Moderate. Some disturbance during the operational phase is inevitable. It is likely that some species will be disturbed and potentially displaced by the development.

Operation Impact 2: *Collisions with solar panel infrastructure*

Nature: The solar photovoltaic facility is comprised of panelling occupying a large area. Avifaunal species can be disorientated by the absorbent light, and consequently be displaced from an area more extensive than just the developed footprint of the facility.

Conversely, certain bird species may be attracted to the solar arrays. Waterbirds (especially waterfowl and comorants) may mistake the reflective surface for an expanse of water, and attempt to land on the panels resulting in injuries from colliding with the solar infrastructure. This impact has been termed as the "lake effect". This impact has not yet been recorded in South Africa.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Low (27)**	**Low (18)**
Status	Negative	Negative
Reversibility	Low (birds may be injured or killed)	
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Possible.	

Mitigation	The impact should be monitored by the Operation and Maintenance Manager (O&M Manager) and should this be found to be a significant impact a suitably qualified avifaunal specialist should be consulted to recommend suitable mitigation.
Cumulative Impacts	Potentially Moderate. The Moeding Solar PV Facility falls within an area earmarked for the development of a number of solar facilities which will also contribute to the area covered by solar panels thus increasing the probability of collisions.
Residual Impacts	None. The solar panels will be decommissioned after 20 years and when this occurs the impact will cease.

5.4.2 For the OVERHEAD POWER LINE

Construction Phase

Construction Impact 1: *Habitat Loss Due to Power Line Construction*

Impact Nature: During the construction of the power line, some habitat destruction and alteration will occur.

The disturbance and destruction of "unimpacted", near-natural habitat will be significantly reduced for Alternative 2 as this option will only extend for a very short distance (324m) through such habitat, after which the power line will turn into the Mookodi – Magopele 132kV power line to be constructed parallel to the N18 Road.

Alternative 1 is proposed to run across approximately 3.2km of near-natural habitat and as such it is expected that habitat destruction will be higher, however the area impacted was rated as Medium-Low and the impacts are still expected to be moderately low. Subsequently these activities may have a very slight impact on foraging, breeding and roosting ecology of avian species within the area through modification of habitat.

It is envisaged that the only Red Data species that will be potentially displaced by the habitat transformation that will take place as a result of the construction of the power line is, Kori bustard (*Ardeotis kori*). This displacement will only be from a very restricted area due to the small size of the area affected by the of the power line alternatives. The impact on smaller, non-Red Data species that are potentially breeding in the area will be local and very restricted in extent, and will not have a significant effect on regional or national populations.

	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Long-term (4)	Medium-term (3)	Long-term (4)	Short-term (2)

Magnitude	Low (4)	Minor (3)	Minor (3)	Minor (2)
Probability	Highly Probable (4)	Probable (3)	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Low (21)**	**Low (24)**	**Low (15)**
Status	Negative	Negative	Negative	Slightly Negative
Reversibility	Moderate	High	High	High
Irreplaceable loss of resources	Very limited loss of resources	Very limited loss of resources	Very limited loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent		Yes, to a large extent	
Mitigation	• All construction activities must be carried out according to the generally accepted environmental best practise. • The temporal and spatial footprint of the development should be kept to a minimum. • The boundaries of the development footprint areas are to be clearly demarcated and it must be ensured that all activities remain within the demarcated footprint area. • Existing roads must be used as much as possible for access during construction. • Provide adequate briefing for site personnel on the possible important (Red Data) species occurring and/or nesting in the area and the procedures to be followed (for example notification of ECO and avoidance of area until appropriate recommendations has been provided by ECO). • Any bird nests that are found during the construction phase must be reported to the Environmental Officer (EO). • The above measures must be included in a site specific EMPr and monitored by an ECO.			
Cumulative Impacts	The development falls within an area earmarked for the development of a number of developments (solar facilities). This project will contribute to the loss of natural habitat within the area. However, as the wider landscape is already somewhat degraded due to agricultural practices in the area and the proximity to the town of Vryburg, the contribution would be small and the overall significance low.			
Residual Impacts	Moderate. The vegetation within the development area can be rehabilitated after the life time of the facility if proposed mitigation measures are put in place.			

Construction Impact 2: *Disturbance Due To Power Line Construction Activities*

Impact Nature: The disturbance of avifauna during the construction of the power line may occur. Species sensitive to disturbance include ground-nesting species resident within the development footprint. Disturbance can also influence the community structure of avifauna within close proximity to the development as certain species will be displaced and forced to find alternative territories.

Disturbance could have a negative impact on the breeding activities of various species, particularly if this occurs during a sensitive period in the breeding cycle.

Species of concern are predominantly Kori Bustards. Other small avian species do occur within the development footprint but these species are non-Red Data species.

The project site is located within an agricultural habitat close to National and Domestic roads. Therefore, species within this landscape often experience disturbance. As a result, disturbance of birds by the proposed power line is anticipated to be of low significance as birds will move away from the area temporarily. The relatively small scale of the development (in relation to the large agricultural landscape) is unlikely to have a significant impact on avifauna. However, species are particularly sensitive to disturbance during the breeding season and this must be borne in mind during the construction phase.

	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)	Short-term (2)	Short-term (2)
Magnitude	Low (4)	Low (4)	Minor (2)	Minor (2)
Probability	Highly Probable (4)	Probable (3)	Probable (3)	Improbable (2)
Significance	**Low (28)**	**Low (21)**	**Low (15)**	**Low (10)**
Status	Negative	Negative	Slightly Negative	Slightly Negative
Reversibility	Moderate	High	High	High
Irreplaceable loss of resources	Very limited loss of resources	Very limited loss of resources	Very limited loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	• Strict control must be maintained over all activities during construction, in line with an approved construction EMPr. • During construction, if any of the Red Data species identified in this report are observed to be roosting and/or breeding in the vicinity, the EO must be notified and were deemed necessary an appropriate buffer should be placed around the nests and/or roosting areas. If uncertain on the size of such buffer the ECO may contact an avifaunal specialist for advice. • The construction equipment camps must be as close to the site as possible. • Contractors and working staff should remain within the development area and movement outside these areas especially into avian micro-habitats must be restricted.			

	• Driving must take place on existing and new access roads and a speed limit of 30 km/h must be implemented on all internal roads. • Breeding, egg lying and incubation occur typically between October and February for Kori bustard and most of the sensitive ground nesting avifaunal species. During these months disturbances within natural and near-natural habitats should be limited as far as possible.
Cumulative Impacts	Potentially Moderate. The development falls within an area earmarked for the development of a number of solar facilities which will also contribute to the disturbance of avifauna within the area. However, as the wider landscape is already somewhat disturbed due to agricultural practises in the area and the proximity to the town of Vryburg, the contribution would be small and the overall significance low.
Residual Impacts	Low. Some disturbance during the construction phase is inevitable. It is likely that some species will be disturbed and potentially displaced by the development.

Operation Phase

Operation Impact 1: *Disturbance along the Power Line*

Impact Nature: The disturbance of avifauna during the operation of the power line may occur. Species sensitive to disturbance include ground-nesting species resident within the development footprint. Disturbance can also influence the community structure of avifauna within close proximity to the development as certain species will be displaced and forced to find alternative territories.

Disturbance could have a negative impact on the breeding activities of various species, particularly if this occurs during a sensitive period in the breeding cycle.

Species of concern are predominantly Kori Bustards. Other small avian species do occur within the development footprint but these species are non-Red Data species.

The proposed site is located within an agricultural habitat close to National and Domestic roads. Therefore, species within this landscape often experience disturbance. As a result, disturbance of birds by the proposed power line is anticipated to be of low significance as birds will move away from the area temporarily. The relatively small scale of the development (in relation to the large agricultural landscape) is unlikely to have a significant impact on avifauna. However, species are particularly sensitive to disturbance during the breeding season and this must be borne in mind during the operational (maintenance) phase.

