OCTOBER 2015

# MAJUBA SOLAR PHOTOVOLTAIC FACILITY

AVIFAUNAL IMPACT ASSESSMENT REPORT FOR THE MAJUBA SOLAR PHOTOVOLTAIC FACILITY

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## EXECUTIVE SUMMARY

Eskom Holdings SOC Ltd is planning a Solar Photovoltaic (PV) project in the Mpumalanga Province, South Africa. In line with environmental legislation, Feathers Environmental Services was appointed to conduct an avifaunal specialist study. The proposed Majuba Solar Photovoltaic Facility is to be developed within boundaries of the Majuba (coal-fired) Power Station and will have a generating capacity of approximately 65MW.

A combined total of at least 168 bird species have been recorded within the relevant SABAP quarter degree square and pentad. The presence of these species in the broader area provides an indication of the diversity of species that could potentially occur at the proposed development site. SABAP1 recorded 166 species and SABAP2 has recorded 73 species to date. Of the 168 species, 12 are Red List species, five near-endemics, two regional endemics and three endemic species. It is likely that the greatest impact in the area to be transformed by the proposed development will be on smaller species that are currently foraging and nesting in these parcels of land.

The site visit produced a combined list of 31 species, covering both the project development area (PDA) and to a very limited extent, the surrounding area. Species that featured prominently include Southern Red Bishop *Euplectes orix*, Southern Masked-Weaver *Ploceus velatus*, Levaillant's Cisticola *Cisticola tinniens,* Common Myna *Acridotheres tristis,* Speckled Pigeon *Columba guinea,* Orange-breasted Waxbill *Amandava subflava* and Long-tailed Widowbird *Euplectes progne.* These are species that are often associated with urban, peri-urban, wetland and farmland environments, so the relatively high reporting rate is not unexpected. No Red List species or raptor nests were recorded during the data collection period. In addition, no distinct flights paths across the proposed site were recorded.

All of these species have the potential to be displaced by the solar development as a result of habitat transformation and disturbance. However sufficient similar habitat is available within the broader study area, so it is unlikely that the displacement impact will be of regional or national significance. These species may also be susceptible to collisions with the solar PV panels.

While renewable energy sources, such as solar energy, hold great potential to alleviate dependence on fossil fuels they are not without their environmental risks and negative impacts. Potential impacts that were identified relating to the PV plant itself are: loss of habitat; disturbance; bird collisions with PV panels; and the nesting of birds on plant infrastructure, of which habitat destruction is likely to be the most significant. Given the numerous wetland systems that occur within the broader study area, it is possible that there will be movement of waterbirds (among other species), that do not necessarily utilise

the site, but would be vulnerable to impacts (i.e. collision) with the plant infrastructure, when passing through or over the development. Potential impacts of associated infrastructure include the following: collisions with overhead power lines; electrocution of birds on pylons and within the substation yard; habitat destruction and disturbance as a result of construction activities associated with the internal access roads, additional on-site substations and operations buildings.

In general, the site has been determined to have medium to low sensitivity in terms of avifauna, based on the micro-habitats available within the confines of the proposed site and the species these habitats are likely to support. Given the presence of existing habitat degradation and disturbance associated with the mining, energy generation and industrial activities that are prevalent in the study area, it is anticipated that the proposed Majuba Solar Photovoltaic Facility can be constructed at the proposed site with acceptable levels of impact on the resident avifauna.

There will undoubtedly be some impact on avifauna but it is the specialist's professional opinion that the impact will be acceptable provided the following conditions are met:

- Adherence to the site specific EMPr. Of particular concern is the layout of the power line infrastructure. Ideally an avifaunal walk down should be conducted once the power line towers have been surveyed and marked. Input must be given into micro siting as well as which sections of power line require marking with bird flight diverters. This walk down should also ground truth all other project component final layouts.
- A post construction avifaunal monitoring programme must be established in conjunction with a suitably qualified avifaunal specialist, and in accordance with the BirdLife South Africa best practice guidelines (currently in prep). This programme will gather site specific information on the impacts of the Majuba Solar Photovoltaic Facility on avifauna. In addition the monitoring programme will contribute to an overall understanding of avifaunal impacts related to solar developments in South Africa.

## DECLARATION OF INDEPENDENCE

I, **Megan Diamond**, in my capacity as a specialist consultant, hereby declare that I:

- Act as an independent specialist to Savannah Environmental (Pty) Ltd for this project.
- Do not have any personal, business or financial interest in the project except for financial remuneration for specialist investigations completed in a professional capacity as specified by the Environmental Impact Assessment Regulations, 2010.
- Will not be affected by the outcome of the environmental process, of which this report forms part of.
- Do not have any influence over the decisions made by the governing authorities.
- Do not object to or endorse the proposed developments, but aim to present facts and my best scientific and professional opinion with regard to the impacts of the development.
- Undertake to disclose to the relevant authorities any information that has or may have the potential to influence its decision or the objectivity of any report, plan, or document required in terms of the Environmental Impact Assessment Regulations, 2010.

## PROFESSIONAL REGISTRATION

The Natural Scientific Professions Act of 2003 aims to "Provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith."

"Only a registered person may practice in a consulting capacity" – Natural Scientific Professions Act of 2003 (20(1)-pg. 14)

| | |
|---|---|
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| Qualification: | BSc Environmental Management – UNISA |
| Affiliation: | South African Council for Natural Scientific Professions |
| Registration number: | 300022/14 |
| Fields of Expertise: | Environmental Science |
| Registration: | Certificated Natural Scientist Member |

## PROFESSIONAL EXPERIENCE

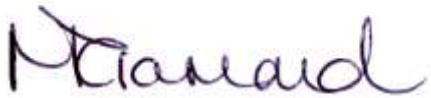
Megan has been involved in conservation for 17 years and holds a BSc in Environmental Management. She has nine years experience in the field of bird interactions with electrical infrastructure and during this time has completed impact assessments for at least 50 projects, many of which have involved the assessment of various forms of electrical infrastructure. In various roles (including Programme Manager) with the Endangered Wildlife Trust's Wildlife & Energy Programme and the Programme's primary project (Eskom-EWT Strategic Partnership) from 2006 to 2013, Megan was responsible for assisting the energy industry and the national utility in minimising the negative impacts (associated with electrical infrastructure) on wildlife through the provision of strategic guidance, risk and impact assessments, training and research.

Megan is a co-author of various papers related to bird and power line interactions as well as the *BirdLife South Africa / Endangered Wildlife Trust best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* and the *Avian Wind Farm Sensitivity Map for South Africa* and played an instrumental role in facilitating the endorsement of these two products by the South African Wind Energy Association (SAWEA), IAIAsa (International Association for Impact Assessment South Africa) and Eskom. In 2011/2012, Megan chaired the Birds and Wind Energy Specialist Group in South Africa.

## INDEMNITY

- This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken.
- This impact assessment report is based on a desktop investigation using the available information and data related to the site to be affected, as well as a three day site visit to the study area on 21-23 September 2015, in accordance with the BirdLife South Africa *Guidelines to minimise the impact on birds of Solar Facilities and Associated Infrastructure in South Africa* (Smit, 2012). No long term investigation or monitoring was conducted.
- The Precautionary Principle has been applied throughout this investigation.
- The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information at the time of study.
- Additional information may become known or available during a later stage of the process for which no allowance could have been made at the time of this report.

- The specialist investigator reserves the right to modify this report, recommendations and conclusions at any stage should additional information become available.
- Information, recommendations and conclusions in this report cannot be applied to any other area without proper investigation.
- This report, in its entirety or any portion thereof, may not be altered in any manner or form or for any purpose without the specific and written consent of the specialist investigator as specified above.
- Acceptance of this report, in any physical or digital form, serves to confirm acknowledgment of these terms and liabilities.



6 October 2015

# 1. INTRODUCTION

## 1.1 Background

In order to demonstrate commitment to sustainable development and a pledge to move towards a cleaner energy future, Eskom is investigating reducing their self-consumption at their various power stations, offices and substations. The Ilanga Photovoltaic Project Portfolio aims to install 150MW of small-scale solar photovoltaic (PV) facilities that will promote the reduction of the utility's carbon footprint and support the demand side management energy efficiency programme. The proposed Majuba Solar Energy Facility, located within the confines of the Majuba Power Station property boundary, near Standerton in the Mpumalanga province (FIGURE 1) is one of five solar projects at existing coal fired power stations currently undergoing environmental assessment processes.

The National Environmental Management Act (NEMBA) (Act 107 of 1998) requires that an Environmental Impact Assessment (EIA) be conducted for any development which could have a significant effect on the environment, with the objective to identify, predict and evaluate the actual and potential impacts of these activities on ecological systems; identify alternatives; and provide recommendations for mitigation to minimize the negative impacts. In order to meet these requirements, Eskom has appointed Savannah Environmental (Pty) Ltd (hereinafter referred to Savannah Environmental) as independent environmental assessment practitioners to manage the EIA process for the proposed development. Feathers Environmental Services was subsequently appointed as the avifaunal specialist to compile this specialist avifaunal impact assessment report which uses a set methodology and various data sets (discussed elsewhere) to determine which avian species regularly occur within the study area, the availability of bird micro habitats (i.e. avifaunal sensitive areas), a description and an assessment of the significance of the potential impacts of the proposed development, an assessment of the site alternative as well as the provision of recommendations for the mitigation of the anticipated impacts.

## 1.2 Project Description

Following the initial scoping studies, a single site alternative was provided for assessment in this EIA phase of the project. The proposed development will have a maximum generating capacity of 65MW and will encompass an area of approximately 97 hectares.

The solar energy facility will consist of:

- » Solar panels (fixed/tracking technology) with an export capacity of up to 75MW;
- » Mounting structures to support the PV panels;
- » Cabling between project components;
- » Central inverter/transformer stations to collect all energy generated from the PV panels;
- » An on-site substation or switching station;
- » A power line to facilitate the connection of the solar energy facility from the on-site substation to an existing substation/power line at the Majuba Power Station;
- » Internal access roads; and
- » Associated buildings including a workshop area for maintenance, storage, and control facility with basic services such as water and electricity.

