FEBRUARY 2016

LETHABO SOLAR PHOTOVOLTAIC FACILITY

AVIFAUNAL IMPACT ASSESSMENT REPORT FOR THE LETHABO SOLAR PHOTOVOLTAIC FACILITY

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EXECUTIVE SUMMARY

Eskom Holdings SOC Ltd is planning a Solar Photovoltaic (PV) project in the Free State Province, South Africa. In line with environmental legislation, Feathers Environmental Services was appointed to conduct an avifaunal specialist study. The proposed Lethabo Solar Photovoltaic Facility is to be developed within the immediate vicinity of the Lethabo (coal-fired) Power Station and will have a maximum generating capacity of approximately 75MW.

A combined total of at least 333 bird species has been recorded within the relevant SABAP quarter degree squares and pentads. The presence of these species in the broader area provides an indication of the diversity of species that could potentially occur at the two identified sites. SABAP1 recorded 326 species and SABAP2 has recorded 144 species to date. Of the 333 species, 22 are Red List species, 12 near-endemics, four regional endemics and one 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 this parcel of land.

The site visit produced a combined list of 41 species, covering both the project development area and to a limited extent, the surrounding area. Species that featured prominently include Cape Turtle-Dove *Streptopelia capicola*, Helmeted Guineafowl, Southern Red Bishop *Euplectes orix* and Crowned Lapwing *Vanellus coronatus*. These are species that are often associated with urban, peri-urban and farmland environments, so there relatively high reporting rate is not unexpected. No Red List species or species of conservation concern were recorded using the data collection methods. In addition no raptor nests or distinct flights paths across either of the proposed sites were recorded. Other species recorded in relative abundance include: African Stonechat, Southern Masked-Weaver, Northern Black Korhaan, Blacksmith Lapwing *Vanellus armatus*, Laughing Dove *Streptopelia senegalensis* and Common Fiscal *Lanius collaris*. 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.

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 facility itself are: displacement as a result of habitat transformation and disturbance; bird collisions with PV panels; and the nesting of birds on solar panel infrastructure, of which displacement is likely to be the most significant. 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 to avifauna within the confines of the proposed sites 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 Lethabo Solar Photovoltaic Facility can be constructed at either of the two proposed sites with acceptable levels of impact on the resident avifauna. The significance of the potential impacts can be further reduced through selection of Alternative Site 2 due to its smaller footprint size and proximity to the power station.

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 soon to be released BirdLife South Africa best practice guidelines. The aim of this programme will be to gather site specific information on the impacts of the solar facility on avifauna. In addition the monitoring programme will further our general 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)

Investigator:	Megan Diamond (*Cert.Sci.Nat)*
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

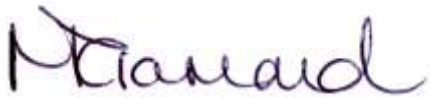
Megan has been involved in conservation for 17 years and holds a BSc in Environmental Management. She has nine years experience in the field of bird interactions with electrical infrastructure and during this time has completed impact assessments for at least 50 projects, many of which have involved 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 7-9 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.



8 February 2016

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 Lethabo Solar Energy Facility, located within the immediate vicinity of the Lethabo Power Station, near Sasolburg in the Free State 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 alternatives as well as the provision of recommendations for the mitigation of the anticipated impacts.

1.2 Project Description

Following the initial scoping studies, two site alternatives were provided for assessment in this EIA phase of the project. Alternative Site 1 will have a generating capacity of 75MW and will encompass an area of approximately 160 hectares. Alternative Site 2 is considerably smaller in both capacity (35MW) and footprint size (52 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 Lethabo 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.

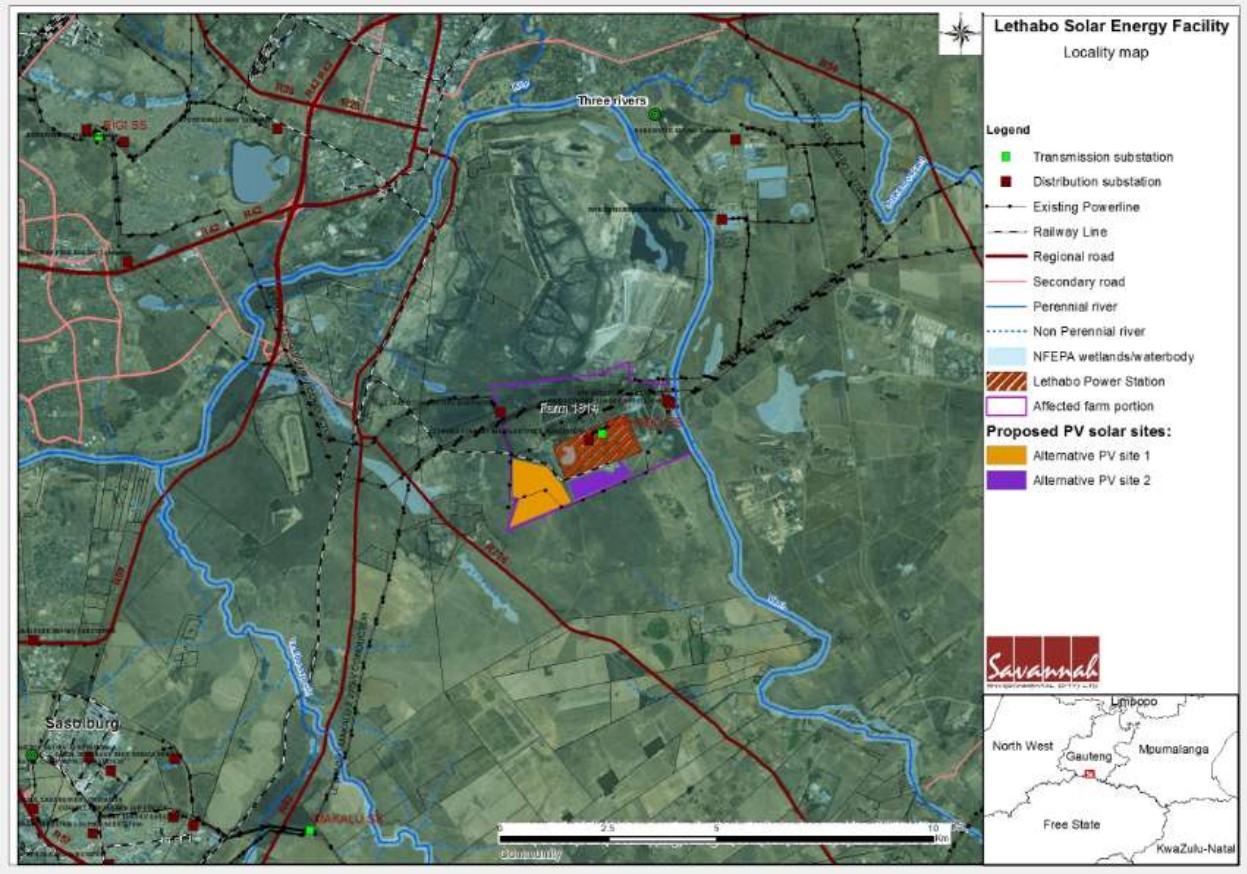


FIGURE 1: Map showing the locality of the proposed Lethabo Solar Energy Facility in the Free State province (Source: Savannah Environmental)