	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Medium-term (3)	Short-term (2)	Short-term (2)	Short-term (2)

Magnitude	Low (4)	Minor (2)	Minor (3)	Minor (2)
Probability	Probable (3)	Probable (3)	Probable (3)	Improbable (2)
Significance	**Low (24)**	**Low (15)**	**Low (18)**	**Low (10)**
Status	Negative	Slightly Negative	Slightly Negative	Slightly Negative
Reversibility	Moderate	High	High	High
Irreplaceable loss of resources	Very limited loss of resources	Unlikely	Very limited loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	• Strict control must be maintained over all activities during operation (maintenance), in line with an approved EMPr. • If birds are nesting on the infrastructure of the facility and cannot be tolerated due to operational risks of fire, electrical short, or panels or other problem, birds should be prevented from accessing nesting sites by using mesh or other manner of excluding them. Birds must not be shot, poisoned or harmed as this is not an effective control method and has negative ecological consequences. Birds already with eggs and chicks should be allowed to fledge their chicks before nests are removed. • If there are any persistent problems with avifauna, then an avifaunal specialist should be consulted for advice on further mitigation. • Contractors and working staff should stay within the development area and movement outside these areas especially into sensitive avian microhabitats must be restricted. • Vehicle movements must be restricted to existing and newly constructed access roads and a speed limit of 30km/h must be implemented on all roads running through the project site during the operational phase.			
Cumulative Impacts	Potentially Moderate. The development falls within an area earmarked for the development of a number of solar facilities which will also contribute to the disturbance of avifauna within the area. However, as the wider landscape is already somewhat disturbed due to agricultural practises in the area and the proximity to the town of Vryburg, the contribution would be small and the overall significance low.			
Residual Impacts	Low. Some disturbance during the operational phase is inevitable. It is likely that some species will be disturbed and potentially displaced by the development.			

Operation Impact 2: *Electrocution of Birds on Power Infrastructure*

Impact Nature: Electrocutions of birds on associated power infrastructure results in injuries or death and could potentially affect large, perching species in the area such as raptors and storks.

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the gap between live components and/or live and earthed components (van Rooyen, 2004b; Lehman *et al.,* 2007).

Of the priority species, Martial Eagle and White-backed Vulture could potentially be affected by this impact.

The impact of electrocution is considered to be of moderate significance, and low significance after the implementation of mitigation in the form of bird friendly structures.

	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (2)	Local (2)	Local (2)	Local (1)
Duration	Long-term (4)	Long-term (4)	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)	Low (4)	Small (2)
Probability	Probable (3)	Improbable (2)	Probable (3)	Improbable (2)
Significance	**Moderate (36)**	**Low (20)**	**Low (30)**	**Low (14)**
Status	Negative	Negative	Negative	Slightly Negative
Reversibility	Low (birds will be injured or killed)	Low (birds will be injured or killed)	Low (birds will be injured or killed)	Low (birds will be injured or killed)
Irreplaceable loss of resources	Limited loss of resources	Very Limited loss of resources	Limited loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	• A "Bird Friendly" structure, with a bird perch (as per standard Eskom guidelines) must be used for the tower infrastructure. • All relevant perching surfaces should be fitted with bird guards and perch guards as deterrents (Hunting, 2002). • Installation of artificial bird space perches and nesting platforms, at a safe distance from energised components (Goudie, 2006; Prinsen *et al.,* 2012).			
Cumulative Impacts	Potentially Moderate. The development falls within an area earmarked for the development of a number of solar facilities which will also contribute to the length and amount of grid connecting infrastructure within the region and therefore will also increase the risk of potential electrocutions.			
Residual Impacts	Low. The power line will be within the area over a long period of time if not permanent. However, if the power line is removed the impacts associated (avian mortalities) will cease.			

Operation Impact 3: *Collision With The Power Line*

Impact Nature: Collisions are the biggest single threat posed by transmission power lines to birds in Southern Africa (van Rooyen 2004). Avian species most susceptible and impacted upon

are bustards, storks and cranes (especially bustards which have been confirmed are at risk within the project site). These species are heavy-bodied birds with limited manoeuvrability (as a result of high wing loading), which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (Van Rooyen 2004, Anderson 2001). Many of the collision sensitive species are considered threatened in Southern Africa.

The Red Data species that are vulnerable to power line collisions are generally long living, slow reproducing species. Furthermore, various species require specific conditions for breeding, resulting in very few successful breeding attempts and breeding might be restricted to very small areas. Consistent high adult mortality over an extensive period could have a serious long term effects on the population.

Potential collision impacts (risk) with the proposed power line by certain species such as Kori Bustard and Secretarybird are possible. This is particularly true for the Bustards which have low manoeuvrability once in flight. All three species mentioned have been recorded within the top ten avian species in South Africa prone to collisions with overhead power lines.

Overall, the impact assessment found this risk impacts to be of moderate to low significance. However, this is related to the amount and frequency large avifaunal species such as bustard and korhaan inhabit or visit the traversed habitat.

	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (2)	Local (1)	Low (1)	Low (1)
Duration	Long-term (4)	Long-term (4)	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)	Low (3)	Small (2)
Probability	Highly Probable (4)	Probable (3)	Probable (3)	Improbable (2)
Significance	**Moderate (48)**	**Low (27)**	**Low (24)**	**Low (14)**
Status	Negative	Negative	Negative	Slightly Negative
Reversibility	Low (birds will be injured or killed)	Low (birds will be injured or killed)	Low (birds will be injured or killed)	Low (birds will be injured or killed)
Irreplaceable loss of resources	Limited loss of resources	Limited loss of resources	Limited loss of resources	Very limited loss of resources
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	• Construction of the power line in close proximity to the existing line will reduce the cumulative impacts and collision risk. • All relevant perching surfaces must be fitted with bird guards and perch guards as deterrents (Hunting 2002). • Bird deterrent devices such as "bird diverters" and "flappers" can be used.			

Cumulative Impacts	Potentially Moderate. The development falls within an area earmarked for the development of a number of solar facilities which will also contribute to the length and amount of grid connecting infrastructure within the region and therefore will also increase the risk of potential collisions.
Residual Impacts	Low. The power line will be within the area over a long period of time if not permanent. However, if the power line is removed the impacts associated (avian mortalities) will cease.

5.5 Known and potential cumulative impacts due to nearby developments

» The property earmarked for the proposed PV is located within a REDZ area (REDZ 6: Vryburg).
» Approximately 21 solar facilities are planned within a radius of 30 km of the proposed Moeding Solar PV Facility, each with their own grid connection infrastructure (refer to Figure 9 and Table 5)
» The following facilities are located adjacent or within the project site investigated for the proposed Moeding Solar PV Facility:
    - Subsolar Rosendal (1 X PV): Within the project site;
    - Subsolar Kabi Solar Tiger Kloof (1 X PV): Within the project site;
    - Biotherm Sedawo (3 X PV): Border to the west of the project site;
    - Subsolar Protea (1 X PV): Border to the south-west of the project site;
    - Subsolar Waterloo (1 X PV): Border to the east of the project site; and
    - Subsolar Khubu (1 X PV): Border to the south-east of the project site.
» Further Solar Energy Facility planned in the immediate vicinity include:
    - Genesis Eco-Energy Woodhouse (2 X PV); and
    - Subsolar Gamma (1 X PV)
» Several more solar developments are likely to be planned throughout the Municipality, many on similar habitats.

Conclusion on cumulative impacts due to this and surrounding developments (also included are the grid connection infrastructure associated with the surrounding developments):

» Transformation and loss of intact avifaunal habitats

Although the degree of this impact is dependent on the location and scale of the development, this is the most significant cumulative impact associated with the construction and operation (maintenance) of Solar Energy Facilities (SEFs). Extensive areas of vegetation (habitat) are cleared to accommodate the considerable amount of infrastructure required at these facilities, reducing the amount of habitat available to birds for foraging, roosting and breeding (Smallie, 2013). Given the considerable space requirements of commercially viable

facilities (> 200 ha), this effect could be significant in some instances, particularly given the possibility that the initial footprint of successful facilities may be expanded over time, and allowing for the possible cumulative effects of multiple facilities in one area. This impact is likely to affect smaller bird species (i.e. larks and pipits) with small home ranges, as entire territories could be removed during construction activities.