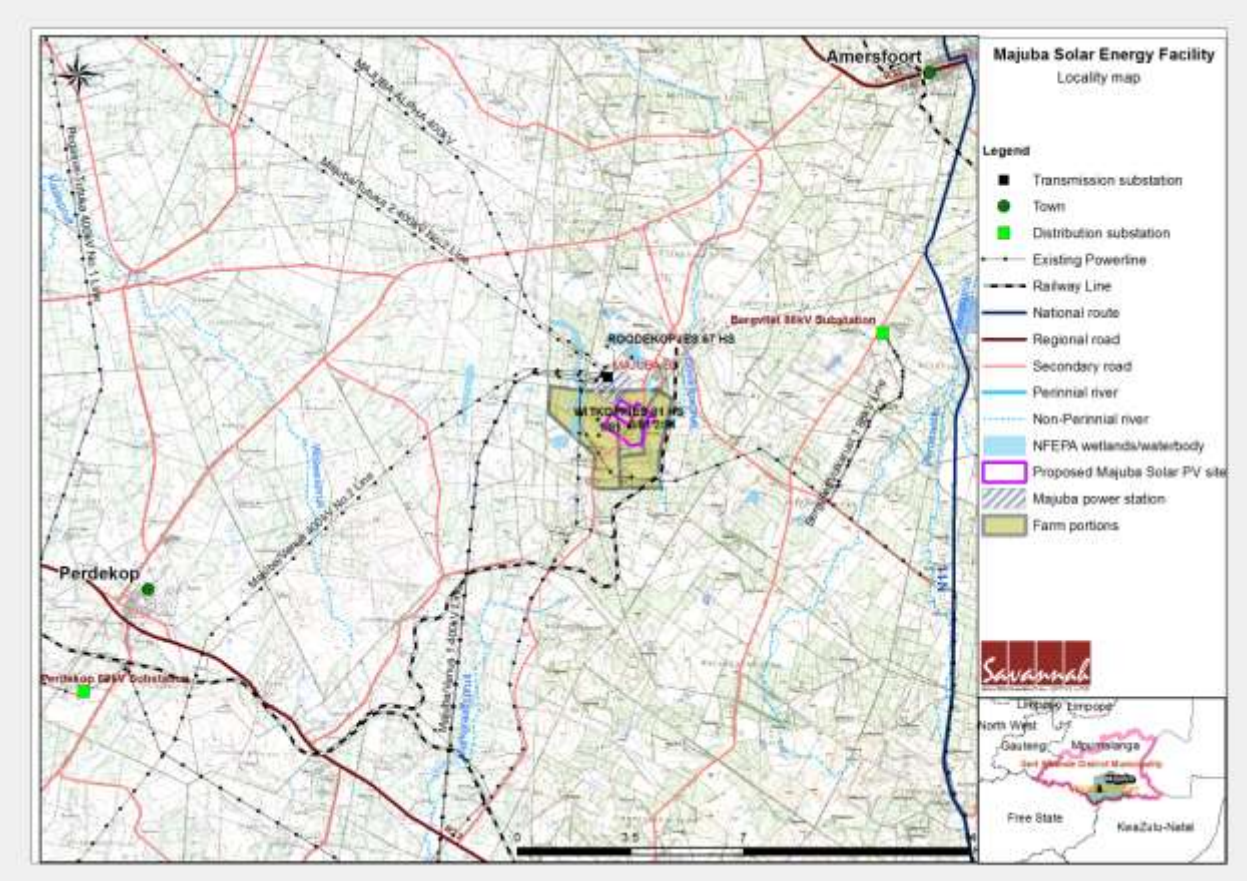



**FIGURE 1:** Map showing the locality of the proposed Majuba Solar Energy Facility in the Mpumalanga province (Source: Savannah Environmental)

## 1.3 Relevant legislation and guidelines

The following pieces of legislation are applicable to the proposed development:

### *1.3.1 The Convention on Biological Diversity*

The Convention on Biological Diversity 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://www.cbd.int/convention/guide/). Although the convention has not developed specific recommendations or guidelines pertaining to birds and energy infrastructure interactions and impacts, it does make provision (in a general policy guideline) for keeping and restoring biodiversity. In addition to this the CBD is an ardent supporter of thorough assessment procedures (Strategic Environmental Assessments (SEA) and Environmental Impact Assessments (EIA)) and requires that Parties apply these processes when planning activities that will have a biodiversity impact. An important principle encompassed by the CBD is the precautionary principle which essentially states that where serious threats to the environment exist, lack of full scientific certainty should not be used a reason for delaying management of these risks. The burden of proof that the impact will *not* occur lies with the proponent of the activity posing the threat. In addition, the Aichi Biodiversity Targets (CBD 2011) address several priority issues i.e. the loss of biodiversity and its causes; reducing direct pressure on biodiversity; safeguarding ecosystems, species and genetic diversity and participatory planning to enhance implementation of biodiversity conservation. Each of these is relevant in the case of energy infrastructure and bird conservation through all project phases from planning to the implementation of mitigation measures for existing developments.

### *1.3.2 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 impacts associated with man-made infrastructure. 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 (Art III, par. 4b and 4c). At CMS/CoP7 (2002) Res. 7.2 on Impact Assessment and Migratory Species was accepted, requesting Parties to apply appropriate SEA and EIA procedures for all proposed developments, including power lines. An agreement developed in the framework of CMS, in

force since November 1999, brings the 119 Range States of the Africa Eurasian Waterbird Agreement (AEWA) region together in a common policy to protect migratory waterbirds that use the flyway from the Arctic to southern Africa. The agreement contains a number of obligations that are relevant to migratory waterbirds and power lines. AEWA has also published a series of practical guidelines that enable Parties to effectively address conservation issues influencing the status of migratory waterbirds. The most relevant guideline for migratory birds and power lines is the *Guideline on how to avoid, minimise or mitigate impact of infrastructural developments and related disturbance affecting waterbirds* (Tucker & Treweek, 2008).

### *1.3.3 The Agreement on the Conservation 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 habitats 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, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the South African penguin. The core activities carried out under AEWA are described in its Action Plan, which is legally binding for all countries that have joined the Agreement. The AEWA Action Plan details the various measures to be undertaken by Contracting Parties (South Africa included) to guarantee the conservation of migratory waterbirds within their national boundaries. These include species and habitat protection and the management of human activities as well as legal and emergency measures.

### *1.3.4 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.

### *1.3.5 Guidelines to minimise the impact on birds of Solar Facilities and Associated Infrastructure in South Africa*

The most important guidance document from an avifaunal impact perspective that is currently applicable (but not legally binding) to solar energy development in South Africa is the *Guidelines to minimise the impact on birds of Solar Facilities and Associated Infrastructure in South Africa* (Smit, 2012) published by BirdLife South Africa (BLSA). These guidelines recommend a site assessment of 3-5 days to confirm the presence, habitat preferences and flyways of threatened, endemic or range restricted species in the study area.

## 1.4 Terms of Reference

The avifaunal specialist has conducted this assessment according to the following terms of reference supplied by Savannah Environmental:

The avifaunal specialist has conducted this assessment according to the following terms of reference supplied by Savannah Environmental:

- an indication of the methodology used in determining the significance of potential environmental impacts;
- a description of all environmental issues that were identified during the environmental impact assessment process;
- an assessment of the significance of direct, indirect and cumulative impacts according to the criteria provided by Savannah Environmental (APPENDIX 3);
- a description and comparative assessment of all alternatives identified during the environmental impact assessment process;
- recommendations regarding practical mitigation measures for potentially significant impacts, *for inclusion in the Environmental Management Programme (EMPr);*
- an indication of the extent to which the issue could be addressed by the adoption of mitigation measures;
- a description of any assumptions, uncertainties and gaps in knowledge; and
- an environmental impact statement which contains:
    - a summary of the key findings of the environmental impact assessment;
    - an assessment of the positive and negative implications of the proposed activity; and
    - a comparative assessment of the positive and negative implications of identified alternatives.

## 1.5 Methods

The following methodology was employed to compile this report:

- A review of available published and unpublished literature relevant to bird interactions with solar energy facilities was conducted in an effort to understand the likely impacts associated with these facilities and the current level of knowledge in this field. The information gathered from various sources has been adapted to local conditions and species as far as possible.
- Suitable bird habitats and potential sensitive areas within the proposed sites, where the above impacts are likely to occur, were assessed using various GIS (Geographic Information System) layers, Google Earth and confirmed during the three-day site visit to the study area.
- Various avifaunal data sets (listed below) were collected and examined to determine the avifauna likely to occur within the impact zone of the proposed solar energy facility.
- Primary bird data was collected by means of three survey methods during an intensive three-day site visit. These methods included incidental observations, a single vehicle transect and the establishment of four walked transects. Details of these methods are provided in section 2.4 of this report.
- The potential impacts of the proposed facility and associated infrastructure were evaluated and the significance of each was assessed according to criteria provided by Savannah Environmental (APPENDIX 3).
- Sensitive areas within each of the proposed sites have been identified and mapped.
- Practical mitigation recommendations for potentially significant impacts have been provided for inclusion in the EMPr.

## 1.6 Data sources used

The following data sources and reports were used in varying levels of detail for this study:

- International literature on avian interactions with solar energy facilities
- The Southern African Bird Atlas Project 1 (Harrison *et al*, 1997) - Quarter Degree Square 2729BB (62 cards).
- The Southern African Bird Atlas Project 2 (http://sabap2.adu.org.za/v1/index.php) - Pentad 2705_2945 (3 cards).
- The Important Bird Areas report (Barnes 1998) was consulted to determine the location of the nearest IBA's and their importance for this study.

- The Co-ordinated Avifaunal Roadcount project (Young *et al*, 2003) data was consulted to obtain relevant data on large terrestrial bird report rates in the area.
- The Co-ordinated Waterbird Count (Taylor *et al*, 1999) data was consulted determine if large concentrations of water birds, associated with South African wetlands, may occur within the study area.
- The conservation status and endemism information of all bird species occurring in the aforementioned degree squares was then determined with the use of Taylor (2014), the IUCN 2013 Red List and the BirdLife South Africa Checklist of Birds in South Africa (2014).
- The latest vegetation classification of South Africa (Mucina & Rutherford, 2006) was consulted in order to determine which vegetation types that occur on each site.
- KMZ. shapefiles of the proposed solar energy facility locations were obtained from Savannah Environmental.
- Google Earth ©2015 imagery was used to assess the study area at a landscape level and identify the micro habitats available at each of the proposed sites. These habitats were confirmed by personal observations noted during the three-day site visit to the study area.
- The BirdLife South Africa position statement on solar energy and birds and *Guidelines to minimise the impact on birds of Solar Facilities and associated infrastructure in South Africa* (Smit. 2012) was used for evaluating the potential impacts and to inform the site visit requirements for the EIA phase.

## 1.7 Limitations & assumptions

The author made the assumption that the sources of information used are reliable. However, it must be noted that there are limiting factors and these may potentially undermine the accuracy of the predicted results:

- Providing an accurate predictive assessment of the impacts on birds from solar energy developments is extremely difficult at this time, particularly in South Africa where the deployment of this technology is still relatively new. Very little information is available from both international and local studies. Recent, unpublished, mortality studies at three solar energy facilities (using different solar technologies) in southern California revealed that a diversity of bird species is susceptible to injury and mortality at solar facilities regardless of the type of technology employed (Kagan et al. 2014). However, it must be noted that a number of facility related factors could influence impacts and mortality rates at a particular facility. An alarmist approach of applying mortality rates recorded at a single facility to all similar solar facilities must be avoided as each solar facility must be assessed individually taking all variables into account.

- SABAP1 data (Harrison *et al*, 1997) is more than two decades old, but this comprehensive dataset provides a valuable baseline against which any changes in species presence; abundance and distribution can be monitored. In addition, SABAP 2 data is not yet readily available with sufficient coverage for the study area. However a fairly substantial amount of primary data was collected on site, providing a more up to date and detailed data set. However it must be borne in that the observations made during the site visit were made over a short period of time in a single season (spring) and may not be a true indication of all bird species potentially present in the area.
- The proposed array and number of solar panels to be constructed as well as the position of associated infrastructure have not yet been finalized.
- The routing and proposed structure configuration for the grid connection was not available for assessment. This is a potentially serious limitation since the power line could potentially pose a collision and electrocution risk to birds.

Predictions in this study are based on experience of these and similar species in different parts of South Africa, through the authors' experience working in the avifaunal specialist field since 2006.