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:

- 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 Squares 2627DB (736 cards) and 2627DD (233 cards).
- The Southern African Bird Atlas Project 2 (http://sabap2.adu.org.za/v1/index.php) - Pentads 2640_2755 (16 cards) and 2645_2755 (20 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 Lethabo Solar Photovoltaic Facility is to be developed within the immediate vicinity of the Lethabo (coal-fired) Power Station, located approximately 25 km northeast of Sasolburg. Both alternative sites are located on Portion 0 of Farm 1814, in the jurisdiction of Fezile Dabi District Municipality and Metsimaholo Local Municipality within the Free State Province. The natural environment in the broader study area has been largely transformed by agriculture as well as mining and industrial activities and residential developments.

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 2627DB and 2627DD quarter degree squares is classified as Mixed Grassland (Harrison *et al,* 1997). According to Mucina and Rutherford (2006), the two site locations are comprised entirely of the Central Free State Grassland vegetation type of which almost 25% is already transformed by cultivation. 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 Northern Black Korhaan and the smaller passerine species that are currently foraging and nesting in the proposed parcels 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, 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 two alternative development sites revealed the presence of grassland habitat (degraded and disturbed to a large extent) and small wetland areas (FIGURE 2). In addition, commercial dryland cultivation, irrigated agricultural lands, the Vaal river system, eucalyptus plantations as well as mines, quarries, industrial and residential areas feature prominently within the immediate surrounds of the two proposed development sites.

FIGURE 2: Examples of the microhabitat (degraded grassland and small wetlands) observed, at each of the two proposed sites, 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 333 bird species has been recorded within the relevant SABAP quarter degree squares and pentads (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 two alternative sites. Of the 333 species, 27 are Red List species, 11 near-endemics, two endemics and five regional endemic species. Although Red List endemics (Black Harrier *Circus maurus*, Blue Korhaan *Eupodotis caerulescens*, Agulhas Long-billed Lark *Certhilauda brevirostris* and Melodious Lark *Mirafra cheniana*) have been recorded in the broader study, the report rates for each of these 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 either of the two identified sites. 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 either of the two site locations, the small size of the proposed properties, the degraded nature of the vegetation and the proximity to the existing sources of disturbance will preclude species of conservation concern from occupying these areas. The proposed development sites do however support a diversity of more common small terrestrial species, and development in these areas 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 Lethabo PV Solar Facility

COMMON NAME	SCIENTIFIC NAME	REGIONAL STATUS (Endemism)	GLOBAL STATUS	SABAP 1	SABAP 2	GRASSLAND	CULTIVATION	WETLANDS	HABITAT LOSS & DISTURBANCE	COLLISION PV PANELS	COLLISION POWER LINES	ELECTROCUTION
Buzzard, Jackal	Buteo rufofuscus	(ne)		x		x						x
Cisticola, Cloud	Cisticola textrix	(ne)		x	x	x			x	x		
Courser, Double-banded	Rhinoptilus africanus	NT	LC	x		x			x	x		
Crane, Blue	Anthropoides paradiseus	NT	VU	x		x					x	
Duck, Maccoa	Oxyura maccoa	NT	NT	x				x		x	x	
Falcon, Lanner	Falco biarmicus	VU	LC	x	x	x			x		x	x
Finfoot, African	Podica senegalensis	VU	LC	x				x		x		
Flamingo, Greater	Phoenicopterus ruber	NT	LC	x				x		x	x	
Flamingo, Lesser	Phoenicopterus minor	NT	NT	x				x		x	x	
Flycatcher, Fairy	Stenostira scita	(ne)		x	x	x			x	x		
Flycatcher, Fiscal	Sigelus silens	(ne)		x	x	x			x	x		
Godwit, Black-tailed	Limosa limosa	-	NT	x				x	x	x		
Grass-Owl, African	Tyto capensis	VU	LC	x		x		x	x		x	x
Grassbird, Cape	Sphenoeacus afer	(ne)		x		x			x	x		
Harrier, Black	Circus maurus	EN (ne)	VU	x		x	x	x			x	
Kingfisher, Half-collared	Alcedo semitorquata	NT	LC	x				x		x		
Korhaan, Blue	Eupodotis caerulescens	(reg. end)	NT	x		x			x		x	
Lark, Agulhas Long-billed	Certhilauda brevirostris	NT (end)	NR	x		x	x		x	x		
Lark, Cape Clapper	Mirafra apiata	(ne)		x		x			x	x		
Lark, Cape Long-billed	Certhilauda curvirostris	(end)		x		x	x		x	x		
Lark, Eastern Long-billed	Certhilauda semitorquata	(reg. end)		x		x			x	x		
Lark, Melodious	Mirafra cheniana	(ne)	NT	x		x			x	x		
Painted-snipe, Greater	Rostratula benghalensis	VU	LC	x				x		x		
Pelican, Pink-backed	Pelecanus rufescens	VU	LC	x				x			x	
Plover, Chestnut-banded	Charadrius pallidus	NT	NT	x				x		x		
Pratincole, Black-winged	Glareola nordmanni	NT	NT	x		x	x		x	x		
Rock-thrush, Sentinal	Monticola explorator	(reg. end)		x		x	x		x	x		
Roller, European	Coracias garrulus	NT	NT	x	x	x			x	x		
Secretarybird	Sagittarius serpentarius	VU	VU	x		x			x		x	
Starling, Pied	Spreo bicolor	(reg. end)		x	x	x			x			
Stork, Abdim's	Ciconia abdimii	NT	LC	x		x	x		x		x	
Stork, Black	Ciconia nigra	VU	LC	x				x			x	
Stork, White	Ciconia ciconia	BONN		x	x	x	x	x	x		x	
Stork, Yellow-billed	Mycteria ibis	EN	LC	x				x			x	
Sunbird, Greater Double-collared	Cinnyris afer	(reg. end)		x	x	x		x	x	x		
Tern, Caspian	Sterna caspia	VU	LC	x				x		x		
Thrush, Karoo	Turdus smithi	(ne)		x	x	x		x	x	x		
Vulture, Cape	Gyps coprotheres	EN	VU	x		x					x	x
Weaver, Cape	Ploceus capensis	(ne)		x		x			x	x		
White-eye, Cape	Zosterops virens	(ne)		x	x	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. The closest CAR routes are situated approximately 5km east and 13km south west of the proposed development sites. Data emanating from this project indicates that this in an area that has been largely ruined for large terrestrial birds, probably as a result of the intensive agricultural practices that have dominated this region over the years. The absence of Kori Bustard *Ardeotis kori*, Blue Crane *Anthropoides paradiseus*, Grey Crowned Crane *Balearica regulorum*, Blue Korhaan and Secretarybird *Sagittarius serpentarius* is testament to this. Given, the scarcity of large terrestrial birds in the general area and the current level of existing disturbance, it is unlikely that large terrestrial species of conservation concern will be present at either of the two identified sites. Northern Black Korhaan *Afrotis afraoides*, Spur-winged Goose *Plectropterus gambensis*, Black-headed Heron *Ardea melanocephala* and Helmeted Guineafowl *Numida meleagris* were the only large terrestrial species observed at the proposed development sites and their immediate surrounds 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 in the vicinity of the proposed project.