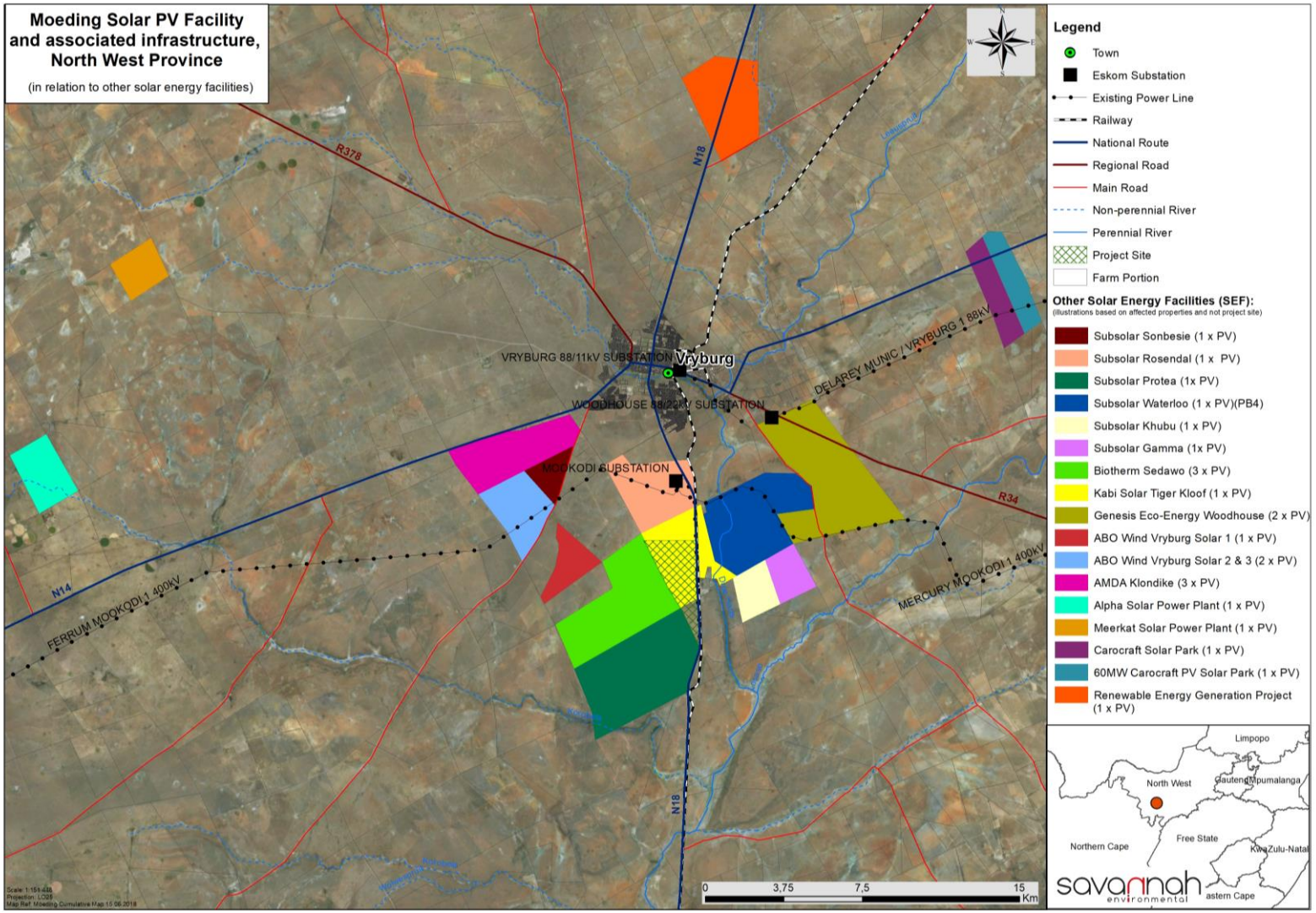

Figure 9: Location Map of the proposed Moeding Solar PV Facility relative to the other Solar facilities planned within a radius of 30 km (Map provided by Savannah Environmental Pty (Ltd)).

Table 5: Table listing the Solar Projects located within a 30 km radius from the proposed Moeding Solar PV Facility

Project Name	Location	Approximate distance from the project site	Project Status
Sonbesie Solar Power Plant	Remaining Extent of the farm Retreat 671	6,2km north west of the site	Authorised
Sediba Solar Energy Facility (Rosendal)	Remaining Extent of the Farm Rosendal 673	Located within the project site	Authorised
Protea Solar Power Plant	Remaining Extent of the farm Hartsboom 734	Located adjacent (west)	Authorised
Waterloo Solar Park	Remaining Extent of Farm Waterloo 992	Located adjacent (east)	Authorisation granted (Preferred Bidder Round 4)
Khubu Solar Power Plant	Portion 5 of Championskloof 731	Located adjacent (south east)	Authorised
Gamma Solar Power Plant	Portion 4 Championskloof	5,9km east of the site	Authorised
Sendawo PV 1 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Sendawo PV 2 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Sendawo PV 3 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Tiger Kloof Solar Energy Facility	Remaining Extent of Portion 3 and Portion 4 of the Farm Waterloo 730	Located within the project site	Authorised
Woodhouse Solar 1 PV Facility	Remaining Extent of the Farm Woodhouse 729	8km east of the site	Authorised
Woodhouse Solar 2 PV Facility	Remaining Extent of the Farm Woodhouse 729	8km east of the site	Authorised
Alpha Solar Power Plant	Remaining Extent of farm Middelpan 605	30km west of the site	Authorised
Klondike PV1 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Klondike PV2 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Klondike PV3 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Meerkat Solar Power Plant	Portion 3 of Vyflings Pan 598	28,5km west of the site	Authorised
Carocraft Solar Park	Remaining Extent of Farm Weltevrede 681	19km north east of the site	Authorised
Vryburg Solar 1	Portion 2 of Farm Frankfort 672	5km west of the site	Authorised
Vryburg Solar 2	Portion 1 of Farm Retreat 671	7.7km north west of the site	Authorised

Vryburg Solar 3	Portion 1 of Farm Retreat 671	8.3km north west of the site	Authorised
60MW Carocraft PV Solar Park	Remaining Extent of Farm Weltevrede 681	19km north east of the site	Authorised

5.5.1 *Cumulative Impacts associated with the Moeding Solar PV Facility and associated grid connection infrastructure*

Cumulative Impact 1: *Avifaunal Habitat Loss*

Impact Nature: Cumulative impact on avifauna in the area as a result of habitat loss and increased risk associated with PV facilities and associated grid connection infrastructure.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (2)	Regional (3)
Duration	Long Term (4)	Long-Term (4)
Magnitude	Minor (3)	Moderate (6)
Probability	Probable (3)	Highly Probable (4)
Significance	**Low (27)**	**Medium (52)**
Status	Slightly Negative	Negative
Reversibility	Moderate Potential	Low Potential
Irreplaceable loss of resources	Yes (birds may be displaced, injured or killed)	Yes (birds may be displaced, injured or killed)
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	• The mitigation measures mentioned within the previous sections (Sections 5.4.1 & 5.4.2) have relevance and should be implanted in order to prevent detrimental impacts	

Cumulative Impact 2: *Avifaunal Disturbance*

Impact Nature: Cumulative impact on avifauna in the area as a result of disturbance and increased risk associated with PV facilities and associated grid connection infrastructure.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (3)
Duration	Long-term (4)	Long-Term (4)
Magnitude	Minor (3)	Moderate (6)
Probability	Probable (3)	Highly Probable (4)

Significance	**Low (24)**	**Medium (52)**
Status	Slightly Negative	Negative
Reversibility	Moderate Potential	Low Potential
Irreplaceable loss of resources	Yes (birds may be displaced)	Yes (birds may be displaced)
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	• The mitigation measures mentioned within the previous sections (Sections 5.4.1 & 5.4.2) have relevance and should be implanted in order to prevent detrimental impacts	