## 2. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The proposed Majuba Solar Photovoltaic Facility is to be developed within boundaries of the Majuba (coal-fired) Power Station, located between the towns of Volksrust and Amersfoort in the Mpumalanga Province. The proposed site is located on Portion 1, 2 and 6 of the farm Witkoppies 81 HS. The natural environment in this area has been largely transformed by agriculture as well activities associated with the Power Station.

### 2.1 Vegetation

Vegetation is one of the primary factors determining bird species distribution and abundance in an area. The following description of the vegetation on the site focuses on the vegetation structure and not species composition since it is widely accepted within ornithological circles that vegetation structure is more important in determining which bird species will occur there. The classification of vegetation types is from Harrison *et al* (1997) and Mucina & Rutherford (2006).

Both site locations are located within the Grassland Biome. Grasslands are maintained mainly by a combination of relatively high summer rainfall; frequent fires; frost and grazing. These factors generally preclude the growth of trees and shrubs. Sweet grassland is

generally found in the lower rainfall areas. Vegetation is taller and sparser, and nutrients are retained in the leaves during winter. Relatively few species favour sweet grassland over sour or mixed grassland. Sour grassland generally occurs in the higher rainfall areas on leached soils. Vegetation is shorter and denser, and nutrients are withdrawn from the leaves during the winter months. Many grassland bird species show a preference for sour grassland over sweet or mixed. Mixed grassland is a combination or a transition between the two grassland types above. The grassland in the 2729BB quarter degree square is classified as a combination of Sour and Mixed Grassland (Harrison *et al,* 1997). According to Mucina and Rutherford (2006), the site location is comprised entirely of the *Amersfoort Highveld Clay Grassland* vegetation type (FIGURE 2) of which a quarter is transformed predominantly by cultivation. Other prominent vegetation types in the broader study area include *Soweto Highveld Grassland, Bloemfontein Karroid Shrubland and Wakkerstroom Montane Grassland,* all of which also fall within the greater Grassland Biome. The main relevance of this information to avifauna is that since the site is composed of grassland, one can expect grassland associated bird species to feature prominently. It is likely that the greatest impact in the area to be transformed by the proposed development will be on smaller passerine species that are currently foraging and nesting in this parcel of land.

## 2.2 Avifaunal Habitats

Whilst much of the distribution and abundance of bird species can be attributed to the broad vegetation types present in an area, it is the smaller spatial scale habitats (micro habitats) that support the requirements of a particular bird species that need to be examined in greater detail. Micro habitats are shaped by factors other than vegetation, such as topography, land use (CSIR, 2009), food availability and various anthropogenic factors all of which will either attract or deter birds and are critically important in mapping the site in terms of avifaunal sensitivity and ultimately informing the mitigation requirements. Investigation of the development site revealed the presence of grassland habitat (disturbed to a fairly large extant) interspersed with wetland areas and small stands of trees (FIGURE 2). Commercial dryland cultivation, wetlands, several drainage lines, small river systems, eucalyptus plantations as well as mines, quarries and industrial areas feature prominently within the immediate surrounds of the proposed development site.

**FIGURE 2:** Examples of the microhabitat observed, at the proposed site, during the site visit

## 2.3 Relevant Bird Populations

### *2.3.1 Southern African Bird Atlas Project 1 and 2*

A combined total of at least 168 bird species have been recorded within the relevant SABAP quarter degree square and pentad (APPENDIX 1). The presence of these species in the broader area provides an indication of the diversity of species that could potentially occur at the proposed development site. Of the 168 species, 12 are Red List species, five near-

endemics, two regional endemics and three endemic species. Although Red List endemics (Blue Korhaan *Eupodotis caerulescens*, Agulhas Long-billed Lark *Certhilauda brevirostris,* Botha's Lark *Spizocorys fringillaris* and Rudd's Lark *Heteromirafra ruddi*) have been recorded in the broader study, the report rates for each of the three lark species are low which suggests that these species may not in fact occur frequently within the quarter degree squares or pentads and are therefore unlikely to occur at the identified site. The Red List bird species as well as those with a level of endemism, recorded in the study area by SABAP1 and 2 are presented in TABLE 1.

Although this assessment focuses on the impacts on Red List species, as these are the species of highest conservation concern, the impact on the more common species has also been considered, although not on an individual species basis. It is worth noting that since the impacts are usually the same across various species, Red List species can often be used as surrogate species for the others in terms of impacts and the necessary mitigation.

While most of the grassland dependent Red List species (recorded in this area) could possibly occur at the proposed development site, the small size of the proposed property and the proximity to the existing sources of disturbance will in all likelihood preclude species of conservation concern from occupying this area. The proposed development site does however support a relatively small diversity of more common small terrestrial species and development in this area will undoubtedly displace these species either temporarily of perhaps more permanently. However sufficient similar habitat is available within the broader study area, so it is highly unlikely that the displacement impact will be of regional or national significance.

**TABLE 1:** Annotated list of bird species likely to occur within the development area and immediate surrounds of the proposed Majuba PV Solar Facility

| COMMON NAME | SCIENTIFIC NAME | REGIONAL STATUS | GLOBAL STATUS | ENDEMISM | SABAP 1 | SABAP 2 | GRASSLAND | CULTIVATION | WETLANDS | HABITAT LOSS & DISTURBANCE | COLLISION | ELECTROCUTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bustard, Denham's | Neotis denhami | VU | NT | | x | | x | | | x | x | |
| Buzzard, Jackal | Buteo rufofuscus | | | Near Endemic | x | | x | | | | x | x |
| Cisticola, Cloud | Cisticola textrix | | | Near Endemic | x | x | x | | | x | | |
| Crane, Blue | Anthropoides paradiseus | NT | VU | | x | | x | x | x | x | x | |
| Crane, Grey Crowned | Balearica regulorum | EN | EN | | x | | x | x | x | x | x | x |
| Duck, Maccoa | Oxyura maccoa | NT | NT | | x | x | | | x | | x | |
| Falcon, Lanner | Falco biarmicus | VU | LC | | x | | x | | | x | x | x |
| Flamingo, Greater | Phoenicopterus ruber | NT | LC | | x | | | | x | | x | |
| Flycatcher, Fairy | Stenostira scita | | | Near Endemic | x | | x | | | x | | |
| Korhaan, Blue | Eupodotis caerulescens | - | NT | Regional Endemic | x | x | x | | | x | x | |
| Korhaan, White-bellied | Eupodotis senegalensis | VU | LC | | x | | x | x | | x | x | |
| Lark, Agulhas Long-billed | Certhilauda brevirostris | NT | NR | Near Endemic | x | | x | x | | x | | |
| Lark, Botha's | Spizocorys fringillaris | EN | EN | Endemic | x | | x | | | x | | |
| Lark, Cape Clapper | Mirafra apiata | | | Near Endemic | x | | x | | | x | | |
| Lark, Rudd's | Heteromirafra ruddi | EN | VU | Endemic | x | | x | | | x | | |
| Pratincole, Black-winged | Glareola nordmanni | NT | NT | | x | | x | x | | x | | |
| Secretarybird | Sagittarius serpentarius | VU | VU | | x | x | x | | | x | x | |
| Starling, Pied | Spreo bicolor | | | Regional Endemic | x | x | x | | | x | | |
| Stork, White | Ciconia ciconia | BONN | | | x | | x | x | x | | x | |
| Thrush, Karoo | Turdus smithi | | | Near Endemic | x | | x | | | x | | |

### *2.3.2 Coordinated Avifaunal Roadcount (CAR) Data*

Cranes, bustards, storks and other large birds that spend most of their time on the ground, need wide, open spaces and are certainly not restricted to protected areas. Agricultural habitats are used extensively for feeding, roosting and breeding, often because no natural, pristine habitats are available, and sometimes because the agricultural habitats are especially attractive to birds. The Co-ordinated Avifaunal Roadcounts (CAR) project monitors the populations of 21 species of large 'terrestrial' birds in agricultural habitats (Young *et.al.* 2003). Although CAR road counts do not give an absolute count of the all the individuals in a population, they do provide a measure of relative abundance in a particular area. CAR route MW05 has relevance to the study and runs to the south and east of the project area. The route falls within the Wakkerstroom Precinct. This precinct has an exceptional diversity of large terrestrial birds, including several Red Data Book species, namely all three crane species, Denham's Bustard *Neotis denhami*, Blue Korhaan, White-bellied Korhaan *Eupodotis senegalensis*, Black-bellied Bustard *Lissotis melanogaster*, Southern Bald Ibis Geronticus *calvus* and Secretarybird *Sagittarius serpentarius*. However, only the following species were recorded along route MW05: Grey Crowned Crane *Balearica regulorum*, White Stork *Ciconia ciconia*, Blue Korhaan and Southern Bald Ibis.

Helmeted Guineafowl *Numida meleagris* was the only large terrestrial species observed at the proposed development site during the data collection period.

### *2.3.3 Coordinated Waterbird Count (CWAC) Data*

A CWAC site is any body of water, other than the oceans, which supports a significant number (set at approximately 500 individual waterbirds, irrespective of the number of species) of birds which use the site for feeding, and/or breeding and roosting (Harrison et al, 2004). This definition includes natural pans, vleis, marshes, lakes, rivers, as well as a range of manmade impoundments (i.e. sewage works). The presence of a CWAC site within the study area is an indication of a large number of bird species occurring there and the overall sensitivity of the area. There are no CWAC sites within close proximity (i.e. within 10 km) to the site. The closest sites are Fickland Pan and Wim Rabe Pan both of which are approximatey 31km from Majuba Power Station and have recorded large number of Little Grebe *Tachybaptus ruficollis*, Black-headed Heron *Ardea melanocephala* and Maccoa Duck *Oxyura maccoa,* Glossy Ibis *Plegadis falcinellus*, Yellow-billed Duck *Anas undulata* and Red-billed Teal *Anas erythrorhyncha,* Red-knobbed Coot *Fulica cristata* and Little Stint *Calidris minuta*.

Of the species mentioned above, Red-knobbed Coot, Yellow-billed Duck and Red-billed Teal were recorded at the dam (Focal Site 1), located approximately 500m north east of the proposed development area, during the data collection period.

### *2.3.4 Important Bird Areas (IBAs)*

Some sites are exceptionally important for maintaining the taxa dependent upon the habitats and ecosystems in which they occur. Vigorous protection of the most critical sites is one important approach to conservation. Many species may be effectively conserved by this means. Patterns of bird distribution are such that, in most cases, it is possible to select sites that support many species. These sites, carefully identified on the basis of the bird numbers and species complements they hold, are termed Important Bird Areas (IBAs). IBAs are selected such that, taken together, they form a network throughout the species' biogeographic distributions. IBAs are key sites for conservation – small enough to be conserved in their entirety and often already part of a protected-area network.