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.

Although the proposed development sites are not within an established IBA, the Middle Vaal River IBA (SA038) is located approximately 30km west of the proposed development sites and is one of the few remaining pristine sections of the Vaal system. This area supports more than 5000 waterfowl and it is likely that these species will utilize the entire Vaal river system (including those sections of the river located to east of the Lethabo Power Station) as a flyway. No distinct waterfowl flight paths were observed across the proposed sites in relation to the Vaal River.

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 7 to 9 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 two areas that have been identified as possible development sites for the Lethabo PV Solar project are located in an open, homogeneous habitats, 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 four walked transects (WT) totaling 4.03 kilometers were established across the proposed sites (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 high diversity of bird species in the broader study area, the proposed development sites are limited in habitat diversity and do not contain any topographical landscape features. Therefore, the local avifaunal richness present within the two study sites 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
Apalis, Bar-throated	Apalis thoracica	2	1	0.50
Bishop, Southern Red	Euplectes orix	27	5	6.70
Canary, Yellow-fronted	Crithagra mozambica	1	1	0.25
Cisticola, Zitting	Cisticola juncidis	3	3	0.74
Dove, Laughing	Streptopelia senegalensis	6	5	1.49
Dove, Red-eyed	Streptopelia semitorquata	3	1	0.74
Fiscal, Common	Lanius collaris	7	7	1.74
Guineafowl, Helmeted	Numida meleagris	69	9	17.12
Heron, Black-headed	Ardea melanocephala	1	1	0.25
Kite, Black-shouldered	Elanus caeruleus	2	1	0.50
Korhaan, Northern Black	Afrotis afraoides	9	9	2.23
Lapwing, Blacksmith	Vanellus armatus	6	4	1.49
Lapwing, Crowned	Vanellus coronatus	26	16	6.45
Lark, Red-capped	Calandrella cinerea	1	1	0.25
Lark, Rufous-naped	Mirafra africana	2	2	0.50
Longclaw, Cape	Macronyx capensis	2	1	0.50
Martin, Brown-throated	Riparia paludicola	2	1	0.50
Masked-weaver, Southern	Ploceus velatus	13	9	3.23
Mousebird, Speckled	Colius striatus	1	1	0.25
Myna, Common	Acridotheres tristis	4	3	0.99
Neddicky, Neddicky	Cisticola fulvicapilla	3	2	0.74
Pipit, African	Anthus cinnamomeus	1	1	0.25
Prinia, Black-chested	Prinia flavicans	1	1	0.25
Quail, Common	Coturnix coturnix	1	1	0.25
Sparrow, Cape	Passer melanurus	2	1	0.50
Sparrow, House	Passer domesticus	1	1	0.25
Starling, Cape Glossy	Lamprotornis nitens	1	1	0.25
Stonechat, African	Saxicola torquatus	13	13	3.23
Swallow, White-throated	Hirundo albigularis	2	1	0.50
Swamp-warbler, Lesser	Acrocephalus gracilirostris	1	1	0.25
Turtle-dove, Cape	Streptopelia capicola	73	36	18.11
Wheatear, Capped	Oenanthe pileata	1	1	0.25
Widowbird, Long-tailed	Euplectes progne	1	1	0.25

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, totalling approximately 17 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
Apalis, Bar-throated	Apalis thoracica	1	1	0.06
Canary, Yellow-fronted	Crithagra mozambica	2	1	0.12
Dove, Laughing	Streptopelia senegalensis	23	11	1.35
Fiscal, Common	Lanius collaris	1	1	0.06
Francolin, Orange River	Scleroptila levaillantoides	6	4	0.35
Goose, Egyptian	Alopochen aegyptiacus	2	1	0.12
Goose, Spur-winged	Plectropterus gambensis	9	1	0.53
Guineafowl, Helmeted	Numida meleagris	41	4	2.41
Korhaan, Northern Black	Afrotis afraoides	16	12	0.94
Lapwing, Crowned	Vanellus coronatus	31	20	1.82
Masked-weaver, Southern	Ploceus velatus	25	7	1.47
Myna, Common	Acridotheres tristis	6	4	0.35
Pipit, African	Anthus cinnamomeus	1	1	0.06
Prinia, Black-chested	Prinia flavicans	1	1	0.06
Quail, Common	Coturnix coturnix	1	1	0.06
Sparrow, Cape	Passer melanurus	4	3	0.24
Sparrow, House	Passer domesticus	3	2	0.18
Stonechat, African	Saxicola torquatus	1	1	0.06
Turtle-dove, Cape	Streptopelia capicola	55	22	3.24
Wheatear, Capped	Oenanthe pileata	3	3	0.18
Widowbird, Long-tailed	Euplectes progne	1	1	0.06

FIGURE 3: Location of the four walked transects (blue lines) and driven transect (yellow line) indicating the areas surveyed during the site visit conducted from 7-9 September 2015.

2.4.3 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 4). In addition, observations related to the extent and direction of distinct bird flight paths within the impact zone particularly in relation to the Vaal River and other roosting and foraging areas sites were also recorded.

TABLE 4: Incidental Sightings Summary Data

SPECIES	SCIENTIFIC NAME	#BIRDS	#RECORDS
Crow, Pied	Corvus albus	3	1
Dove, Laughing	Streptopelia senegalensis	7	2
Francolin, Orange River	Scleroptila levaillantoides	2	1
Guineafowl, Helmeted	Numida meleagris	55	6
Ibis, Hadeda	Bostrychia hagedash	3	1
Korhaan, Northern Black	Afrotis afraoides	5	5
Lapwing, Blacksmith	Vanellus armatus	3	2
Lapwing, Crowned	Vanellus coronatus	3	1
Masked-weaver, Southern	Ploceus velatus	2	2
Myna, Common	Acridotheres tristis	2	1
Sparrow, House	Passer domesticus	1	1
Stonechat, African	Saxicola torquatus	6	4
Turtle-dove, Cape	Streptopelia capicola	13	8

The site visit produced a combined list of 41 species (APPENDIX 2), covering both the project development area and to a limited extent, the surrounding area. Species that featured prominently include Cape Turtle-Dove *Streptopelia capicola*, Helmeted Guineafowl, Southern Red Bishop *Euplectes orix* and Crowned Lapwing *Vanellus coronatus*. These are species that are often associated with urban, peri-urban and farmland environments, so there relatively high reporting rate is not unexpected. No Red List species or species of conservation concern were recorded using the data collection methods. In addition no raptor nests were noted during the site survey and the only indication of a possible breeding site was Helmeted Guineafowl egg shells observed along Walked Transect 2. No distinct flights paths across either of the proposed sites were recorded. The only two flights that were noted were of Egyptian Goose *Alopochen aegyptiacus* (two individuals) flying in an area outside of the impact zone and another single flight involving Spur-winged Goose (nine individuals) flying in a northerly direction across Alternative Site 1.