Cumulative Impact 3: *Electrocution of birds due to overhead power lines*

Impact Nature: Cumulative impact on avifauna in the area as a result of electrocution due to overhead power lines and increased risk associated with an increase in grid connection infrastructure.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (3)
Duration	Long-term (4)	Long-Term (4)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Highly Probable (4)
Significance	**Low (27)**	**Medium (52)**
Status	Slightly Negative	Negative
Reversibility	Moderate Potential	Low Potential
Irreplaceable loss of resources	Low (birds will be injured or killed)	Moderate possibility (birds will be injured or killed)
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	• The mitigation measures mentioned within the previous section (Section 5.4.2) have relevance and should be implanted in order to prevent detrimental impacts	

Cumulative Impact 4: *Collisions of Birds with overhead powerlines*

Impact Nature: Cumulative impact on avifauna in the area as a result of collisions and increased risk associated with an increase in grid connection infrastructure.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**

Extent	Local (1)	Regional (3)
Duration	Long Term (4)	Long-Term (4)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Highly Probable (4)
Significance	**Low (27)**	**Medium (52)**
Status	Slightly Negative	Negative
Reversibility	Moderate Potential	Low Potential
Irreplaceable loss of resources	Low (birds will be injured or killed)	Moderate possibility (birds will be injured or killed)
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	• Mark sections of the lines in High to Medium-High sensitive areas with anti-collision marking devices (diurnal and nocturnal diverters) to increase the visibility of the power line and reduce likelihood of collisions. Marking devices should be spaced 10 m apart, and must be installed as soon as the conductors are strung. • These line marking devices include spiral vibration dampers, strips, Bird Flight Diverters, bird flappers, aerial marker spheres, ribbons, tapes, flags and aviation balls (Prinsen et al. 2012). • Construction of the power lines in close proximity to the existing power line will is recommended as far as possible as this reduce the cumulative impacts and collision risk. All relevant perching surfaces should be fitted with bird guards and perch guards as deterrents (Hunting 2002).	

5.6 Comparison of Power Line Route Options

In terms of the Overhead Power Line Alternatives, Alternative 2 is, from an Avifaunal perspective the most preferred option as this option will extend over a very short distance within unimpacted habitat after which the power line will connect into the Mookodi-Magopela line (turn-in-turn-out). This existing power line's servitude, furthermore, is located in an already transformed area. Subsequently, minimal additional habitat disturbance will occur and by locating the proposed power line near existing power line infrastructure, the total surface area that may contain infrastructure that may pose collision risk, are greatly reduced.

However, Overhead Power Line Alternative 1 is still located within a Medium-Low Sensitive area and it is expected that if this option were to be selected that potential impacts will still be relatively low and acceptable from an Avifaunal perspective.

6 RECOMMENDED PROTOCOLS AND THE NECESSITY OF FUTURE MONITORING

According to the standards and procedures for assessing and monitoring the impacts of SEFs on birds in southern Africa as specified by Bird Life South Africa's "Best Practice Guidelines" this report and assessment has been written and executed in accordance with the Stage 1 and 2 approach.

» **Stage 1**: A preliminary assessment, part of planning for an EIA application. This should give an overview of the biological context, likely impacts and potential red flags to development, identify alternatives and determine the appropriate assessment regime.
» **Stage 2**: A more in-depth study, possibly including structured and repeated data collection on which to base the impact assessment report and provide a baseline against which post-construction monitoring can be compared.

A summary of the route and procedures followed by this recommended multi-tiered approach are provided below:

"The first tier, preliminary assessment, should be undertaken before the formal EIA process is initiated. Should this initial assessment endorse the development, a full avian impact assessment should then be based on the second tier of work (a more in-depth assessment of impacts and mitigation, possibly requiring the collection of baseline data), with the scope of this additional work informed by the findings of the preliminary avifaunal study. Baseline data-collection and monitoring may be central to the following impact assessment process, and where deemed necessary, this should be used to help determine

1) *if the project should proceed,*
2) *what measures are necessary to avoid, minimize and mitigate the impacts of the project, and*
3) *the nature and extent of construction-phase and post-construction (operational-phase) monitoring.*

Should the third stage in the process, avian impact assessment, also endorse the proposed development and it goes ahead, a fourth tier of work could consist of construction-phase monitoring (where required), leading on to post-construction monitoring, in which the actual impacts of the project are documented, and effective mitigation measures are designed and implemented. Monitoring is an important component for assessing and managing biodiversity at solar developments

(UNEP/CMS 2015). Should significant effects be observed, an adaptive management approach to reduce impacts may be required.": Jenkins et al. 2017.

Based on the finding and results obtained from this assessment as well as monitoring results obtained for proposed Sendawo 1 Solar PV Energy Facility (a PV facility located adjacent-west of Moeding Solar and within a very similar habitat type), the proposed area contain a relative low diversity of faunal species within a relative extensive and more or less homogenous vegetation cover and subsequently the proposed Moeding PV Solar Facility will affect a limited to small avifaunal community. Furthermore, the impacts associated with this Solar PV development on the local faunal community is regarded as relative small in nature and scale.

From the above mentioned, it can be concluded that this Assessment/Study is deemed sufficient and that the implementation of Stage 3 and 4 assessments and monitoring **will not** be necessary.

The results obtained from the 6 month pre-construction monitor programme for the Sendawo 1 75MW Solar Energy Facility is provided below (it is expected, due to close proximity and very similar habitats, that these results are a very close reflection to results that may be obtained for the project site of the proposed Moeding Solar PV Facility) :

Pre-construction monitoring conducted over six months at the core study area revealed fewer than expected priority species. Two walk transects of 1km each were identified at the site and each surveyed 24 times through the course of the monitoring, to record the diversity and abundance of avifauna. Table 24 below lists the densities and variety of priority species actually recorded at the site in this manner. The densities of priority species are indicated as mean individuals per survey, and individuals per kilometre (index of kilometric abundance - IKA). In addition to the walk transects, one vantage point was selected from which a representative sample of the proposed PV areas could be observed, to record the flight altitude and patterns of priority species. However, no priority species flight activity was recorded in 36 hours of vantage point watches.

Table 24: Priority species recorded during pre-construction monitoring at the core study area.

Species	Taxonomic name	Regional Status	Mean number of individuals per survey recorded during transect counts	Number of individuals per kilometre
Black-chested Prinia	*Petrochelidon spilodera*	Endemic	0.13	0.06
Ant-eating Chat	*Myrmecocichla formicivora*	Endemic	0.04	0.02
Bokmakierie	*Afrotis afraoides*	Endemic	0.04	0.02
Cape Sparrow	*Colius colius*	Endemic	0.13	0.06
Crimson-breasted Shrike	*Prinia flavicans*	Near-endemic	0.04	0.02
Eastern Clapper Lark	*Telophorus zeylonus*	Near-endemic	0.21	0.10
Kalahari Scrub-Robin	*Passer melanurus*	Near-endemic	0.21	0.10
Lanner Falcon	*Laniarius atrococcineus*	Near-endemic	0.25	0.13
Marico Flycatcher	*Mirafra fasciolata*	Near-endemic	0.13	0.06
Northern Black Korhaan	*Erythropygia paena*	Near-endemic	1.04	0.52
Sabota Lark	*Bradornis mariquensis*	Near-endemic	0.08	0.04
Scaly-feathered Finch	*Calendulauda sabota*	Near-endemic	0.63	0.31
Shaft-tailed Whydah	*Sporopipes squamifrons*	Near-endemic	0.08	0.04
South African Cliff-Swallow	*Vidua regia*	Breeding endemic	0.08	0.04
Spike-heeled Lark	*Chersomanes albofasciata*	Near-endemic	0.21	0.10
White-backed Mousebird	*Falco biarmicus*	VU	0.13	0.06
Martial Eagle	*Polemaetus bellicosus*	EN	Incidental	Incidental
Kori Bustard	*Ardeotis kori*	NT	Incidental	Incidental
Steppe Buzzard	*Buteo vulpinus*	-	Incidental	Incidental

7 DISCUSSION AND CONCLUSION

While the proposed Moeding Solar PV Facility will have an impact on avifauna due to the extensive spatial requirements of the development, the project site is not considered unique (also classified as low sensitive REDZ within the Strategic Environmental Assessment) and is furthermore not considered critical for the conservation of Red Data species. Therefore, the facility is unlikely to have any long-term significant impacts on avifaunal species within the project site.