The proposed development site is located on the boundary (within the buffer) of the Grassland Biosphere Reserve IBA (SA020). This IBA holds a significant portion of South Africa's population of the globally endangered White-winged Flufftail *Sarothrura ayresi*. In addition, Corn Crake *Crex crex*, Little Bittern *Ixobrychus minutus*, Baillon's Crake *Porzana pusilla*, Red-chested Flufftail *Sarothrura rufa*, African Rail *Rallus caerulescens*, and breeding populations of African Marsh Harrier *Circus ranivorus*, Grey Crowned Crane and African Grass Owl *Tyto capensis* also occur in the various wetland systems prevalent in the area. Approximately 85 % of the global population of Rudd's Lark *Heteromirafra ruddi* is thought to occur inside this IBA. Botha's Lark also occurs in this IBA and both species may occur in the grasslands that are also found within this site. The largest Southern Bald Ibis breeding colony in the world also occurs inside this IBA, with large numbers foraging and roosting throughout the area. Blue Crane *Anthropoides paradiseus*, Denham's Bustard *Neotis denhami*, White-bellied Korhaan *Eupodotis senegalensis,* Short-tailed Pipit *Anthus brachyurus* and Black-winged Lapwing *Vanellus melanopterus* are common at low densities. Black-winged Pratincole *Glareola nordmanni* and White Stork occasionally occur in very large numbers during the summer months. Furthermore, the project site also lies approximately 14km south of the southern boundary of another IBA, the Amersfoort-Bethal-Carolina District (SA018). This IBA is known to hold a large proportion (>10%) of the global population of the endangered Botha's Lark (Barnes 1998). This species favours short dense, natural grassland found on plateaus and upper hill slopes. The globally threatened Wattled Crane *Bugeranus carunculatus* was listed as a vagrant to this IBA, while other key listed species recorded in this IBA include Southern Bald Ibis, Lesser Kestrel *Falco naumanni*, Blue Crane, African Grass Owl, Lanner Falcon *Falco biarmicus* and Black-winged Lapwing *Vanellus melanopterus*.

None of the aforementioned species were recorded at the proposed site during the data collection period.

## 2.4 Primary Data Collection

Due to the size and location of the proposed project, the anticipated avifaunal sensitivity and in accordance with the BirdLife South Africa *Guidelines to minimise the impact on birds of Solar Facilities and associated infrastructure in South Africa* (Smit. 2012), a single three-day site visit was conducted in the study area from 21 to 23 September 2015. In order to describe the avifaunal community present, a concerted effort was made to sample the avifauna in all of the primary habitats that were available both in the impact zone and the larger project site boundaries by applying the following techniques:

### *2.4.1 Walked Transects*

The area that has been identified as a possible development site for the Majuba PV Solar project is located in an open, homogeneous habitat, in which small bird populations are relatively visible and uniformly distributed. Conditions like these favour the use of simple strip (walked) transects to determine the bird community structure within an area. The length, number and distribution of these transects may vary according to site size, habitat diversity, and the richness and relative significance of the small terrestrial avifauna (Jenkins, 2012, Bibby et al). A total of three walked transects (WT) totaling 2.20 kilometers were established across the proposed site (FIGURE 3). These transects were conducted in the early morning and the number of all bird species seen or heard were recorded. For more detail on the exact methods of conducting walked transects see Jenkins *et al* (2014).

Despite the relatively high diversity of bird species in the broader study area, the proposed development site is incredibly small in size and limited in habitat diversity and therefore, the site specific avifaunal richness is comparatively lower when compared to the surrounding region. The data emanating from the walk transect surveys is presented in TABLE 2.

**TABLE 2:** Walked Transect Summary Data

| SPECIES | SCIENTIFIC NAME | #BIRDS | #RECORDS | #BIRDS/KM |
|---|---|---|---|---|
| Bishop, Southern Red | Euplectes orix | 27 | 3 | 12.27 |
| Bushshrike, Gorgeous | Telophorus quadricolor | 1 | 1 | 0.45 |
| Canary, Yellow-fronted | Crithagra mozambica | 6 | 3 | 2.73 |
| Cisticola, Levaillant's | Cisticola tinniens | 28 | 14 | 12.72 |
| Cisticola, Wing-snapping | Cisticola ayresii | 1 | 1 | 0.45 |
| Crow, Pied | Corvus albus | 1 | 1 | 0.45 |
| Fiscal, Common | Lanius collaris | 4 | 4 | 1.82 |
| Kite, Black-shouldered | Elanus caeruleus | 4 | 3 | 1.82 |
| Lapwing, Crowned | Vanellus coronatus | 2 | 1 | 0.91 |
| Longclaw, Cape | Macronyx capensis | 8 | 5 | 3.64 |
| Masked-weaver, Southern | Ploceus velatus | 17 | 7 | 7.73 |
| Mousebird, Speckled | Colius striatus | 6 | 1 | 2.73 |
| Myna, Common | Acridotheres tristis | 13 | 4 | 5.91 |
| Pigeon, Speckled | Columba guinea | 16 | 1 | 7.27 |
| Sparrow, Cape | Passer melanurus | 6 | 4 | 2.73 |
| Starling, Pied | Spreo bicolor | 1 | 1 | 0.45 |
| Stonechat, African | Saxicola torquatus | 6 | 6 | 2.27 |
| Swallow, White-throated | Hirundo albigularis | 2 | 1 | 0.91 |
| Thick-knee, Spotted | Burhinus capensis | 2 | 1 | 0.91 |
| Turtle-dove, Cape | Streptopelia capicola | 3 | 2 | 1.36 |
| Wagtail, African Pied | Motacilla aguimp | 1 | 1 | 0.45 |
| Waxbill, Orange-breasted | Amandava subflava | 9 | 1 | 4.09 |
| Widowbird, Long-tailed | Euplectes progne | 10 | 4 | 4.55 |

### *2.4.2 Vehicle Transects*

This is a very similar data collection technique to that above, the aim being to establish indices of abundance for large terrestrial species and raptors. However during the site visit it became apparent that large terrestrial species and raptors were unlikely to feature prominently, as a result of the existing disturbance in the area. Despite the lack of large terrestrial species presence, a single Vehicle Transect (VT) count was established on suitable roads surrounding the site, and within the confines of the power station property, totalling approximately 8.84 kilometres (FIGURE 3) and all species encountered along this route were recorded and presented in TABLE 3.

**TABLE 3:** Vehicle Transect Summary Data

| SPECIES | SCIENTIFIC NAME | #BIRDS | #RECORDS | #BIRDS/KM |
|---|---|---|---|---|
| Bishop, Yellow-crowned | Euplectes afer | 4 | 1 | 0.45 |
| Canary, Yellow-fronted | Crithagra mozambica | 1 | 1 | 0.11 |
| Cisticola, Levaillant's | Cisticola tinniens | 1 | 1 | 0.11 |
| Crow, Pied | Corvus albus | 1 | 1 | 0.11 |
| Dove, Laughing | Streptopelia senegalensis | 1 | 1 | 0.11 |
| Fiscal, Common | Lanius collaris | 4 | 4 | 0.45 |
| Guineafowl, Helmeted | Numida meleagris | 27 | 4 | 3.05 |
| Ibis, Hadeda | Bostrychia hagedash | 4 | 1 | 0.45 |
| Kite, Black-shouldered | Elanus caeruleus | 1 | 1 | 0.11 |
| Lapwing, Blacksmith | Vanellus armatus | 7 | 5 | 0.79 |
| Masked-weaver, Southern | Ploceus velatus | 9 | 3 | 1.02 |
| Myna, Common | Acridotheres tristis | 21 | 7 | 2.38 |
| Pigeon, Speckled | Columba guinea | 14 | 4 | 1.58 |
| Pipit, African | Anthus cinnamomeus | 1 | 1 | 0.11 |
| Sparrow, Cape | Passer melanurus | 25 | 5 | 2.83 |
| Starling, Pied | Spreo bicolor | 2 | 1 | 0.23 |
| Swallow, White-throated | Hirundo albigularis | 1 | 1 | 0.11 |
| Turtle-dove, Cape | Streptopelia capicola | 1 | 1 | 0.11 |
| Wagtail, African Pied | Motacilla aguimp | 1 | 1 | 0.11 |
| Waxbill, Common | Estrilda astrild | 4 | 1 | 0.45 |
| Widowbird, Long-tailed | Euplectes progne | 1 | 1 | 0.11 |

### *2.4.3 Focal Site Surveys*

Any particularly sensitive habitats deemed likely to support nesting species or significant numbers of roosting species must be monitored to confirm occupancy, evidence of breeding and if possible the outcomes of such activity. Major wetlands or waterbodies on or close to the development area must be identified, mapped (FIGURE 3) and surveyed using the standard protocols set out by the CWAC Initiative (Taylor et al., 1999). Two focal sites (dams) were surveyed during data collection period (TABLE 4). No species were recorded at Focal Site 2. This dam is likely to be associated with the electricity generation process and therefore unattractive to the resident avifauna.

**TABLE 4:** Focal Site Summary Data

| SPECIES | SCIENTIFIC NAME | FOCAL SITE 1 | FOCAL SITE 2 |
|---|---|---|---|
| Coot, Red-knobbed | Fulica cristata | x | no species recorded |
| Duck, Yellow-billed | Anas undulata | x | |
| Shelduck, South African | Tadorna cana | x | |
| Teal, Red-billed | Anas erythrorhyncha | x | |
| Teal, Hottentot | Anas hottentota | x | |

### *2.4.4 Incidental observations*

In an effort to maximise the benefit from the time spent on site travelling to and from survey points, all birds observed during this time were recorded using an incidental data collection technique (TABLE 5). In addition, observations related to the extent and direction of distinct bird flight paths (if any) within the impact zone particularly in relation to the dams and roosting and foraging areas sites were also recorded.

**TABLE 5:** Incidental Sightings Summary Data

| SPECIES | SCIENTIFIC NAME | #BIRDS | #RECORDS |
|---|---|---|---|
| Crow, Pied | Corvus albus | 2 | 1 |
| Cisticola, Levaillant's | Cisticola tinniens | 2 | 2 |
| Fiscal, Common | Lanius collaris | 1 | 1 |
| Kite, Black-shouldered | Elanus caeruleus | 4 | 3 |
| Lapwing, Crowned | Vanellus coronatus | 2 | 1 |
| Longclaw, Cape | Macronyx capensis | 1 | 1 |
| Myna, Common | Acridotheres tristis | 3 | 2 |
| Sparrow, Cape | Passer melanurus | 2 | 1 |
| Stonechat, African | Saxicola torquatus | 2 | 2 |
| Widowbird, Long-tailed | Euplectes progne | 8 | 1 |
| Starling, Cape Glossy | Lamprotornis nitens | 1 | 1 |


**FIGURE 3:** Location of the three walked transects (blue lines), driven transect (red line) and two focal sites surveyed during the site visit conducted from 21-23 September 2015.

The site visit produced a combined list of 31 species (APPENDIX 2), covering both the project development area (PDA) and to a very limited extent, the surrounding area. Species that featured prominently include Southern Red Bishop *Euplectes orix*, Southern Masked-Weaver *Ploceus velatus*, Levaillant's Cisticola *Cisticola tinniens,* Common Myna *Acridotheres tristis,* Speckled Pigeon *Columba guinea,* Orange-breasted Waxbill *Amandava subflava* and Widowbird, Long-tailed *Euplectes progne.* These are species that are often associated with urban, peri-urban, wetland and farmland environments, so there relatively high reporting rate is not unexpected. No Red List species or raptor nests were recorded during the data collection period. In addition, no distinct flights paths across either of the proposed sites were recorded.