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 have been previously observed foraging at Alternative Site 1 and the

broader study area (pers. comms Pieter Muller – Eskom Land Development representative). Similarly Barn Swallow *Hirundo rustica* are also likely to feature prominently during the summer months.

Other species recorded in relative abundance include: African Stonechat, Southern Masked-Weaver, Northern Black Korhaan, Blacksmith Lapwing *Vanellus armatus*, Laughing Dove *Streptopelia senegalensis* and Common Fiscal *Lanius collaris*. 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. In addition, the majority of these species 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 vegetation present at both alternative sites is degraded to a fairly large extent and subject to significant existing disturbance. It is therefore unlikely to support the more sensitive grassland 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 post construction. 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 nearby 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 mining, energy generation and industrial activities in the immediate vicinity of the two sites. 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 to moderate 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 subject to monitoring in accordance with the facilities' management plan. Monitoring surveys conducted from 29 October 2013 to 21 March 2014 at the California-based Ivanpah Solar Electric Generating System, yielded the following results (Harvey and Associates, 2014):

- 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 a period of three months (November 2013 to February 2014) and an additional 54 for the following three month period (February 2014 to 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 a likely underestimate 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.

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 moderate 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 Northern Black Korhaan, Spur-winged Goose, Egyptian Goose among others 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 two sites is considered to be low. The only sensitive feature present at each of the proposed development sites 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 present at Alternative Site 1 sites 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 Alternative Site 1 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. Despite the presence of a wetland at Site Alternative 2, the entire area is considered to be of low sensitivity, since the wetland is subject to disturbance of high intensity, is highly transformed and very poor in species diversity. A map delineating these areas is been provided below (FIGURE 4).

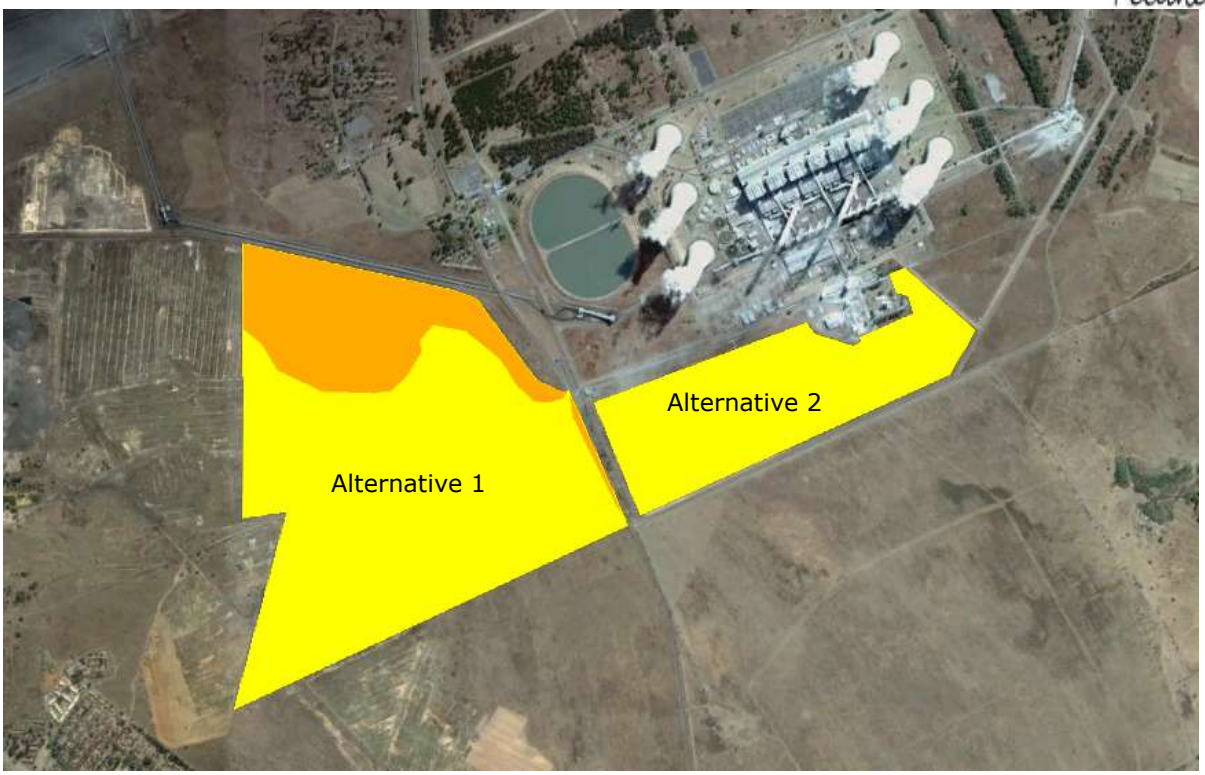


FIGURE 4. Avifaunal sensitivity map - medium sensitivity areas are represented by the orange polygons and low sensitivity areas are represented by the yellow polygons.

4.2 Comparison of Alternatives

One of the main objectives of this study is to evaluate the identified feasible alternatives and nominate a preferred alternative for development.

From an avifaunal perspective, the impacts associated with the construction of the proposed solar facility at any of the two alternatives sites are considered to be identical. However, one factor that sets one site apart from the other is the size of Alternative Site 2 and its proximity to the generation facilities and associated infrastructure. Alternative Site 2 is almost half the size of Alternative Sites 1 and therefore it stands to reason that a smaller footprint size will result in less vegetation and habitat loss if the facility is constructed at this site. The level of disturbance is also more significant at Alternative Site 2 which has in all likelihood affected the diversity and density bird species utilizing this site.

Based on this discussion, it is recommended that the proposed Lethabo PV Solar Facility be developed at Alternative Site 2.