During the site survey a total of 55 bird species were recorded within the project site.

Endemic species recorded during the site visit included Southern Pale Chanting Goshawk, Northern Black Korhaan, Namaqua Sandgrouse, Acacia Pied Barbet, Bokmakierie, Sabota Lark, Spike-heeled Lark, Grey-backed Sparrow Lark, African Red-eyed Bulbul, Barred Wren-Warbler, Chestnut-vented Warbler, Kalahari Scrub Robin, Ant-eating Chat, Chat Flycatcher, Scaly-feathered Weaver and Yellow Canary.

Red listed species recorded within and around the development footprint area included Kori Bustard - *Ardeotis kori* (Near Threatened) and Lanner Falcon - *Falco biarmicus* (Vulnerable). Listed avifaunal species not recorded within the site although highly likely to occur within the area include White-backed Vulture - *Gyps africanus* (Critically Endangered), Greater Flamingo - *Phoenicopterus roseus* (Near Threatened) and Secretary Bird - *Sagittarius serpentarius* (Vulnerable).

During the site visit, the following micro-habitats were identified namely:

- Savannah Variations:
  - Savannah Grassland with some characteristics of Savannah Parklands
  - Savannah Shrubland
  - Tree Savannah
    - Natural
    - Transformed
  - Savannah Woodland
- Grassy pan wetlands with woody/shrubby peripheries.

The largest portion of the project site is covered by the *Savannah Grassland habitat unit* which supported the highest species diversity within the project site, due to the structural variation provided by the composition of trees, shrubs and grass patches. However, this habitat type has a very broad distribution throughout the region and from a broad geographical perspective are more homogenous and subsequently this habitat type is **Medium to Low** sensitive to the proposed development as a large area of this habitat type outside of the development area will remain intact allowing for suitable and sufficient habitat for local avifaunal species outside of the project site. Other habitat units classified as Medium-Low due to a general low avifaunal diversity and abundance as well as due to the fact that these units have undergone some transformation included the *Savannah Shrubland* and the *transformed Tree Savannah Habitat.* The relatively small *natural Tree Savannah* and *Savannah Woodland* has been assessed as being **Medium-Sensitive**. These two habitat types combined, contributed to the areas general habitat and niche diversity and relative to its size, contained a significant species diversity and abundance (higher density of avifaunal

species than the Savannah Grassland). This diversity and abundance are due to the structural and compositional variation in the vegetation. *The ephemeral pans with the woody peripheries* were assessed as being of **High sensitivity**. These habitats provide a source of surface water in the area and support a number of large trees, which could potentially be important for roosting and nesting.

The proposed Moeding Solar PV Facility is located in an area that has been selected for several future solar facilities (21 other projects). Due to the variety of solar facilities under investigation within the area, it is important to consider the cumulative impact of the facilities on avian populations. The most significant cumulative impacts of the solar facilities will be habitat loss and disturbance of bird species. These impacts are important within this Grassland biome which supports 24% of South Africa's endemic species. Due to the fact that most of the proposed development footprint are is situated within a moderately transformed habitat and the proposed area contain a relative low diversity of faunal species within a relative extensive an more or less homogenous vegetation cover, the proposed PV Solar development will subsequently only affect a limited to small avifaunal community. Furthermore, the impacts associated with this Solar PV development, on the local faunal community is regarded as relative small in nature and scale. As such this specific area does not contribute greatly to the functionality and diversity of the greater landscape and subsequently the cumulative impact can be regarded as moderate to low.

Furthermore, from the above-mentioned statement this project site is located within a Low Risk Site (Regime 1) and it can be concluded that this Assessment/Study is deemed sufficient and that the implementation of Stage 3 and 4 assessments and monitoring, according to the "Best Practice Guidelines: Birds & Solar Energy" **will not** be necessary.

From the location of the proposed development footprint area (according to the proposed facility layout) relative to different avifaunal habitats, it can be concluded that the majority of the proposed development will occur within the **Medium-Low** sensitivity avifaunal habitats with some encroachment into the **Medium Sensitive** habitats. However, the development within these Medium sensitive areas are regarded as acceptable as this will not have a significant impact on local habitat diversity and avifaunal populations with most of these species, encountered within these Medium Sensitive Areas, moving into adjacent similar habitats. No **High Sensitive** areas will be impacted by the proposed development. Subsequently, the development will not likely have a significantly and/or detrimental impact on avifaunal habitats and associated populations.

» A summary of pre- and post-mitigation impact significance ratings for the different impacts and risks factors identified for the proposed development are provided below.

Table 6: Summary of pre and post mitigation impact significance ratings.

PROPOSED SOLAR PV FACILITY			
Construction & Operational Phase			
Phase	**Impact (Ecology & Surface Hydrology)**	**Significance Pre-Mitigation**	**Significance Post Mitigation**
Construction	Habitat Loss Due to Construction	Medium (44)	Low (27)
	Disturbance During Construction	Medium (40)	Low (18)
Operation	Disturbance During Operation	Medium (40)	Low (24)
	Collisions with solar panel infrastructure	Low (27)	Low (18)

PROPOSED OVERHEAD POWER LINE					
Construction & Operational Phase					
		Alternative 1		**Alternative 2**	
Phase	**Impact**	**Significance Pre-Mitigation**	**Significance Post Mitigation**	**Significance Pre-Mitigation**	**Significance Post Mitigation**
Construction	*Habitat Loss Due to Power Line Construction*	Medium (36)	Low (21)	Low (24)	Low (15)
	Disturbance due to power line construction activities	Low (28)	Low (21)	Low (15)	Low (10)
Operation	*Disturbance along the power line*	Low (24)	Low (15)	Medium (28)	Low (10)
	Electrocution of Birds on Power Infrastructure	Medium (36)	Low (20)	Medium (30)	Low (14)
	Collision with the power line	Medium (44)	Low (27)	Low (24)	Low (14)

Cumulative Impacts (including associated grid connection infrastructure)		
Impact	**Over impact of the proposed project considered in isolation**	**Cumulative impact of the project and other projects within the area**
Avifaunal Habitat Loss	Low (27)	Medium (52)
Avifaunal Disturbance	Low (24)	Medium (52)
Electrocution of birds due to overhead power lines	Low (27)	Medium (52)
Collisions of Birds with overhead powerlines	Low (27)	Medium (52)

Based upon the results obtained from the field-work as well as the results from above impact tables the following can be concluded in terms of the different Power Line Alternatives (2 Alternatives):

- » Alternative 2 is, from an Avifaunal perspective, the most preferred option as this option will extend over a very short distance within unimpacted habitat, after which the power line will connect into the Mookodi-Magopela line (turn-in-turn-out).
- » This servitude, furthermore, is located in an already transformed area.
- » Subsequently, minimal additional habitat disturbance will occur and by locating the proposed power line near existing power line infrastructure, the total surface area that may contain infrastructure that may pose collision risk, are greatly reduced.

- » However, Overhead Power Line Alternative 1 is still located within a Medium-Low Sensitive area and it is expected that if this option were to be selected that potential impacts will still be relatively low and acceptable from an Avifaunal perspective.

Thus, from the survey it can be concluded that the majority of the proposed development will occur within a medium-low sensitive avifaunal area with only a small portion of the development occurring within some Medium sensitivity areas. Due to this and the fact that the project site is represented by a relatively low diversity of avifaunal species the general significance the impacts on avifauna can be regarded as moderate-low and can be lowered further with the relevant mitigation measures in place.