Although Amur Falcon *Falco amurensis* and Lesser Kestrel *Falco naumanni* (both summer migrants to South Africa) were not recorded during the surveys owing to the timing of the site visit, these species are likely to forage within the confines of the power station property and in the broader study area. Similarly Barn Swallow *Hirundo rustica* are also likely to feature prominently during the summer months.

All of these species have the potential to be displaced by the solar development as a result of habitat transformation and disturbance. However sufficient similar habitat is available within the broader study area, so it is highly unlikely that the displacement impact will be of regional or national significance. They may also be susceptible to collisions with the solar PV panels.

## 3. GENERAL DESCRIPTION OF BIRD INTERACTIONS WITH ELECTRICAL INFRASTRUCURE

While renewable energy sources, such as solar energy, hold great potential to alleviate dependence on fossil fuels they are not without their environmental risks and negative impacts. Poorly sited or designed solar energy facilities can have negative impacts on not only vulnerable species and habitats but also entire ecological processes. These impacts are extremely variable and are dependent on a number of contributing factors which include the design and specifications of the development, topography, habitats capable of supporting various bird species as well as the number and diversity of birds present at the development site. Solar energy facilities may impact birds and bird populations in the following key ways. These can be grouped as either lethal, direct mortality impacts (i.e. collisions with the PV panels and associated infrastructure) that affect individual birds; or the non-lethal, less direct impacts (i.e. displacement) as a result of habitat transformation and disturbance that are common to most forms of development (Drewitt & Langston, 2008).

### 3.1 Displacement as a result of habitat loss or transformation

Although this impact is dependent on the location and the scale of the facility, this is potentially the most significant impact associated with the construction and operation (maintenance) of solar energy facilities. 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). This impact is likely to have dire consequences for the smaller grassland bird species (i.e. the larks) with small home ranges as entire territories could be removed during construction activities. The grassland and wetland vegetation present at the proposed development site is subject to significant existing disturbance. It is therefore unlikely to support the more sensitive species listed in TABLE 1 and any habitat destruction impacts that may occur are likely to only affect local bird populations. Unfortunately, due to the nature of this impact, it would be extremely difficult to mitigate and therefore the significance of the impact cannot be reduced to negligible levels.

### 3.2 Displacement as a result of disturbance

Excavation and construction activities at solar energy facilities are a source of significant disturbance particularly as a result of the machinery and construction personnel that are present on site for the duration of the construction and to a lesser degree the ongoing maintenance at the facility. For most bird species, construction activities are likely to be a cause of temporary disturbance and will impact on foraging, breeding and roosting behaviours or in more extreme cases, result in displacement from the site entirely.

Internationally, results of point count surveys conducted, both within the heliostat arrays and the desert habitat surrounding the Ivanpah Solar Plant (California), estimated that almost five times as many birds were present in the desert habitat (10.2 birds/hectare) compared to the number of birds present amongst the heliostat units (2.1 birds/hectare). This demonstrates that, for certain species, displacement is temporary and that the transformed habitat between the arrays is capable of supporting these species. However it is not preferable to a larger suite of avifaunal species that appear to favour the natural vegetation types in the surrounding habitat (Harvey *et al,* 2014). Additional studies comparing habitat use in solar PV arrays with managed grasslands at airports in the USA (DeVault *et al*, 2014) indicated that species richness and evenness amongst the solar arrays (37 species) was reduced compared to that of the grasslands (46 species). This supports the view that solar development will have an impact on avifauna diversity at a local level.

The study area is already subjected to a fairly significant degree of disturbance associated with the energy generation and industrial activities in the immediate vicinity of the proposed site. It is therefore difficult to predict at this stage how detrimental the disturbance impacts will be on local bird populations in the short or long-term. However based on the footprint of the PV facility and the bird species likely to occupy the study area, low impacts are probable.

### 3.3 Mortality

As mentioned previously, there is a paucity of information available related to avifaunal impacts at solar facilities. To date, a single scientific study detailing the results of an extensive forty-week monitoring survey at, the now decommissioned, Solar One concentrated solar power (CSP) facility in southern California has been published (McCrary et al. 1986). Over a two-year period, the authors found a total of 70 bird carcasses (comprised of 26 bird species) amongst the heliostat mirrors. This may not appear to be significant, but considering that and estimated 10% to 30% of carcasses were removed by scavengers, mortality figures are likely to be higher. Fifty seven (81%) of the birds died through collision with infrastructure, mostly (>75%) colliding with the heliostats. Species killed in this manner included water birds, small raptors, gulls, doves, sparrows and warblers. The remaining 19% died through burning in the standby points (points in mid-air where subsets of mirrors are focused onto before focusing onto the central receiver – unique to CSP technology). Species killed in this manner were mostly swallows and swifts. A fairly extensive expanse of agriculture and the facility's evaporation ponds may have contributed to the abundance of bird species at the facility.

Since the McCrary *et al* (1986) study, several larger solar facilities have been constructed and are currently subject to monitoring in accordance with the facilities' Avian and Bat Monitoring and Management Plan (Harvey and Associates, 2014). Monitoring surveys conducted from 29 October 2013 to 21 March 2014 at the California-based Ivanpah Solar Electric Generating System, yielded the following results:

- A total of 91 avian mortalities and five injured birds.
- Of these, 24 mortalities and three injured birds (25% in total), showed signs of flux damage.
- Evidence of collision with heliostats was observed in 14 detections (14.6%).
- The cause of injury or mortality for the remaining 57.3% could not be confirmed.
- Overall the estimated number of fatalities from the project and non-project related causes for the period of 29th October 2013 to 21 March 2014 comes to 401 (or 80 estimated bird mortalities per month).

» Subsequent monitoring for two months in April and May 2014 yielded mortality figures of 101 and 82 birds respectively.

Similarly, reports of weekly mortality searches conducted at the California Valley Solar Ranch indicate that 152 avian mortalities were reported for the period 16 November 2013 to 15 February 2014 and an additional 54 for the period 16 February 2014 to 15 May 2014 (Harvey & Associates, 2014a and 2014b). The majority of these mortality records (90%) are based on feather spots and as a result the cause of death could not be established. These figures give an unadjusted (for searcher efficiency and scavenger removal) number of 1030 mortalities per year. This is likely to be undervalued due to the lack of adjustment for searcher efficiency and scavenger removal.

In some cases, the reflective surfaces of PV panels act as attractants for approaching birds that mistakenly identify the facility as water body (lake effect). This causes disorientation and can result in birds colliding with the panels or becoming stranded on site, as many water birds are unable to take-off from dry land (grebes and cormorants) and thereby falling victim to predation. In a recent report by Kagan, *et al* (2014) the unusually high number of water bird mortalities at the Desert Sunlight PV facility (44%) seems to support this premise.

A recent comprehensive review of the impact of sheet glass and avian mortalities in the USA estimated that between 365 and 988 million birds are killed annually by collisions (Loss *et al,* 2014). Photovoltaic panels are likely to pose a similar risk to avifauna in South Africa.

Although no distinct flights paths were recorded across the proposed site, it is likely that the smaller flocking species (recorded within the project development site) and the waterbirds (recorded at the focal site) will utilize the airspace surrounding the development area, flying between roosting and foraging areas in the immediate surrounds of the development site. Reflective PV arrays constructed in this area may confuse approaching birds, resulting in collisions with the panels. However, based on the footprint of the PV facility and the bird species likely to occupy the study area, medium impacts are probable.

## 3.4 Other Impacts

Although this does not form part of the brief, it is important to note that birds could have an impact on the PV arrays once the facility becomes operational. These include:

» Defecation on the PV cells by birds utilising or flying over the facility. A build-up of feacal matter on the panels is likely to cause interruptions to and/or reduced production of power at the facility;

» Certain bird species may be attracted to the solar arrays, using the PV structures on which to perch, roost or even nest (Smit et al. 2012). An increase in the number of birds roosting, nesting and feeding at the facility could lead to increased defecation on the solar infrastructure and panel obstruction, resulting in conflict between the local bird populations and facility operators.

## 3.5 Associated Infrastructure Impacts

### *3.5.1 Collisions with power line infrastructure*

Collisions are the biggest single threat posed by power lines to birds in southern Africa (van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited maneuverability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004, Anderson 2001). Several existing power lines traverse through the study area and it is a proven fact that placing a new line next to an existing line reduces the risk of collisions to birds. The reasons for that are two-fold, namely it creates a more visible obstacle to birds and the resident birds, particularly breeding adults, are used to an obstacle in that geographic location and have learnt to avoid it (APLIC 1994).

### *3.5.2 Electrocutions on power line and other electrical infrastructure*

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004).

Electrocution risk is strongly influenced by the power line voltage of the and design of the pole structure and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energized components. The electrocution impact is rated to be of medium significance for the proposed power line but can be reduced to a low significance if an appropriate structure type is used in the construction of the power line.

Electrocutions within the proposed substation are envisaged to have a negative impact on a variety of bird species, which may be attracted to the electrical infrastructure within the substation yard as it may provide a suitable substrate on which to nest. Since it is difficult to predict with any certainty where birds are likely to nest within the substation yard, coupled with the costs associated with insulating the entire substation, electrocutions will need to be mitigated using site-specific recommendations if and when they occur.

### *3.5.3 Habitat destruction and disturbance associated with the construction and maintenance of power line and other infrastructure*

During the construction phase and maintenance of power lines and substations, some habitat destruction and alteration inevitably takes place. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, through the modification of habitat. The new line will undoubtedly destroy and modify a certain amount of habitat. However at a landscape level, is it unlikely to have a major impact on Red List species recorded in the area.

Similarly, the above mentioned construction activities impact on bird through disturbance, particularly during breeding activities. This could lead to breeding failure if the disturbance happens during a critical part of the breeding season. In general the disturbance that will be caused by the construction activities will be temporary and this, coupled with the fact that there is currently considerable disturbance in the area, the construction of the substation and power line should not lead to a species being permanently displaced from the area.

Since details pertaining to the voltage size, structure type and routing/location of the associated infrastructure have not been provided, this impact has been assessed in general terms. Large terrestrial species observed in the study area, particularly Secretarybird and the various waterbirds will be susceptible to collision with the power line infrastructure associated with this project. However given the project size, the existing infrastructure and the suite of mitigation measures available to reduce possible mortalities the significance of this impact can be reduced to acceptable levels.

# 4. IDENTIFICATION OF POTENTIAL IMPACTS

## 4.1 Sensitivity Mapping

At both a landscape and site specific level, the avifaunal sensitivity of the site is considered to be medium to low. The only sensitive features present at the proposed development site are the wetland areas. The wetlands have been buffered by a conservative 80m and assigned a medium sensitivity rating. Ordinarily, wetland systems would be assigned a higher sensitivity rating given their importance in terms of avifauna. However, owing to the fact that the wetland system is modified, subject to existing disturbances of medium intensity, but still has some degree of connectivity with other ecosystems with intermediate levels of species diversity, a medium sensitivity has been allocated. The remainder of the site is fairly uniform and comprised of disturbed grassland with no topographical features, resulting in low species richness with no identifiable avifaunal flight paths and is therefore considered to be of low sensitivity. A map delineating these areas is been provided below (FIGURE 4).

**FIGURE 4:** Avifaunal sensitivity map – the medium sensitivity areas (wetlands and associated buffers) are represented in orange and low sensitivity areas are represented by the yellow polygons.