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 Northern Black Korhaan and smaller passerine species.		
	Without mitigation	**With mitigation**
Extent	1 site bound	1 site bound
Duration	5 permanent	5 permanent
Magnitude	4 low	2 minor
Probability	4 highly probable	3 probable
Significance	**Medium (40)**	**Low (24)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?		
Yes through the selection of the alternative site that presents the least environmental impact.		
Mitigation:		
Restricting the construction footprint to a bare minimum - this can be achieved by selecting Alternative Site 2 as the preferred alternative. This site has a smaller footprint size, lower avifaunal species richness and is subject to significant existing habitat degradation and disturbance. 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:		
The surrounding area is already heavily transformed as a result of mining, energy generation, urban, agricultural and pastoral activities. However the areas that have been earmarked for development are not particularly sensitive and therefore the cumulative impact is deemed not to be that significant		
Residual Impacts:		
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. It is unlikely that the large terrestrial birds (i.e. Northern Black Korhaan) will continue to use the habitat amongst the solar arrays.		

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 Northern Black Korhaan and 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? Partially		
Mitigation: 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. 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: In addition to the proposed Lethabo PV Solar arrays, there are several activities (i.e. mining, energy generation, industrial, urban, agricultural and pastoral) 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 sites, 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: 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	4 low	2 minor
Probability	3 probable	3 probable
Significance	**Medium (30)**	**Low (24)**
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated? Yes		
Mitigation: 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: An extensive power line network features prominently both on the proposed sites 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: 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 (Northern Black Korhaan) 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	4 low	2 minor
Probability	3 probable	2 improbable
Significance	**Medium (30)**	**Low (14)**
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated? Yes		
Mitigation: 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: An extensive power line network features prominently both on the proposed sites and within the broader study area. Any additional power lines will undoubtedly increase the collision risk to power line sensitive species (i.e. Northern Black Korhaan, Spur-winged Goose, Egyptian Goose, Black-headed Heron 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: 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? Yes		
Mitigation: Only Eskom approved bird friendly tower/pole structures must be used for the entire length of the power line.		
Cumulative impacts: An extensive power line network features prominently both on the proposed sites 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 to high 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: 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 electricity network features prominently 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 to high 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? Yes		
Mitigation: Similarly to the impacts associated with substations, it is recommended that if ongoing 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: None		
Residual Impacts: None		

TABLE 5-8: Impacts table for the cumulative impact of the proposed Solar Photovoltaic (PV) project and the existing developments and operations within the study area

NATURE: Cumulative impact of the proposed Solar Photovoltaic (PV) project (i.e. PV panels and associated electrical infrastructure) and the existing developments and operations (i.e. mining, energy generation, industrial activities and residential developments) within the study area.		
	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	Moderate
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated? Yes		
Mitigation: It is important to note that very little empirical evidence exists that quantifies the current level of impact within the study area and the effect that mitigation (if any) has had on reducing these impacts. It is therefore speculated that the significance of the cumulative impact, as a result of the addition of the solar PV facility, may either be reduced if the mitigation measures (detailed in the tables above) for each impact associated with the solar facility are implemented.		

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): Avoid construction in sensitive vegetation types and wetlands (refer to the botanical and wetland specialist impact assessment for details of sensitivity). 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. 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): 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): 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. 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. 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): Only Eskom approved bird friendly tower/pole structures must be used for the entire length of the power line. 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 Substation mitigation to be applied reactively, if required.
Nest building on PV infrastructure: 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.

Performance Indicator	• The size and extent of areas of sensitive habitat present at start of construction remain intact at end of construction phase. • A post construction monitoring report to be completed at the end of each year of post construction monitoring. This report should include an assessment of the predicted versus observed impacts, the effectiveness of mitigation measures, recommendations for further mitigation and post construction monitoring, if necessary. • Bird flight diverters are fitted to power lines done prior to the solar facility becoming operational. • Power line tower/pole structure to be identified and approved as 'bird friendly' prior to construction • No more than two bird mortalities per month, as a result of the power lines associated with the facility, are reported from the time that the solar facility becomes operational and necessary mitigation measures have been implemented. • No birds recorded breeding in the PV array area or on any associated infrastructure.
Monitoring	• Environmental Control Officer to measure loss of habitat in sensitive areas during construction and to report these as part of their tasks. • Environmental Control Officer to ensure that construction activities are confined to the site footprint to avoid any additional impacts on bird species residing in the broader area. • The establishment of a post construction monitoring programme to monitor the impact of displacement and collision mortality on the resident avifauna. • Environmental Control Officer and/or maintenance staff to conduct weekly checks of all PV arrays for nesting activities and faecal matter fouling on solar panels.

7. CONCLUSION

As is the case with any large scale energy development, the proposed Lethabo PV Solar project 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 Red List 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. mining, energy generation and industrial activities are prevalent in the study area. The construction of the Lethabo 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 moderate to low 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 Lethabo Solar Photovoltaic Facility can be constructed at either of the two proposed sites with acceptable levels of impact on the resident avifauna. The significance of the potential impacts can be further reduced through

selection of Alternative Site 2 due to its smaller footprint size and proximity to the power station.

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 Lethabo solar 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 SABAP 1 & 2 SPECIES LIST