From an avifaunal perspective the overall impacts (including cumulative) for the project is considered to be low and no objective or motives were identified which would hinder the development of Moeding Solar and associated infrastructure on the affected properties. The development will be appropriate and acceptable from an avifaunal perspective and will not cause detrimental impacts to the avifauna species located within the affected properties. Therefore, it is the opinion that the development may be authorised, constructed and operated.

8 REFERENCES

Anderson, M.D. 2001. The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa. Draft report to Eskom Resources and Strategy Division. Johannesburg. South Africa.

Allan, D.G.1996b. Population structure and breeding habits of the Blue Crane *Anthropoides paradiseus* in the Western Cape Province and Karoo, South Africa. In Beilfuss R et al. (eds), *The African Crane and Wetland Training Workshop,* Maun, Botswana, 1993. International Crane Foundation pp. 355-376.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa: Johannesburg.

Goudie, R.I., 2006. Effects of power lines on birds. Harlequin Enterprises. St. John's, Newfoundland.

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

Herholdt, J.J., Anderson, M.D. 2006. Observations on the population and breeding status of the African Whitebacked Vulture, the Black-chested Snake Eagle, and the Secretarybird in the Kgalagadi Transfontier Park. Ostrich 77, 127-135.

Hunting, K., 2002. A roadmap for PIER research on avian power line electrocution in California. California Energy Commission, California.

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

Jenkins, A., Smallie, J. 2009. Terminal Velocity. End of the line for Ludwig's Bustard? Africa – Birds and Birding. 35 – 39.

Kagan, R.A., T.C. Viner, P.W. Trail, and E.O. Espinoza. 2014. Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis. National Fish and Wildlife Forensics Laboratory.

King, D.I. & Byers, B.E. 2002. An evaluation of power line rights-of-way as habitat for early-successional shrubland birds. Wildlife Society Bulletin 30: 868-874.

Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: a global review. Biological Conservation 136: 159-174.
Alexander, G. & Marais, J. 2007. *A Guide to the Reptiles of Southern Africa*. Struik Nature, Cape Town.

Maclean, G.L. 1999. Southern African endemic birds: Their distribution and conservation. Ostrich 69: Iss. 1-2.

Marnewick MD, Retief EF, Theron NT, Wright DR, Anderson TA. 2015. Important Bird and Biodiversity Areas of South Africa. Johannesburg: BirdLife South Africa.

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

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

Prinsen, H.A.M., Smallie, J.J., Boere, G.C., Pires, N. 2012. Guidelines on how to avoid or mitigate impact of electricity power grids on migratory birds in the African-Eurasian region. Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) Conservation Guidelines No. 14.

Scott-Shaw, C.R and Escott, B.J. (Eds) (2011) KwaZulu-Natal Provincial Pre-Transformation Vegetation Type Map – 2011. Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

Shaw, J.M., Jenkins, A.R., Smallie, J.J. & Ryan, P.G., 2010. Modelling power-line collision risk for the Blue Crane *Anthropoides paradiseus* in South Africa. Ibis 152: 590-599

Smit, H.A. 2012. Guidelines to minimize the impact on birds of solar facilities and associated infrastructure in South Africa. BirdLife South Africa, Johannesburg.

Van Rooyen, C.S. 2004a. The Management of Wildlife Interactions with overhead lines. In The fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217- 245. Eskom Technology, Services International, Johannesburg.

9 APPENDICES:

Appendix 1. Avifaunal Species List (Identified within the surveyed area

Common Name	Scientific Name	Status	Micro-Habitats within the surveyed area					
			Grassland Savannah	Shrubland Savannah	Tree Savannah (Natural)	Tree Savannah (Secondary Habitat)	Woodland Savannah	Pan Wetland with Woodland Fringe
Helmeted Guineafowl	*Numiba meleagris*		X					
Common Quail	*Coturnix coturnix*			X				X
Western Cattle Egret	*Bubulcus ibis*		X					
Black-winged Kite	*Elanus caeruleus*					X		X
Southern Pale Chanting Goshawk	*Melierax canorus*	Near-Endemic		X				
Greater Kestrel	*Falco rupicoloides*		X					X
Lanner Falcon	*Falco biarmicus*	Vulnerable						X
Kori Bustard	*Ardeotis kori*	Near Threatened	X					
Northern Black Korhaan	*Afrotis afraoides*	Near-Endemic	X		X			
Crowned Lapwing	*Vanellus coronatus*		X					X
Namaqua Sandgrouse	*Pterocles namaqua*	Near-Endemic						X
Ring-necked Dove	*Streptopelia capicola*		X	X	X	X		X
Laughing Dove	*Spilopelia senegalensis*				X	X		
Namaqua Dove	*Oena capensis*		X		X			
Red-eyed Dove	*Streptopelia semitorquata*				X		X	X
Red-faced Mousebird	*Urocolius indicus*				X		X	
African Hoopoe	*Upupa africana*				X			
Acacia Pied Barbet	*Tricholaema leucomelas*	Near-Endemic			X		X	X
Bokmakierie	*Telophorus zeylonus*	Near-Endemic	X		X			
Southern Fiscal	*Lanius collaris*		X	X		X		
Fork-tailed Drongo	*Dicrurus adsimilis*		X			X		
Pied Crow	*Corvus albus*		X					
Cape Penduline Tit	*Anthoscopus minutus*		X	X	X	X		X
Eastern Clapper Lark	*Mirafra fasciolata*		X					
Sabota Lark	*Calendulauda sabota*	Near-Endemic	X					X

Spike-heeled Lark	*Chersomanes albofasciata*	Near-Endemic	X					X
Red-capped Lark	*Calandrella cinerea*							X
Grey-backed Sparrow-Lark	*Eremopterix verticalis*	Near-Endemic	X		X			X
African Red-eyed Bulbul	*Pycnonotus nigricans*	Near-Endemic	X		X		X	X
Rock Martin	*Ptyonoprogne fuligula*		X					
Greater Striped Swallow	*Cecropis cucullata*		X					
Desert Cisticola	*Cisticola aridulus*		X		X	X		
Rufous-naped Lark	*Mirafra africana*		X		X			
Lefaillant's Cisticola	*Cisticola natalensis*		X			X		X
Black-chested Prinia	*Prinia flavicans*		X	X	X	X		X
Barred Wren-Warbler	*Calamonastes fascilatus*	Near-Endemic					X	
Yellow-bellied Eremomela	*Eremomela icteropygialis*		X	X	X	X	X	X
Chestnut-vented Warbler	*Sylvia subcaerulea*	Endemic	X	X	X	X	X	X
Cape Starling	*Lamprotornis nitens*				X		X	
Kalahari Scrub Robin	*Cercotrichas paena*	Near-Endemic	X	X	X	X	X	X
Familiar Chat	*Emarginata familiaris*							X
Ant-eating Chat	*Myrmecocichla formicivora*	Endemic	X	X				
Chat Flycatcher	*Melaenornis infuscatus*	Near-Endemic						X
White-bellied Sunbird	*Cinnyris talatala*				X		X	
Southern Grey-headed Sparrow	*Passer diffusus*		X			X		
Scaly-feathered Weaver	*Sporopipes squamifrons*	Near-Endemic	X	X	X	X		
Red-billed Quelea	*Quelea quelea*		X	X	X	X		X
Red-headed Finch	*Amadina erythrocephala*							X
Red-billed Firefinch	*Lagonosticta senegala*				X	X	X	
Violet-eared Waxbill	*Granatina granatina*				X		X	
Black-faced Waxbill	*Estrilda erythronotos*							X
African Pipit	*Anthus cinnamomeus*		X					
Black-throated Canary	*Crithagra atrogularis*		X					X
Yellow Canary	*Crithagra mozambica*	Near-Endemic	X	X	X			X
Golden-breasted Bunting	*Emberiza flaviventris*		X		X		X	X

Appendix 2. Avifaunal Species List obtained from SABAP (South African Bird Atlass Project) – Birds recorded within the greater Quarter Degree Grid (SABAP 1 & 2) as well as within the affected Pentad (SABAP 2).