## 5. ASSESSMENT OF IMPACTS AND IFENTIFICATION OF MANAGEMENT ACTIONS

The above mentioned impacts are quantified and assessed in the tables below.

**TABLE 5-1:** Impacts table for displacement through habitat transformation

| **NATURE:** Displacement as a result of habitat transformation associated with the construction of the facility (PV arrays and associated infrastructure) resulting in a negative direct impact on the resident avifauna, particularly smaller passerine species. | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | 1 site bound | 1 site bound |
| ***Duration*** | 5 permanent | 5 permanent |
| ***Magnitude*** | 6 moderate | 2 minor |
| ***Probability*** | 4 highly probable | 3 probable |
| ***Significance*** | **Medium (48)** | **Low (24)** |
| ***Status*** | Negative | Negative |
| ***Reversibility*** | Low | Low |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?***<br>Yes through the avoidance of sensitive wetland habitats | | |
| ***Mitigation:***<br>Restricting the construction footprint to a bare minimum.<br><br>Recommendations (i.e. the avoidance of key vegetation types and wetlands) emanating from the botanical and wetland specialist studies must be strictly adhered to and implemented. | | |
| ***Cumulative impacts:***<br>The surrounding area is already heavily transformed as a result of energy generation and agricultural activities. Although relatively small in size, the proposed development sites do contain habitats of importance for various bird species and therefore the cumulative impact is deemed to be of moderate significance | | |
| ***Residual Impacts:***<br>Smaller passerine species may return once the construction activity is completed and the site rehabilitated, but it is unlikely that the numbers will recover to those recorded prior to the development due to the significant habitat transformation that will take place. | | |

**TABLE 5-2:** Impacts table for displacement through disturbance

| **NATURE:** Displacement as a result of disturbance associated with noise and movement of construction and operational equipment and personnel, resulting in a negative direct impact on the resident avifauna, particularly smaller passerine species. | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | 1 site bound | 1 site bound |
| ***Duration*** | 2 short | 2 short |
| ***Magnitude*** | 6 moderate | 4 low |
| ***Probability*** | 4 highly probable | 3 probable |
| ***Significance*** | **Medium (36)** | **Low (21)** |
| ***Status*** | Negative | Negative |
| ***Reversibility*** | Medium | Medium |
| ***Irreplaceable loss of resources?*** | No | No |
| ***Can impacts be mitigated?***<br>Partially | | |
| ***Mitigation:***<br>It is essential that a post construction monitoring programme be established to monitor the impact of disturbance and barrier effects on the resident avifauna. If required, mitigation measures will be proposed after analysis of the post construction monitoring data.<br><br>In addition construction activities must be confined to the site footprint to avoid any additional impacts on bird species residing in the broader area. | | |
| ***Cumulative impacts:***<br>In addition to the proposed Majuba PV Solar arrays, there are several activities (i.e. energy generation, and agricultural) that feature prominently both within the impact zone and the broader study area and are a significant source of existing disturbance. These activities, coupled with the limited habitat diversity and degradation within the proposed development site, are a likely cause of the absence of Red List species within the impact zone. Those species that have persisted have undoubtedly developed a tolerance for the current levels of disturbance and are likely to persist within the broader area despite the development of the solar facility. | | |
| ***Residual Impacts:***<br>The majority of species observed in the development area may return once the construction activity is completed | | |

**TABLE 5-3:** Impacts table for collision mortality on solar panels

| **NATURE:** Collisions of priority avifauna (waterbirds, doves, weavers, canaries, larks) with the solar panels, resulting in a negative direct mortality impact. | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | 2 local | 2 local |
| ***Duration*** | 4 long term | 4 long term |
| ***Magnitude*** | 6 moderate | 4 low |
| ***Probability*** | 3 probable | 3 probable |
| ***Significance*** | **Medium (36)** | **Medium (30)** |
| ***Status*** | Negative | Negative |
| ***Reversibility*** | Low | Medium |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?***<br>Yes | | |
| ***Mitigation:***<br>It is essential that a post construction monitoring programme, that includes carcass searches, be established to monitor the impact of collision on the resident avifauna. If results of the monitoring reveal significant mortality levels, modifications to the panel design can be made to reduce the illusionary characteristics of the panel. | | |
| ***Cumulative impacts:***<br>An extensive power line network features prominently within the immediate vicinity of the proposed development site and within the broader study area. The addition of reflective PV panels will undoubtedly increase the collision risk particular for waterbird species (present the broader study area) that are susceptible to power line collisions too. Collisions with the proposed PV panels will have a medium to high cumulative impact. | | |
| ***Residual Impacts:***<br>It is envisaged that mitigation, if required, will reduce but not eliminate collision mortality | | |

**TABLE 5-4:** Impacts table for collision mortalities with overhead power lines

| **NATURE:** Collisions of priority avifauna with overhead power lines, resulting in a negative direct mortality impact, particularly large terrestrial species and water dependent species (storks, ducks, geese, ibis) | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | 2 local | 1 site bound |
| ***Duration*** | 4 long term | 4 long term |
| ***Magnitude*** | 6 moderate | 4 low |
| ***Probability*** | 3 probable | 2 improbable |
| ***Significance*** | **Medium (36)** | **Low (18)** |
| ***Status*** | Negative | Negative |
| ***Reversibility*** | Low | High |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?***<br>Yes | | |
| ***Mitigation:***<br>Every effort must be made to select a route that poses the least risk to birds, preferably routing the proposed power lines alongside existing power line infrastructure in an effort to increase conductor visibility. High risk sections of power line must be identified by a qualified avifaunal specialist during the walk through phase of the project, once the alignment has been finalized. If power line marking is required, bird flight diverters must be installed on the full span length on each of the conductors (according to Eskom guidelines). Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung. | | |
| ***Cumulative impacts:***<br>An extensive power line network features prominently within the immediate vicinity of the proposed development site and within the broader study area. Any additional power lines will undoubtedly increase the collision risk to power line sensitive species (i.e. large terrestrial species and various waterfowl species) that may be present the broader study area and therefore collisions with the proposed grid connections will have a medium to high cumulative impact. However given the proximity of the proposed sites to the existing power line and substation infrastructure, the proposed grid connections are likely to be relatively short in length and installation of anti-collision devices on the conductors/earthwires will further reduce this impact. | | |
| ***Residual Impacts:***<br>Mitigation will reduce but not entirely eliminate collision mortality | | |

**TABLE 5-5:** Impacts table for electrocutions on distribution (<132kV) power line tower/pole structures

| **NATURE:** Electrocutions of priority avifauna on distribution (<132kV) power line tower/pole structures, resulting in a negative direct mortality impact, particularly large eagle species, herons and storks. | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | 2 local | 1 site bound |
| ***Duration*** | 4 long term | 4 long term |
| ***Magnitude*** | 4 low | 2 minor |
| ***Probability*** | 3 probable | 2 improbable |
| ***Significance*** | **Medium (30)** | **Low (14)** |
| ***Status*** | Negative | Negative |
| ***Reversibility*** | Low | Medium |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?***<br>Yes | | |
| ***Mitigation:***<br>Only Eskom approved bird friendly tower/pole structures must be used for the entire length of the power line. | | |
| ***Cumulative impacts:***<br>An extensive power line network features prominently within the immediate vicinity of the proposed development site and within the broader study area. Any additional power lines will undoubtedly increase the electrocution risk to power line sensitive species (i.e. large eagles, storks and herons) that may be present the broader study area and therefore electrocutions on the towers of the proposed grid connections will have a medium cumulative impact. However given the low reporting rates of these species in the area, the proximity of the proposed sites to the existing power line and substation infrastructure resulting in shorter grid connections with fewer towers and construction of Eskom approved bird friendly tower/pole structures will further reduce this impact. | | |
| ***Residual Impacts:***<br>Mitigation will reduce electrocution mortality to negligible levels. | | |

**TABLE 5-6:** Impacts table for electrocutions in substations and switching stations

| **NATURE:** Electrocutions of priority avifauna in substations and switching stations, resulting in a negative direct mortality impact, particularly crows, small raptors and owls. | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | 2 local | 1 site bound |
| ***Duration*** | 4 long term | 4 long term |
| ***Magnitude*** | 4 low | 2 minor |
| ***Probability*** | 3 probable | 2 improbable |
| ***Significance*** | **Medium (30)** | **Low (14)** |
| ***Status*** | Negative | Negative |
| ***Reversibility*** | Low | Medium |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?*** Yes | | |
| ***Mitigation:*** Substation hardware is often too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if on-going impacts are recorded once operational, site specific mitigation be applied reactively. This is an acceptable approach since Red List bird species are unlikely to frequent the substation and be electrocuted. | | |
| ***Cumulative impacts:*** An extensive power line network features prominently within the immediate vicinity of the proposed development site and within the broader study area. Any electrical infrastructure in the form of substations and switching stations will undoubtedly increase the electrocution risk to those species (i.e. owls, crows, weavers, swallows) that are attracted to these structures and installations as a result of the roosting and nesting opportunities that they provide. Additional substations and switching stations will have a medium cumulative impact. Reactive mitigation as discussed above will reduce this impact. | | |
| ***Residual Impacts:*** Mitigation will reduce electrocution mortality to negligible levels. | | |

**TABLE 5-7:** Impacts table for nest building on PV infrastructure

| **NATURE:** Nest building by birds on PV infrastructure (i.e. electrical boxes associated with each array) would result in a negative direct impact on maintenance activities | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | 1 site bound | 1 site bound |
| ***Duration*** | 4 long term | 4 long term |
| ***Magnitude*** | 2 minor | 0 small |
| ***Probability*** | 3 probable | 2 improbable |
| ***Significance*** | **Low (21)** | **Low (10)** |
| ***Status*** | Negative | Negative |
| ***Reversibility*** | Low | High |
| ***Irreplaceable loss of resources?*** | No | No |
| ***Can impacts be mitigated?***<br>Yes | | |
| ***Mitigation:***<br>Similarly to the impacts associated with substations, it is recommended that if on-going impacts are recorded once operational, that these are assessed by a suitably qualified avifaunal specialist and site specific mitigation (e.g commercial bird deterrent options) is applied reactively. Assessment of this impact should be included in the monitoring and maintenance schedules of the EMPr. | | |
| ***Cumulative impacts:***<br>None | | |
| ***Residual Impacts:***<br>None | | |

## 6. MEASURES FOR INCLUSION IN THE ENVIRONMENTAL MANAGEMENT PROGRAME

Based on the anticipated impacts described above the following recommendations are provided regarding practical mitigation measures for potentially significant impacts to be included in the Environmental Management Programme (EMPr).