COMMON NAME	SCIENTIFIC NAME	REGIONAL STATUS	GLOBAL STATUS	ENDEMISM	SABAP 1	SABAP 2
Apalis, Bar-throated	Apalis thoracica				x	
Avocet, Pied	Recurvirostra avosetta				x	x
Babbler, Arrow-marked	Turdoides jardineii				x	
Barbet, Acacia Pied	Tricholaema leucomelas				x	
Barbet, Black-collared	Lybius torquatus				x	x
Barbet, Crested	Trachyphonus vaillantii				x	x
Bee-eater, European	Merops apiaster					x
Bee-eater, Little	Merops pusillus				x	
Bee-eater, White-fronted	Merops bullockoides					x
Bishop, Southern Red	Euplectes orix				x	x
Bishop, Yellow	Euplectes capensis				x	
Bishop, Yellow-crowned	Euplectes afer				x	x
Bittern, Little	Ixobrychus minutus				x	
Bokmakierie, Bokmakierie	Telophorus zeylonus				x	x
Boubou, Southern	Laniarius ferrugineus				x	
Bulbul, African Red-eyed	Pycnonotus nigricans				x	x
Bulbul, Dark-capped	Pycnonotus tricolor				x	x
Bunting, Cape	Emberiza capensis				x	
Bunting, Cinnamon-breasted	Emberiza tahapisi				x	
Bunting, Golden-breasted	Emberiza flaviventris				x	
Buttonquail, Kurrichane	Turnix sylvaticus				x	
Buzzard, Jackal	Buteo rufofuscus			near endemic	x	
Buzzard, Steppe	Buteo vulpinus				x	x
Canary, Black-throated	Crithagra atrogularis				x	x
Canary, Cape	Serinus canicollis				x	
Canary, Yellow	Crithagra flaviventris				x	x
Canary, Yellow-fronted	Crithagra mozambicus				x	
Chat, Anteating	Myrmecocichla formicivora				x	x
Chat, Familiar	Cercomela familiaris				x	x
Cisticola, Cloud	Cisticola textrix			near endemic	x	x
Cisticola, Desert	Cisticola aridulus				x	x
Cisticola, Lazy	Cisticola aberrans				x	
Cisticola, Levaillant's	Cisticola tinniens				x	x
Cisticola, Rattling	Cisticola chiniana				x	
Cisticola, Wailing	Cisticola lais				x	
Cisticola, Wing-snapping	Cisticola ayresii				x	
Cisticola, Zitting	Cisticola juncidis				x	x
Cliff-Chat, Mocking	Thamnolaea cinnamomeiventris				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
Coucal, Burchell's	Centropus burchellii				x	
Coucal, White-browed	Centropus superciliosus				x	
Courser, Bronze-winged	Rhinoptilus chalcopterus				x	
Courser, Double-banded	Rhinoptilus africanus	NT	LC		x	
Courser, Temminck's	Cursorius temminckii				x	
Crake, African	Crecopsis egregia				x	
Crake, Black	Amaurornis flavirostris				x	
Crane, Blue	Anthropoides paradiseus	NT	VU		x	
Crombec, Long-billed	Sylvietta rufescens				x	
Crow, Cape	Corvus capensis				x	
Crow, Pied	Corvus albus				x	x
Cuckoo, African	Cuculus gularis				x	
Cuckoo, Diderick	Chrysococcyx caprius				x	x
Cuckoo, Jacobin	Clamator jacobinus				x	
Cuckoo, Klaas's	Chrysococcyx klaas				x	
Cuckoo, Red-chested	Cuculus solitarius				x	x
Darter, African	Anhinga rufa				x	x
Dove, Laughing	Streptopelia senegalensis				x	x
Dove, Namaqua	Oena capensis				x	
Dove, Red-eyed	Streptopelia semitorquata				x	x
Dove, Rock	Columba livia				x	x
Duck, African Black	Anas sparsa				x	x
Duck, Comb	Sarkidiornis melanotos				x	
Duck, Fulvous	Dendrocygna bicolor				x	
Duck, Maccoa	Oxyura maccoa	NT	NT		x	

Duck, Mallard	Anas platyrhynchos				x	
Duck, White-backed	Thalassornis leuconotus				x	
Duck, White-faced	Dendrocygna viduata				x	x
Duck, Yellow-billed	Anas undulata				x	x
Eagle, Long-crested	Lophaetus occipitalis					x
Eagle, Wahlberg's	Aquila wahlbergi				x	
Eagle-Owl, Spotted	Bubo africanus				x	x
Eagle-Owl, Verreaux's	Bubo lacteus				x	
Egret, Cattle	Bubulcus ibis				x	x
Egret, Great	Egretta alba				x	
Egret, Little	Egretta garzetta				x	x
Egret, Yellow-billed	Egretta intermedia				x	x
Eremomela, Yellow-bellied	Eremomela icteropygialis				x	
Falcon, Amur	Falco amurensis				x	x
Falcon, Lanner	Falco biarmicus	VU	LC		x	x
Falcon, Red-footed	Falco vespertinus				x	
Finch, Cuckoo	Anomalospiza imberbis				x	
Finch, Red-headed	Amadina erythrocephala				x	x
Finch, Scaly-feathered	Sporopipes squamifrons				x	
Finfoot, African	Podica senegalensis	VU	LC		x	
Firefinch, African	Lagonosticta rubricata				x	
Firefinch, Jameson's	Lagonosticta rhodopareia				x	
Firefinch, Red-billed	Lagonosticta senegala				x	
Fiscal, Common	Lanius collaris				x	x
Fish-Eagle, African	Haliaeetus vocifer				x	
Flamingo, Greater	Phoenicopterus ruber	NT	LC		x	
Flamingo, Lesser	Phoenicopterus minor	NT	NT		x	
Flufftail, Red-chested	Sarothrura rufa				x	
Flycatcher, Fairy	Stenostira scita			near endemic	x	x
Flycatcher, Fiscal	Sigelus silens			near endemic	x	x
Flycatcher, Marico	Bradornis mariquensis				x	
Flycatcher, Spotted	Muscicapa striata				x	x
Francolin, Orange River	Scleroptila levaillantoides				x	
Francolin, Red-winged	Scleroptila levaillantii				x	
Go-away-bird, Grey	Corythaixoides concolor				x	
Godwit, Black-tailed	Limosa limosa		NT		x	
Goose, Egyptian	Alopochen aegyptiacus				x	x
Goose, Spur-winged	Plectropterus gambensis				x	x
Goshawk, Gabar	Melierax gabar				x	
Grass-Owl, African	Tyto capensis	VU	LC		x	
Grassbird, Cape	Sphenoeacus afer			near endemic	x	
Grebe, Black-necked	Podiceps nigricollis				x	
Grebe, Great Crested	Podiceps cristatus				x	
Grebe, Little	Tachybaptus ruficollis				x	x
Greenshank, Common	Tringa nebularia				x	x
Guineafowl, Helmeted	Numida meleagris				x	x
Gull, Grey-headed	Larus cirrocephalus				x	x
Hamerkop, Hamerkop	Scopus umbretta				x	
Harrier, Black	Circus maurus	EN	VU	near endemic	x	
Harrier-Hawk, African	Polyboroides typus				x	
Heron, Black	Egretta ardesiaca				x	
Heron, Black-headed	Ardea melanocephala				x	x
Heron, Goliath	Ardea goliath				x	x
Heron, Green-backed	Butorides striata				x	
Heron, Grey	Ardea cinerea				x	x
Heron, Purple	Ardea purpurea				x	x
Heron, Squacco	Ardeola ralloides				x	
Hobby, Eurasian	Falco subbuteo				x	
Honey-Buzzard, European	Pernis apivorus					x
Honeybird, Brown-backed	Prodotiscus regulus				x	
Honeyguide, Greater	Indicator indicator				x	
Honeyguide, Lesser	Indicator minor				x	
Hoopoe, African	Upupa africana				x	x
House-Martin, Common	Delichon urbicum				x	
Ibis, African Sacred	Threskiornis aethiopicus				x	x
Ibis, Glossy	Plegadis falcinellus				x	x
Ibis, Hadeda	Bostrychia hagedash				x	x
Indigobird, Dusky	Vidua funerea				x	
Indigobird, Village	Vidua chalybeata				x	
Jacana, African	Actophilornis africanus				x	
Kestrel, Greater	Falco rupicoloides				x	