Common name	Scientific name	Conservation status	Regional endemism	Susceptibility to		
				Collision	Electrocution	Disturbance / habitat loss
Avocet, Pied	*Recurvirostra avosetta*	-	-	-	-	-
Barbet, Acacia Pied	*Tricholaema leucomela*	-	Near-endemic	-	-	Moderate
Barbet, Crested	*Trachyphonus vaillantii*	-	-	-	-	Moderate
Batis, Pririt	*Batis pririt*	-	Near-endemic	-	-	Moderate
Bee-eater, European	*Merops apiaster*	-	-	-	-	-
Bee-eater, Little	*Merops pusillus*	-	-	-	-	Moderate
Bee-eater, Little	*Merops pusillus*	-	-	-	-	Moderate
Bee-eater, Swallow-tailed	*Merops hirundineus*	-	-	-	-	-
Bishop, Southern Red	*Euplectes orix*	-	-	-	-	-
Bishop, Yellow-crowned	*Euplectes afer*	-	-	-	-	Moderate
Bokmakierie	*Telophorus zeylonus*	-	Near-endemic	-	-	Moderate
Bulbul, African Red-eyed	*Pycnonotus capensis*	-	Near-endemic	-	-	Moderate
Bunting, Cinnamon-breasted	*Emberiza tahapisi*	-	-	-	-	Moderate
Bunting, Golden-breasted	*Emberiza flaviventris*	-	-	-	-	Moderate
Bustard, Kori	*Ardeotis kori*	Near-threatened	-	High	-	Moderate
Buzzard, Common	*Buteo buteo*	-	-	Moderate	Moderate	-
Canary, Black-throated	*Crithagra atrogularis*	-	-	-	-	Moderate
Canary, Yellow	*Crithagra flaviventris*	-	Near-endemic	-	-	Moderate
Chat, Ant-eating	*Myrmecocichla formicivora*	-	Endemic	-	-	Moderate
Chat, Familiar	*Cercomela familiaris*	-	-	-	-	-
Cisticola, Desert	*Cisticola aridulus*	-	-	-	-	Moderate

Cisticola, Levaillant's	*Cisticola tinniens*	-	-	-	-	-
Cisticola, Rattling	*Cisticola chiniana*	-	-	-	-	-
Cisticola, Zitting	*Cisticola juncidis*	-	-	-	-	Moderate
Cliff-Swallow, South African	*Petrochelidon spilodera*	-	Endemic	-	-	Moderate
Coot, Red-knobbed	*Fulica cristata*	-	-	-	-	-
Cormorant, Reed	*Microcarbo africanus*	-	-	Moderate	-	-
Cormorant, White-breasted	*Phalacrocorax lucidus*	-	-	Moderate	-	-
Courser, Burchell's	*Cursorius rufus*	Vulnerable	Near-endemic	-	-	Moderate
Courser, Temminck's	*Cursorius temminckii*	-	-	-	-	Moderate
Crane, Blue	*Anthropoides paradieus*	Near-threatened	Endemic	High	-	-
Crombec, Long-billed	*Sylvietta rufescens*	-	-	-	-	Moderate
Crow, Pied	*Corvus ablus*	-	-	Moderate	Moderate	-
Cuckoo, Diederick	*Chrysococcyx caprius*	-	-	-	-	Moderate
Cuckoo, Jacobin	*Clamator jacobinus*	-	-	-	-	Moderate
Darter, African	*Anhinga rufa*	-	-	Moderate	-	-
Dove, Cape Turtle	*Streptopelia capicola*	-	-	-	-	-
Dove, Laughing	*Spilopelia senegalensis*	-	-	-	-	-
Dove, Namaqua	*Oena capensis*	-	-	-	-	Moderate
Dove, Red-eyed	*Streptopelia semitorquata*	-	-	-	-	Moderate
Dove, Rock	*Columba livia*	-	-	-	-	-
Drongo, Fork-tailed	*Dicrurus adsimilis*	-	-	-	-	-
Duck, Maccoa	*Oxyura maccoa*	Near-threatened	-	Moderate	-	-
Duck, White-faced	*Dendrocygna viduata*	-	-	Moderate	-	-
Duck, Yellow-billed	*Anas undulata*	-	-	Moderate	-	-
Eagle, African Fish	*Haliaeetus vocifer*	-	-	Moderate	Moderate	-
Eagle, Martial	*Polemaetus bellicosus*	Endangered	-	High	High	Moderate
Eagle, Tawny	*Aquila rapax*	Endangered	-	High	Moderate	Moderate
Eagle-Owl, Spotted	*Bubo africanus*	-	-	-	High	Moderate

Egret, Great	*Ardea alba*	-	-	Moderate	-	-
Egret, Little	*Egretta garzetta*	-	-	-	-	-
Egret, Western Cattle	*Bubulcus ibis*	-	-	-	-	-
Egret, Yellow-billed	*Egretta intermedia*	-	-	Moderate	-	-
Falcon, Amur	*Falco amurensis*	-	-	-	-	Moderate
Falcon, Lanner	*Falco biarmicus*	Vulnerable	-	High	Moderate	-
Falcon, Red-footed	*Falco vespertinus*	Near-threatened	-	-	-	Moderate
Finch, Red-headed	*Amadina erythrocephala*	-	Near-endemic	-	-	Moderate
Finch, Scaly-feathered	*Sporopipes squamifrons*	-	Near-endemic	-	-	Moderate
Firefinch, Red-billed	*Lagonosticta senegala*	-	-	-	-	Moderate
Fiscal, Common	*Lanius collaris*	-	-	-	-	-
Flamingo, Greater	*Phoenicopterus ruber*	Near-threatened	-	High	-	-
Flamingo, Lesser	*Phoenicopterus minor*	Near-threatened	-	High	-	-
Flycatcher, Fairy	*Stenostira scita*	-	Endemic	-	-	Moderate
Flycatcher, Fairy	*Stenostira scita*	-	Endemic	-	-	Moderate
Flycatcher, Fiscal	*Sigelus silens*	-	Endemic	-	-	Moderate
Flycatcher, Marico	*Bradornis mariquensis*	-	Near-endemic	-	-	Moderate
Francolin, Orange River	*Scleroptila levaillantoides*	-	Near-endemic	-	-	Moderate
Goose, Egyptian	*Alopochen aegyptiaca*	-	-	High	High	-
Goose, Spur-winged	*Plectropterus gambensis*	-	-	Moderate	-	-
Goshawk, Southern Pale Chanting	*Melierax canorus*	-	Near-endemic	-	Moderate	Moderate
Grebe, Little	*Tachybaptus ruficollis*	-	-	-	-	-
Guineafowl, Helmeted	*Numida meleagris*	-	-	Moderate	-	-
Hamerkop	*Scopus umbretta*	-	-	Moderate	Moderate	-
Heron, Black-headed	*Ardea melanocephala*	-	-	Moderate	Moderate	-
Heron, Green-backed	*Butorides striata*	-	-	-	-	-
Heron, Grey	*Ardea cinerea*	-	-	High	High	-
Hoopoe, African	*Upupa africana*	-	-	-	-	-