**OBJECTIVE:** Assessment and mitigation of mortality and displacement caused by the PV solar panels and associated electrical infrastructure (power lines and substations)

| | |
|---|---|
| **Project component/s** | PV solar panels and power line network |
| **Potential Impact** | Mortality of avifauna caused by collision with the solar panels and power line network. Electrocution of avifauna on the power line towers/poles and within the substation yards. Displacement of avifauna due to disturbance and habitat transformation. |
| **Activity/risk source** | The construction and operation of the PV solar facility and the associated electrical infrastructure (power lines and substations). |
| **Mitigation: Target/Objective** | The limitation of avifaunal mortality and displacement as far as practically possible |

| Mitigation: Action/control | Responsibility | Timeframe |
|---|---|---|
| *Displacement (Habitat Loss or Transformation & Disturbance):*<br><br>Avoid construction in sensitive vegetation types and wetlands (refer to the botanical and wetland specialist impact assessment for details of sensitivity).<br><br>Construction activities must be confined to the site footprint to avoid any additional disturbance impacts on bird species residing in the broader area. | PV Solar Facility Developer, Environmental Control Officer and Avifaunal Specialist | From the commencement of construction (inclusive of all project components - PV panels, power line(s) and substations) to the completion of construction. |

| | | |
|---|---|---|
| Establish a post construction monitoring programme to monitor the impact of disturbance and collision mortality on the resident avifauna. Monitoring must conducted in accordance with the BirdLife South Africa Best Practice Guidelines and should consist of a number of visits covering all four seasons. Monitoring should comprise of the following data collection techniques: walked and driven transect surveys (ensuring comparability to pre-construction surveys), vantage point counts (to characterise the site in terms of bird flight behaviour) and incidental observations. | | Timing related to the commencement of the monitoring is dependent on the construction schedule and will need to be discussed with the site operator as soon as these schedules have been finalised.<br><br>Post construction monitoring should be conducted for a minimum three years of operation. Additional monitoring requirements will be determined following an assessment of the data collected over the three year period. |
| *Collision Mortality (PV arrays):*<br><br>Carcass searches must conducted between the PV arrays (using either a randomised approach or at systematically selected PV arrays) on a weekly basis to determine the extent of collision mortalities. Detection trials must be incorporated into these searches. | PV Solar Facility Developer, Environmental Control Officer and Avifaunal Specialist | Post construction monitoring should be conducted for a minimum three years of operation. Additional monitoring requirements will be determined following an assessment of the data collected over the three year period. |
| *Collision Mortality (Power Line Infrastructure):*<br><br>Every effort must be made to select a route that poses the least risk to birds, preferably by minimising the length of power line as much as possible and routing the proposed power lines alongside existing power line infrastructure in an effort to increase conductor visibility. | PV Solar Facility Developer, Environmental Control Officer and Avifaunal Specialist | Walk through to be conducted prior to construction, once the alignment(s) has/have been finalised.<br><br>Bird flight diverters must be installed as soon as the conductors are strung. |

| | | |
|---|---|---|
| High risk sections of power line must be identified by a qualified avifaunal specialist during the walk through phase of the project, once the alignment has been finalized.<br><br>If power line marking is required, these anti-collision devices must be installed on the full span length on each of the conductors (according to Eskom guidelines). Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. | | |
| *Electrocution Mortality (Power Line and Substation Infrastructure):*<br><br>Only Eskom approved bird friendly tower/pole structures must be used for the entire length of the power line.<br><br>If on-going impacts are recorded once the substation is operational, it is recommended that an avifaunal specialist investigate the mortalities and provide recommendations for site specific mitigation. | PV Solar Facility Developer, Environmental Control Officer and Avifaunal Specialist | Power line tower/pole structure to be identified and approved as 'bird friendly' prior to construction<br><br>Substation mitigation to be applied reactively, if required. |
| *Nest building on PV infrastructure:*<br><br>If on-going impacts are recorded once the solar facility is operational, it is recommended that these impacts be assessed by a suitably qualified avifaunal specialist and site specific mitigation be applied reactively. | PV Solar Facility Developer, Environmental Control Officer and Avifaunal Specialist | Nest management strategies to be identified and implemented reactively, if required. |

## 7. CONCLUSION

As is the case with any large scale energy development, the proposed Majuba PV Solar Facility has the potential to impact avifauna in a variety of direct and indirect means both during construction and operation of the facility. Due to dearth of available information, knowledge and experience related to avifaunal impacts at solar facilities, particularly in South Africa, a precautionary approach has been followed with regards to the identification and assessment of impacts.

However due to the relatively low importance of the site for many bird species, most impacts are seen as acceptable for avifauna. It is recommended that a post construction monitoring programme be implemented at the site, to better understand the impacts associated with a development of this nature. Although a very brief outline of suggested survey methodologies has been described in this report (Section 6), this monitoring programme will need to be fully developed in conjunction with a suitably qualified avifaunal specialist and incorporated into the site specific EMPr.

Although there are no large scale commercial solar plants (proposed or established) within 20km of the study area, several other drivers of habitat transformation i.e. energy generation and industrial activities are prevalent in the study area. The construction of the Majuba PV solar plant and associated infrastructure would contribute to cumulative habitat loss and therefore have further impacts on the occurrence of avifauna in the area. An additional barrier would also be created for birds resulting in possible further displacement and or adjustment of flight paths for species that use the area as a flight corridor. Considering the bird species occurring in the study area, the cumulative impacts are expected to be of low to moderate significance. However a more strategic approach to assessing the cumulative impacts of renewable energy development in South Africa is required than what is currently being applied (Masden *et al.,* 2010 and Jenkins, 2011) but this falls outside of the scope of this assessment.

## 8. IMPACT STATEMENT

In conclusion, given the presence of existing habitat degradation and disturbance associated with the mining, energy generation and industrial activities that are prevalent in the study area, it is anticipated that the proposed Majuba Solar Photovoltaic Facility can be constructed at the proposed site with acceptable levels of impact on the resident avifauna.

There will undoubtedly be some impact on avifauna but it is the specialist's professional opinion that the impact will be acceptable provided the following conditions are met:

- Adherence to the site specific EMPr. Of particular concern is the layout of the power line infrastructure. Ideally an avifaunal walk down should be conducted once the power line towers have been surveyed and marked. Input must be given into micro siting as well as which sections of power line require marking with bird flight diverters. This walk down should also ground truth all other project component final layouts.
- A post construction avifaunal monitoring programme must be established in conjunction with a suitably qualified avifaunal specialist, and in accordance with the BirdLife South Africa best practice guidelines (currently in prep). This programme will gather site specific information on the impacts of the Majuba Solar Photovoltaic Facility on avifauna. In addition the monitoring programme will contribute to an overall understanding of avifaunal impacts related to solar developments in South Africa.

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## APPENDIX 1 – CONSOLIDATED SPECIES LIST