Kestrel, Lesser	Falco naumanni				x	x
Kestrel, Rock	Falco rupicolus				x	
Kingfisher, Brown-hooded	Halcyon albiventris				x	
Kingfisher, Giant	Megaceryle maximus				x	x
Kingfisher, Half-collared	Alcedo semitorquata	NT	LC		x	
Kingfisher, Malachite	Alcedo cristata				x	x
Kingfisher, Pied	Ceryle rudis				x	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	
Korhaan, Northern Black	Afrotis afraoides				x	x
Lapwing, African Wattled	Vanellus senegallus				x	
Lapwing, Blacksmith	Vanellus armatus				x	x
Lapwing, Crowned	Vanellus coronatus				x	x
Lark, Agulhas Clapper	Mirafra marjoriae				x	
Lark, Agulhas Long-billed	Certhilauda brevirostris	NT	NR	near endemic	x	
Lark, Benguela Long-billed	Certhilauda benguelensis				x	
Lark, Cape Clapper	Mirafra apiata			near endemic	x	
Lark, Cape Long-billed	Certhilauda curvirostris			endemic	x	
Lark, Eastern Clapper	Mirafra fasciolata				x	x
Lark, Eastern Long-billed	Certhilauda semitorquata			regional endemic	x	
Lark, Karoo Long-billed	Certhilauda subcoronata				x	
Lark, Melodious	Mirafra cheniana		NT		x	
Lark, Pink-billed	Spizocorys conirostris				x	
Lark, Red-capped	Calandrella cinerea				x	x
Lark, Rufous-naped	Mirafra africana				x	x
Lark, Sabota	Calendulauda sabota				x	
Lark, Spike-heeled	Chersomanes albofasciata				x	
Longclaw, Cape	Macronyx capensis				x	x
Mannikin, Bronze	Spermestes cucullatus					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	x
Martin, Sand	Riparia riparia				x	
Masked-Weaver, Southern	Ploceus velatus				x	x
Moorhen, Common	Gallinula chloropus				x	x
Mousebird, Red-faced	Urocolius indicus				x	x
Mousebird, Speckled	Colius striatus				x	x
Mousebird, White-backed	Colius colius				x	
Myna, Common	Acridotheres tristis				x	x
Neddicky, Neddicky	Cisticola fulvicapilla				x	x
Night-Heron, Black-crowned	Nycticorax nycticorax				x	
Night-Heron, White-backed	Gorsachius leuconotus				x	
Nightjar, Fiery-necked	Caprimulgus pectoralis				x	
Nightjar, Freckled	Caprimulgus tristigma				x	
Olive-Pigeon, African	Columba arquatrix				x	x
Oriole, Black-headed	Oriolus larvatus				x	
Oriole, Eurasian Golden	Oriolus oriolus				x	
Osprey, Osprey	Pandion haliaetus				x	
Ostrich, Common	Struthio camelus				x	x
Owl, Barn	Tyto alba				x	
Owl, Marsh	Asio capensis				x	x
Painted-snipe, Greater	Rostratula benghalensis	VU	LC		x	
Palm-Swift, African	Cypsiurus parvus				x	x
Paradise-Flycatcher, African	Terpsiphone viridis				x	x
Paradise-Whydah, Long-tailed	Vidua paradisaea				x	
Parakeet, Rose-ringed	Psittacula krameri				x	
Pelican, Pink-backed	Pelecanus rufescens	VU	LC		x	
Petronia, Yellow-throated	Petronia superciliaris				x	
Pigeon, Speckled	Columba guinea				x	x
Pipit, African	Anthus cinnamomeus				x	x
Pipit, Buffy	Anthus vaalensis				x	
Pipit, Long-billed	Anthus similis				x	
Pipit, Plain-backed	Anthus leucophrys				x	
Pipit, Striped	Anthus lineiventris				x	
Plover, Chestnut-banded	Charadrius pallidus	NT	NT		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	x
Prinia, Tawny-flanked	Prinia subflava				x	x
Puffback, Black-backed	Dryoscopus cubla				x	
Pytilia, Green-winged	Pytilia melba				x	
Quail, Common	Coturnix coturnix				x	
Quail, Harlequin	Coturnix delegorguei				x	
Quailfinch, African	Ortygospiza atricollis				x	x
Quelea, Red-billed	Quelea quelea				x	x
Rail, African	Rallus caerulescens				x	
Reed-Warbler, African	Acrocephalus baeticatus				x	x
Reed-Warbler, Great	Acrocephalus arundinaceus				x	
Robin-Chat, Cape	Cossypha caffra				x	x
Rock-Thrush, Sentinel	Monticola explorator				x	
Roller, European	Coracias garrulus	NT	NT		x	x
Roller, Lilac-breasted	Coracias caudatus				x	
Ruff, Ruff	Philomachus pugnax				x	x
Rush-Warbler, Little	Bradypterus baboecala				x	x
Sandgrouse, Namaqua	Pterocles namaqua				x	
Sandpiper, Common	Actitis hypoleucos				x	x
Sandpiper, Curlew	Calidris ferruginea				x	
Sandpiper, Marsh	Tringa stagnatilis				x	
Sandpiper, Wood	Tringa glareola				x	x
Scimitarbill, Common	Rhinopomastus cyanomelas				x	
Scops-Owl, Southern White-faced	Ptilopsus granti				x	
Scrub-Robin, Kalahari	Cercotrichas paena				x	
Secretarybird	Sagittarius serpentarius	VU	VU		x	
Seedeater, Streaky-headed	Crithagra gularis				x	
Shelduck, South African	Tadorna cana				x	x
Shikra, Shikra	Accipiter badius				x	
Shoveler, Cape	Anas smithii				x	
Shrike, Crimson-breasted	Laniarius atrococcineus				x	
Shrike, Lesser Grey	Lanius minor				x	
Shrike, Magpie	Corvinella melanoleuca				x	
Shrike, Red-backed	Lanius collurio				x	
Snipe, African	Gallinago nigripennis				x	
Sparrow, Cape	Passer melanurus				x	x
Sparrow, House	Passer domesticus				x	x
Sparrow, Northern Grey-headed	Passer griseus				x	
Sparrow, Southern Grey-headed	Passer diffusus				x	x
Sparrow-Weaver, White-browed	Plocepasser mahali				x	x
Sparrowhawk, Black	Accipiter melanoleucus					x
Sparrowhawk, Little	Accipiter minullus				x	
Sparrowlark, Chestnut-backed	Eremopterix leucotis				x	
Sparrowlark, Grey-backed	Eremopterix verticalis				x	
Spoonbill, African	Platalea alba				x	x
Spurfowl, Natal	Pternistis natalensis				x	
Spurfowl, Swainson's	Pternistis swainsonii				x	x
Starling, Cape Glossy	Lamprotornis nitens				x	x
Starling, Pied	Spreo bicolor			regional endemic	x	x
Starling, Red-winged	Onychognathus morio				x	x
Starling, Wattled	Creatophora cinerea				x	x
Stilt, Black-winged	Himantopus himantopus				x	
Stint, Little	Calidris minuta				x	x
Stonechat, African	Saxicola torquatus				x	x
Stork, Abdim's	Ciconia abdimii	NT	LC		x	
Stork, Black	Ciconia nigra	VU	LC		x	
Stork, White	Ciconia ciconia				x	x
Stork, Yellow-billed	Mycteria ibis	EN	LC		x	
Sunbird, Amethyst	Chalcomitra amethystina				x	x
Sunbird, Greater Double-collared	Cinnyris afer			regional endemic	x	x
Sunbird, Malachite	Nectarinia famosa				x	
Sunbird, Marico	Cinnyris mariquensis				x	
Sunbird, White-bellied	Cinnyris talatala				x	x
Swallow, Barn	Hirundo rustica				x	x
Swallow, Greater Striped	Hirundo cucullata				x	x