Hornbill, African Grey	*Tockus nasutus*	-	-	-	-	-
Ibis, African Sacred	*Threskiornis aethiopicus*	-	-	Moderate	-	-
Ibis, Glossy	*Plegadis falcinellus*	-	-	Moderate	-	-
Ibis, Hadeda	*Bostrychia hagedash*	-	-	Moderate	Moderate	-
Kestrel, Greater	*Falco rupicoloides*	-	-	-	Moderate	Moderate
Kestrel, Lesser	*Falco naumanni*	-	-	High	-	Moderate
Kingfisher, Brown-hooded	*Halycon albiventris*	-	-	-	-	Moderate
Kingfisher, Pied	*Ceryle rudis*	-	-	-	-	-
Kite, Black-shouldered	*Elanus caeruleus*	-	-	-	-	Moderate
Korhaan, Northern Black	*Afrotis afraoides*	-	Endemic	High	-	Moderate
Korhaan, Red-crested	*Lophotis ruficrista*	-	Near-endemic	Moderate		Moderate
Lapwing, Blacksmith	*Vanellus armatus*	-	-	-	-	-
Lapwing, Crowned	*Vanellus coronatus*	-	-	-	-	-
Lark, Eastern Clapper	*Mirafra fasciolata*	-	Near-endemic	-	-	Moderate
Lark, Fawn-coloured	*Calendulauda semitorquata*	-	Near-endemic	-	-	Moderate
Lark, Rufous-naped	*Mirafra africana*	-	-	-	-	Moderate
Lark, Sabota	*Calendulauda sabota*	-	Near-endemic	-	-	Moderate
Lark, Spike-heeled	*Chersomanes albofasciata*	-	Near-endemic	-	-	High
Longclaw, Cape	*Macronyx capensis*	-	Endemic	-	-	Moderate
Martin, Brown-throated	*Riparia paludicola*	-	-	-	-	Moderate
Masked-Weaver, Southern	*Ploceus velatus*	-	-	-	-	Moderate
Moorhen, Common	*Gallinula chloropus*	-	-	-	-	-
Mousebird, Red-faced	*Urocolius indicus*	-	-	-	-	Moderate
Mousebird, White-backed	*Colius colius*	-	Endemic	-	-	Moderate
Neddicky	*Cisticola fulvicapilla*	-	-	-	-	Moderate
Night-Heron, Black-crowned	*Nycticorax nycticorax*	-	-	-	-	-
Ostrich, Common	*Struthio camelus*	-	-	-	-	-
Owl, Marsh	*Asio capensis*	-	-	Moderate	-	Moderate

Pigeon, Speckled	*Columba guinea*	-	-	-	-	-
Pipit, African	*Anthus cinnamomeus*	-	-	-	-	Moderate
Plover, Kittlitz's	*Charadrius pecuarius*	-	-	-	-	-
Plover, Three-banded	*Charadrius tricollaris*	-	-	-	-	-
Pochard, Southern	*Netta erythrophthalma*	-	-	Moderate	-	-
Prinia, Black-chested	*Prinia flavicans*	-	Near-endemic	-	-	Moderate
Pytilia, Green-winged	*Pytilia melba*	-	-	-	-	Moderate
Quailfinch, African	*Ortygospiza fuscocrissa*	-	-	-	-	Moderate
Quelea, Red-billed	*Quelea quelea*	-	-	-	-	-
Robin-chat, Cape	*Cossypha caffra*	-	-	-	-	-
Roller, European	*Coracias garrulus*	Near-threatened	-	-	-	Moderate
Roller, Lilac-breasted	*Coracias caudatus*	-	-	-	-	-
Ruff	*Philomachus pugnax*	-	-	-	-	-
Sandgrouse, Namaqua	*Pterocles namaqua*	-	Near-endemic	-	-	Moderate
Sandpiper, Common	*Actitis hypoleucos*	-	-	-	-	-
Sandpiper, Curlew	*Calidris ferruginea*	-	-	-	-	-
Sandpiper, Marsh	*Tringa stagnatilis*	-	-	-	-	-
Sandpiper, Wood	*Tringa glareola*	-	-	-	-	-
Scimitarbill, Common	*Rhinopomastus cyanomelas*	-	-	-	-	Moderate
Scrub-Robin, Kalahari	*Erythropygia paena*	-	Near-endemic	-	-	Moderate
Secretarybird	*Sagittarius serpentarius*	Vulnerable	-	High	-	Moderate
Shelduck, South African	*Tadorna cana*	-	Endemic	Moderate	-	-
Shoveler, Cape	*Anas smithii*	-	Near-endemic	Moderate	-	-
Shrike, Crimson-breasted	*Laniarius atrococcineus*	-	Near-endemic	-	-	Moderate
Shrike, Lesser Grey	*Lanius minor*	-	-	-	-	-
Shrike, Red-backed	*Lanius collurio*	-	-	-	-	-
Snake-Eagle, Black-chested	*Circaetus pectoralis*	-	-	Moderate	-	-
Snake-Eagle, Brown	*Circaetus cinereus*	-	-	-	Moderate	Moderate
Sparrow, Cape	*Passer melanurus*	-	Near-endemic	-	-	-

Sparrow, House	*Passer domesticus*	-	-	-	-	-
Sparrow, Southern Grey-headed	*Passer diffusus*	-	-	-	-	-
Sparrowlark, Chestnut-backed	*Eremopterix leucotis*	-	-	-	-	Moderate
Sparrow-Weaver, White-browed	*Plocepasser mahali*	-	-	-	-	Moderate
Spoonbill, African	*Platalea alba*	-	-	Moderate	-	-
Spurfowl, Swainson's	*Pternistis swainsonii*	-	-	Moderate	-	-
Starling, Cape Glossy	*Lamprotornis nitens*	-	-	-	-	-
Stilt, Black-winged	*Himantopus himantopus*	-	-	-	-	-
Stint, Little	*Calidris minuta*	-	-	-	-	-
Stork, Abdim's	*Ciconia abdimii*	Near-threatened	-	-	Moderate	Moderate
Stork, Black	*Ciconia nigra*	Vulnerable	-	High	Moderate	-
Stork, Yellow-billed	*Mycteria ibis*	Endangered	-	Moderate	-	Moderate
Sunbird, Dusky	*Cinnyris fuscus*	-	Near-endemic	-	-	Moderate
Swallow, Barn	*Hirundo rustica*	-	-	-	-	Moderate
Swallow, Greater-striped	*Cecropis cucullata*	-	-	-	-	Moderate
Swallow, Red-breasted	*Cecropis semirufa*	-	-	-	-	-
Swallow, White-throated	*Hirundo albigularis*	-	-	-	-	Moderate
Swift, African Black	*Apus barbatus*	-	-	-	-	-
Swift, Little	*Apus affinis*	-	-	-	-	-
Swift, White-rumped	*Apus caffer*	-	-	-	-	-
Tchagra, Brown-crowned	*Tchagra australis*	-	-	-	-	Moderate
Teal, Cape	*Anas capensis*	-	-	Moderate	-	-
Teal, Red-billed	*Anas erythrorhyncha*	-	-	Moderate	-	-
Tern, Whiskered	*Chlidonias hybrida*	-	-	-	-	-
Tern, White-winged	*Chlidonias leucopterus*	-	-	-	-	-
Thrush, Karoo	*Turdus smithii*	-	Endemic	-	-	Moderate
Tit, Cape Penduline-	*Anthoscopus minutus*	-	Near-endemic	-	-	Moderate

Tit-Babbler, Chestnut-vented	*Sylvia subcaerulea*	-	Near-endemic	-	-	Moderate
Vulture, Cape	*Gyps coprotheres*	Endangered	Near-endemic	High	High	-
Vulture, White-backed	*Gyps africanus*	Critically Endangered	-	High	High	-
Wagtail, Cape	*Motacilla capensis*	-	-	-	-	-
Warbler, Lesser Swamp	*Acrocephalus gracilirostris*	-	-	-	-	-
Waxbill, Black-faced	*Estrilda erythronotos*	-	-	-	-	Moderate
Waxbill, Common	*Estrilda astrild*	-	-	-	-	Moderate
Waxbill, Violet-eared	*Uraeginthus granatinus*	-	-	-	-	Moderate
Weaver, Sociable	*Philetairus socius*	-	Endemic	-	-	Moderate
Wheatear, Capped	*Oenanthe pileata*	-	-	-	-	Moderate
Whydah, Long-tailed Paradise	*Vidua paradisaea*	-	-	-	-	Moderate
Whydah, Pin-tailed	*Vidua macroura*	-	-	-	-	Moderate
Whydah, Shaft-tailed	*Euplectes progne*	-	Near-endemic	-	-	Moderate
Widowbird, Long-tailed	*Euplectes progne*	-	-	-	-	Moderate
Woodpecker, Golden-tailed	*Campethera abingoni*	-	-	-	-	Moderate
Wren-Warbler, Barred	*Calamonastes fasciolatus*	-	Near-endemic	-	-	Moderate