| COMMON NAME | SCIENTIFIC NAME | REGIONAL STATUS | GLOBAL STATUS | ENDEMISM | SABAP 1 | SABAP 2 |
|---|---|---|---|---|---|---|
| Avocet, Pied | Recurvirostra avosetta | | | | x | |
| Barbet, Acacia Pied | Tricholaema leucomelas | | | | x | |
| Barbet, Black-collared | Lybius torquatus | | | | x | |
| Barbet, Crested | Trachyphonus vaillantii | | | | x | |
| Bishop, Southern Red | Euplectes orix | | | | x | x |
| Bishop, Yellow-crowned | Euplectes afer | | | | x | x |
| Bokmakierie, Bokmakierie | Telophorus zeylonus | | | | x | x |
| Boubou, Southern | Laniarius ferrugineus | | | | x | |
| Bulbul, Dark-capped | Pycnonotus tricolor | | | | x | |
| Bunting, Cape | Emberiza capensis | | | | x | |
| Bustard, Denham's | Neotis denhami | VU | NT | | x | |
| Buzzard, Jackal | Buteo rufofuscus | | | Near Endemic | x | |
| Buzzard, Steppe | Buteo vulpinus | | | | x | x |
| Canary, Black-throated | Crithagra atrogularis | | | | x | |
| Canary, Cape | Serinus canicollis | | | | x | x |
| Chat, Anteating | Myrmecocichla formicivora | | | | x | x |
| Cisticola, Cloud | Cisticola textrix | | | Near Endemic | x | x |
| Cisticola, Levaillant's | Cisticola tinniens | | | | x | x |
| Cisticola, Pale-crowned | Cisticola cinnamomeus | | | | | x |
| Cisticola, Wing-snapping | Cisticola ayresii | | | | x | x |
| Cisticola, Zitting | Cisticola juncidis | | | | x | x |
| Cliff-Swallow, South African | Hirundo spilodera | | | | x | x |
| Coot, Red-knobbed | Fulica cristata | | | | x | x |
| Cormorant, Reed | Phalacrocorax africanus | | | | x | x |
| Cormorant, White-breasted | Phalacrocorax carbo | | | | x | x |
| Crane, Blue | Anthropoides paradiseus | NT | VU | | x | |
| Crane, Grey Crowned | Balearica regulorum | EN | EN | | x | |
| Crow, Cape | Corvus capensis | | | | x | x |
| Cuckoo, Diderick | Chrysococcyx caprius | | | | x | x |
| Cuckoo, Red-chested | Cuculus solitarius | | | | x | |
| Darter, African | Anhinga rufa | | | | x | |
| Dove, Laughing | Streptopelia senegalensis | | | | x | |
| Dove, Namaqua | Oena capensis | | | | x | |
| Dove, Red-eyed | Streptopelia semitorquata | | | | x | |
| Dove, Rock | Columba livia | | | | x | |
| Duck, African Black | Anas sparsa | | | | x | |
| Duck, Fulvous | Dendrocygna bicolor | | | | x | |
| Duck, Maccoa | Oxyura maccoa | NT | NT | | x | x |
| Duck, White-backed | Thalassornis leuconotus | | | | x | |
| Duck, White-faced | Dendrocygna viduata | | | | x | |
| Duck, Yellow-billed | Anas undulata | | | | x | x |
| Eagle-Owl, Spotted | Bubo africanus | | | | x | |
| Egret, Cattle | Bubulcus ibis | | | | x | x |
| Egret, Great | Egretta alba | | | | x | |
| Egret, Little | Egretta garzetta | | | | x | x |
| Egret, Yellow-billed | Egretta intermedia | | | | x | |
| Falcon, Amur | Falco amurensis | | | | x | x |
| Falcon, Lanner | Falco biarmicus | VU | LC | | x | |
| Finch, Red-headed | Amadina erythrocephala | | | | x | |
| Fiscal, Common | Lanius collaris | | | | x | x |
| Flamingo, Greater | Phoenicopterus ruber | NT | LC | | x | |
| Flycatcher, Fairy | Stenostira scita | | | Near Endemic | x | |
| Goose, Egyptian | Alopochen aegyptiacus | | | | x | x |
| Goose, Spur-winged | Plectropterus gambensis | | | | x | x |
| Grebe, Black-necked | Podiceps nigricollis | | | | x | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Grebe, Great Crested | Podiceps cristatus | | | | x | |
| Grebe, Little | Tachybaptus ruficollis | | | | x | x |
| Greenshank, Common | Tringa nebularia | | | | x | |
| Guineafowl, Helmeted | Numida meleagris | | | | x | |
| Gull, Grey-headed | Larus cirrocephalus | | | | x | |
| Hamerkop, Hamerkop | Scopus umbretta | | | | x | x |
| Heron, Black-headed | Ardea melanocephala | | | | x | x |
| Heron, Grey | Ardea cinerea | | | | x | x |
| Heron, Squacco | Ardeola ralloides | | | | x | |
| Hoopoe, African | Upupa africana | | | | x | |
| Ibis, African Sacred | Threskiornis aethiopicus | | | | x | |
| Ibis, Glossy | Plegadis falcinellus | | | | x | x |
| Ibis, Hadeda | Bostrychia hagedash | | | | x | x |
| Ibis, Southern Bald | Geronticus calvus | | | | x | |
| Jacana, African | Actophilornis africanus | | | | x | |
| Kestrel, Greater | Falco rupicoloides | | | | x | |
| Kestrel, Lesser | Falco naumanni | | | | x | x |
| Kestrel, Rock | Falco rupicolus | | | | x | |
| Kingfisher, Giant | Megaceryle maximus | | | | x | |
| Kingfisher, Malachite | Alcedo cristata | | | | x | |
| Kingfisher, Pied | Ceryle rudis | | | | x | |
| Kite, Black & Yellowbilled | Milvus migrans | | | | x | |
| Kite, Black-shouldered | Elanus caeruleus | | | | x | x |
| Kite, Yellow-billed | Milvus aegyptius | | | | x | |
| Korhaan, Blue | Eupodotis caerulescens | - | NT | Regional Endemic | x | x |
| Korhaan, White-bellied | Eupodotis senegalensis | VU | LC | | x | |
| Lapwing, African Wattled | Vanellus senegallus | | | | x | x |
| Lapwing, Blacksmith | Vanellus armatus | | | | x | x |
| Lapwing, Crowned | Vanellus coronatus | | | | x | x |
| Lark, Agulhas Clapper | Mirafra marjoriae | NT | - | Endemic | x | |
| Lark, Botha's | Spizocorys fringillaris | EN | EN | Endemic | x | |
| Lark, Cape Clapper | Mirafra apiata | | | Near Endemic | x | |
| Lark, Eastern Clapper | Mirafra fasciolata | | | | x | x |
| Lark, Pink-billed | Spizocorys conirostris | | | | x | |
| Lark, Red-capped | Calandrella cinerea | | | | x | |
| Lark, Rudd's | Heteromirafra ruddi | EN | VU | Endemic | x | |
| Lark, Rufous-naped | Mirafra africana | | | | x | x |
| Lark, Spike-heeled | Chersomanes albofasciata | | | | x | x |
| Longclaw, Cape | Macronyx capensis | | | | x | x |
| Marsh-Harrier, African | Circus ranivorus | | | | x | |
| Martin, Banded | Riparia cincta | | | | x | x |
| Martin, Brown-throated | Riparia paludicola | | | | x | x |
| Martin, Rock | Hirundo fuligula | | | | x | |
| Martin, Sand | Riparia riparia | | | | x | |
| Masked-Weaver, Southern | Ploceus velatus | | | | x | x |
| Moorhen, Common | Gallinula chloropus | | | | | x |
| Mousebird, Speckled | Colius striatus | | | | x | x |
| Myna, Common | Acridotheres tristis | | | | x | x |
| Neddicky, Neddicky | Cisticola fulvicapilla | | | | x | |
| Ostrich, Common | Struthio camelus | | | | x | |
| Owl, Barn | Tyto alba | | | | x | |
| Owl, Marsh | Asio capensis | | | | x | |
| Palm-Swift, African | Cypsiurus parvus | | | | x | |
| Pigeon, Speckled | Columba guinea | | | | x | |
| Pipit, African | Anthus cinnamomeus | | | | x | x |
| Pipit, Long-billed | Anthus similis | | | | x | |
| Plover, Common Ringed | Charadrius hiaticula | | | | x | |
| Plover, Kittlitz's | Charadrius pecuarius | | | | x | |
| Plover, Three-banded | Charadrius tricollaris | | | | x | x |
| Pochard, Southern | Netta erythrophthalma | | | | x | |
| Pratincole, Black-winged | Glareola nordmanni | NT | NT | | x | |
| Prinia, Black-chested | Prinia flavicans | | | | x | |
| Quail, Common | Coturnix coturnix | | | | x | x |
| Quailfinch, African | Ortygospiza atricollis | | | | x | |
| Quelea, Red-billed | Quelea quelea | | | | x | |
| Robin-Chat, Cape | Cossypha caffra | | | | x | |
| Ruff, Ruff | Philomachus pugnax | | | | x | x |
| Sandpiper, Common | Actitis hypoleucos | | | | x | x |
| Sandpiper, Curlew | Calidris ferruginea | | | | x | |
| Sandpiper, Marsh | Tringa stagnatilis | | | | x | |
| Sandpiper, Wood | Tringa glareola | | | | x | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Secretarybird, Secretarybird | Sagittarius serpentarius | VU | VU | | x | x |
| Seedeater, Streaky-headed | Crithagra gularis | | | | x | |
| Shelduck, South African | Tadorna cana | | | | x | x |
| Shoveler, Cape | Anas smithii | | | | x | x |
| Snipe, African | Gallinago nigripennis | | | | x | |
| Sparrow, Cape | Passer melanurus | | | | x | x |
| Sparrow, House | Passer domesticus | | | | x | |
| Sparrow, Northern Grey-headed | Passer griseus | | | | x | |
| Sparrow, Southern Grey-headed | Passer diffusus | | | | x | x |
| Sparrowhawk, Rufous-chested | Accipiter rufiventris | | | | x | |
| Spoonbill, African | Platalea alba | | | | x | |
| Spurfowl, Swainson's | Pternistis swainsonii | | | | x | x |
| Starling, Cape Glossy | Lamprotornis nitens | | | | x | x |
| Starling, Pied | Spreo bicolor | | | Regional Endemic | x | x |
| Stilt, Black-winged | Himantopus himantopus | | | | x | |
| Stint, Little | Calidris minuta | | | | x | |
| Stonechat, African | Saxicola torquatus | | | | x | x |
| Stork, White | Ciconia ciconia | | | | x | |
| Sunbird, Malachite | Nectarinia famosa | | | | x | |
| Swallow, Barn | Hirundo rustica | | | | x | x |
| Swallow, Greater Striped | Hirundo cucullata | | | | x | x |
| Swallow, White-throated | Hirundo albigularis | | | | x | x |
| Swift, Little | Apus affinis | | | | x | x |
| Swift, White-rumped | Apus caffer | | | | x | x |
| Teal, Cape | Anas capensis | | | | x | |
| Teal, Hottentot | Anas hottentota | | | | x | |
| Teal, Red-billed | Anas erythrorhyncha | | | | x | |
| Tern, Whiskered | Chlidonias hybrida | | | | x | |
| Tern, White-winged | Chlidonias leucopterus | | | | x | |
| Thick-knee, Spotted | Burhinus capensis | | | | x | x |
| Thrush, Karoo | Turdus smithi | | | Near Endemic | x | |
| Thrush, Olive | Turdus olivaceus | | | | x | |
| Turtle-Dove, Cape | Streptopelia capicola | | | | x | x |
| Wagtail, Cape | Motacilla capensis | | | | x | x |
| Waxbill, Common | Estrilda astrild | | | | x | x |
| Waxbill, Orange-breasted | Amandava subflava | | | | x | |
| Wheatear, Mountain | Oenanthe monticola | | | | x | |
| Whydah, Pin-tailed | Vidua macroura | | | | x | x |
| Widowbird, Fan-tailed | Euplectes axillaris | | | | x | x |
| Widowbird, Long-tailed | Euplectes progne | | | | x | x |
| Widowbird, Red-collared | Euplectes ardens | | | | x | |
| Wryneck, Red-throated | Jynx ruficollis | | | | x | |

## APPENDIX 2: LIST OF BIRD SPECIES RECORDED ON SITE DURING FIELD SURVEYS

| COMMON NAME | SCIENTIFIC NAME | WT | VT | INCIDENTAL |
|---|---|---|---|---|
| Bishop, Southern Red | Euplectes orix | x | | |
| Bishop, Yellow-crowned | Euplectes afer | | x | |
| Bushshrike, Gorgeous | Telophorus quadricolor | x | | |
| Canary, Yellow-fronted | Crithagra mozambica | | x | |
| Cisticola, Levaillant's | Cisticola tinniens | x | x | x |
| Cisticola, Wing-snapping | Cisticola ayresii | x | | |
| Crow, Pied | Corvus albus | x | x | x |
| Dove, Laughing | Streptopelia senegalensis | | x | |
| Fiscal, Common | Lanius collaris | x | x | x |
| Guineafowl, Helmeted | Numida meleagris | | x | |
| Ibis, Hadeda | Bostrychia hagedash | | x | |
| Kite, Black-shouldered | Elanus caeruleus | x | x | x |
| Lapwing, Blacksmith | Vanellus armatus | | x | |
| Lapwing, Crowned | Vanellus coronatus | x | | x |
| Longclaw, Cape | Macronyx capensis | x | | x |
| Masked-weaver, Southern | Ploceus velatus | x | x | |
| Mousebird, Speckled | Colius striatus | x | | |
| Myna, Common | Acridotheres tristis | x | x | x |
| Pigeon, Speckled | Columba guinea | x | x | |
| Pipit, African | Anthus cinnamomeus | | x | |
| Sparrow, Cape | Passer melanurus | x | x | x |
| Starling, Cape Glossy | Lamprotornis nitens | | | x |
| Starling, Pied | Spreo bicolor | x | x | |
| Stonechat, African | Saxicola torquatus | x | | x |
| Swallow, White-throated | Hirundo albigularis | | x | |
| Thick-knee, Spotted | Burhinus capensis | x | | |
| Turtle-dove, Cape | Streptopelia capicola | x | x | |
| Wagtail, African Pied | Motacilla aguimp | x | x | |
| Waxbill, Common | Estrilda astrild | | x | |
| Waxbill, Orange-breasted | Amandava subflava | x | | |
| Widowbird, Long-tailed | Euplectes progne | x | x | x |

## APPENDIX 3
## METHOD OF ASSESSING THE SIGNIFICANCE OF POTENTIAL ENVIRONMENTAL IMPACTS

Direct, indirect and cumulative impacts of the issues identified are assessed in terms of the following criteria:

| CRITERIA | RATING SCALES | NOTES |
|---|---|---|
| Nature | A description of what causes the effect, what will be affected and how it will be affected | |
| Extent | 1 | the impact will be limited to the site |
| | 2 | the impact will be limited to the local area |
| | 3 | the impact will be limited to the region |
| | 4 | the impact will be national |
| | 5 | the impact will be international |
| Duration | 1 | very short duration (0–1 years) |
| | 2 | short duration (2-5 years) |
| | 3 | medium-term (5–15 years) |
| | 4 | long term (> 15 years) |
| | 5 | permanent |
| Magnitude | 0 | small and will have no effect on the environment |
| | 2 | minor and will not result in an impact on processes |
| | 4 | low and will cause a slight impact on processes |
| | 6 | moderate and will result in processes continuing but in a modified way |
| | 8 | high, processes are altered to the extent that they temporarily cease |
| | 10 | very high and results in complete destruction of patterns and permanent cessation of processes |
| Probability | 1 | very improbable (probably will not happen) |
| | 2 | improbable (some possibility, but low likelihood) |
| | 3 | probable (distinct possibility) |
| | 4 | highly probable (most likely) |
| | 5 | definite (impact will occur regardless of any prevention measures) |
| Significance | determined through a synthesis of the characteristics described above using the following formula and can be assessed as low, medium or high<br>S = (E + D + M) * P | |
| Status | described as either positive, negative or neutral | |
| Reversibility | the degree to which the impact can be reversed | |

| | |
|---|---|
| Irreplaceable loss of resources | the degree to which the impact may cause irreplaceable loss of resources |
| Mitigation | the degree to which the impact can be mitigated |