Swallow, Pearl-breasted	Hirundo dimidiata				x	
Swallow, Red-breasted	Hirundo semirufa				x	
Swallow, White-throated	Hirundo albigularis				x	x
Swamp-Warbler, Lesser	Acrocephalus gracilirostris				x	x
Swamphen, African Purple	Porphyrio madagascariensis				x	
Swift, African Black	Apus barbatus				x	
Swift, Alpine	Tachymarptis melba				x	
Swift, Common	Apus apus				x	
Swift, Horus	Apus horus				x	
Swift, Little	Apus affinis				x	x
Swift, White-rumped	Apus caffer				x	x
Tchagra, Brown-crowned	Tchagra australis				x	
Teal, Cape	Anas capensis				x	
Teal, Hottentot	Anas hottentota				x	
Teal, Red-billed	Anas erythrorhyncha				x	x
Tern, Caspian	Sterna caspia	VU	LC		x	
Tern, Whiskered	Chlidonias hybrida				x	x
Tern, White-winged	Chlidonias leucopterus				x	
Thick-knee, Spotted	Burhinus capensis				x	
Thrush, Groundscraper	Psophocichla litsipsirupa				x	
Thrush, Karoo	Turdus smithi			near endemic	x	x
Thrush, Kurrichane	Turdus libonyanus				x	
Thrush, Olive	Turdus olivaceus				x	
Tit, Ashy	Parus cinerascens				x	
Tit-Babbler, Chestnut-vented	Parisoma subcaeruleum				x	x
Turnstone, Ruddy	Arenaria interpres				x	
Turtle-Dove, Cape	Streptopelia capicola				x	x
Vulture, Cape	Gyps coprotheres	EN	VU		x	
Wagtail, African Pied	Motacilla aguimp				x	
Wagtail, Cape	Motacilla capensis				x	x
Wagtail, Yellow	Motacilla flava				x	
Warbler, Garden	Sylvia borin				x	
Warbler, Icterine	Hippolais icterina				x	
Warbler, Marsh	Acrocephalus palustris				x	
Warbler, Sedge	Acrocephalus schoenobaenus				x	
Warbler, Willow	Phylloscopus trochilus				x	
Waxbill, Black-faced	Estrilda erythronotos				x	
Waxbill, Blue	Uraeginthus angolensis				x	
Waxbill, Common	Estrilda astrild				x	x
Waxbill, Orange-breasted	Amandava subflava				x	x
Waxbill, Violet-eared	Granatina granatina				x	
Weaver, Cape	Ploceus capensis			near endemic	x	
Weaver, Thick-billed	Amblyospiza albifrons					x
Weaver, Village	Ploceus cucullatus				x	
Wheatear, Capped	Oenanthe pileata				x	x
Wheatear, Mountain	Oenanthe monticola				x	x
White-eye, Cape	Zosterops virens			near endemic	x	x
White-eye, Orange River	Zosterops pallidus				x	
Whitethroat, Common	Sylvia communis				x	
Whydah, Pin-tailed	Vidua macroura				x	x
Whydah, Shaft-tailed	Vidua regia				x	
Widowbird, Long-tailed	Euplectes progne				x	x
Widowbird, Red-collared	Euplectes ardens				x	x
Widowbird, White-winged	Euplectes albonotatus				x	x
Wood-Hoopoe, Green	Phoeniculus purpureus				x	x
Woodpecker, Cardinal	Dendropicos fuscescens				x	x
Wryneck, Red-throated	Jynx ruficollis				x	x

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

COMMON NAME	SCIENTIFIC NAME	ALT SITE 1	ALT SITE 2	WT	VT	INCIDENTAL
Apalis, Bar-throated	Apalis thoracica	x		x	x	
Bishop, Southern Red	Euplectes orix	x	x	x		
Canary, Yellow-fronted	Crithagra mozambica	x		x	x	
Cisticola, Zitting	Cisticola juncidis	x	x	x		
Crow, Pied	Corvus albus					x
Dove, Laughing	Streptopelia senegalensis	x	x	x	x	x
Dove, Red-eyed	Streptopelia semitorquata	x		x		
Fiscal, Common	Lanius collaris	x	x	x	x	
Francolin, Orange River	Scleroptila levaillantoides	x			x	x
Goose, Egyptian	Alopochen aegyptiacus				x	
Goose, Spur-winged	Plectropterus gambensis				x	
Guineafowl, Helmeted	Numida meleagris	x	x	x	x	x
Heron, Black-headed	Ardea melanocephala		x	x		
Ibis, Hadeda	Bostrychia hagedash					x
Kite, Black-shouldered	Elanus caeruleus	x		x		
Korhaan, Northern Black	Afrotis afraoides	x		x	x	x
Lapwing, Blacksmith	Vanellus armatus	x	x	x		x
Lapwing, Crowned	Vanellus coronatus	x		x	x	x
Lark, Red-capped	Calandrella cinerea	x		x		
Lark, Rufous-naped	Mirafra africana	x		x		
Longclaw, Cape	Macronyx capensis	x	x	x		
Martin, Brown-throated	Riparia paludicola	x	x	x		
Masked-weaver, Southern	Ploceus velatus	x	x	x	x	x
Mousebird, Speckled	Colius striatus	x		x		
Myna, Common	Acridotheres tristis	x		x	x	x
Neddicky, Neddicky	Cisticola fulvicapilla	x		x		
Pipit, African	Anthus cinnamomeus	x	x	x	x	
Prinia, Black-chested	Prinia flavicans	x		x	x	
Quail, Common	Coturnix coturnix	x		x	x	
Sparrow, Cape	Passer melanurus	x		x	x	
Sparrow, House	Passer domesticus	x		x	x	x
Starling, Cape Glossy	Lamprotornis nitens		x	x		
Stonechat, African	Saxicola torquatus	x	x	x	x	x
Swallow, White-throated	Hirundo albigularis	x	x	x		
Swamp-warbler, Lesser	Acrocephalus gracilirostris	x		x		
Swift, Little	Apus affinis	x				
Turtle-dove, Cape	Streptopelia capicola	x	x	x	x	x
Wheatear, Capped	Oenanthe pileata	x		x	x	
Widowbird, Long-tailed	Euplectes progne	x	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 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	