DEVELOPMENT OF THE LUCKHOFF SOLAR 1, 2 AND 3 PHOTOVOLTAIC SOLAR ENERGY FACILITIES, NEAR LUCKHOFF, FREE STATE PROVINCE

Avifauna Scoping Report

December 2022

Compiled by:
Pachnoda Consulting CC
Lukas Niemand Pr.Sci.Nat

PO Box 72847
Lynwood Ridge
Pretoria
0040

Prepared for:
Luckhoff Solar 1 (Pty) Ltd;
Luckhoff Solar 2 (Pty) Ltd; and
Luckhoff Solar 3 (Pty) Ltd

EXECUTIVE SUMMARY

Pachnoda Consulting cc was requested by Environamics (Pty) Ltd on behalf of Luckhoff Solar 1 (Pty) Ltd, Luckhoff Solar 2 (Pty) Ltd and Luckhoff Solar 3 (Pty) Ltd to compile an avifauna scoping report for the proposed Luckhoff Solar 1, 2 and 3 Photovoltaic Solar Energy Facilities, each with a contracted capacity of up to 240MW. The Luckhoff PV facilities are based approximately 3-10km north of the town of Luckhoff, Free State Province.

The objectives of this phase of the project were to obtain a basic overview of the variation and general status of the avifaunal habitat types and expected bird species likely to be affected by the proposed project.

Four avifaunal habitat types were identified on the study area and surroundings, ranging from natural Northern Upper Karoo shrubland with bush clump mosaics, ephemeral drainage systems and seeps and artificial livestock watering points. A total of 152 bird species have been recorded within the study area, including seven Red listed species (threatened and near threatened species): Blue Crane (*Anthropoides paradiseus* – globally Vulnerable), African Rock Pipit (*Anthus crenatus* – globally near threatened), Maccoa Duck (*Oxyura maccoa* – globally endangered), Cape Vulture (*Gyps coprotheres* – globally vulnerable), White-backed Vulture (*Gyps africanus* – globally critically endangered), Ludwig's Bustard (*Neotis ludwigii* – globally endangered) and Secretarybird (*Sagittarius serpentarius* – globally endangered).

The main potential impacts associated with the proposed PV solar facility are expected to be the following:

- The loss of habitat and subsequent displacement of bird species due to the ecological footprint required during construction, especially if any of the proposed development footprint areas correspond to ephemeral drainage systems or habitat where threatened large-bodied bird species (e.g. Secretarybird and Ludwig's Bustard) occurs (to be confirmed during the EIA/baseline surveys).
- Direct interaction (collision trauma) by birds with the surface infrastructure (photovoltaic panels) caused by polarised light pollution and/or waterbirds colliding with the panels (as they are mistaken for waterbodies), especially during periods of inundation.
- Collision with associated infrastructure (mainly overhead powerlines and reticulation).

In addition, a total of 43 collision-prone bird species have been recorded from the study area (sensu atlas data), of which 17 species were waterbird and shorebird taxa and another 16 species were birds of prey. However, the respective habitat types also provided habitat for at least 39 % of the regional near-endemic bird composition.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

DECLARATION OF INDEPENDENCE

I, Lukas Niemand (Pachnoda Consulting CC) declare that:

- I act as the independent specialist in this application to Environamics (Pty) Ltd, Luckhoff Solar 1 (Pty) Ltd, Luckhoff Solar 2 (Pty) Ltd and Luckhoff Solar 3 (Pty) Ltd;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have no vested financial, personal or any other interest in the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All the particulars furnished by me in this form are true and correct.

Lukas Niemand (Pr.Sci.Nat)
18 December 2022

Lukas Niemand is registered with The South African Council for Natural Scientific Professionals (400095/06) with more than 20 years of experience in ecological-related assessments and more than 15 years in the field of bird interactions with electrical and renewable energy infrastructure. He has conducted numerous ecological and avifaunal impact assessments including Eskom Transmission projects, hydro-electric schemes, solar farms and other activities in South Africa and other African and Middle East countries (Mozambique, Burundi, Malawi, Liberia, Guinea, Gabon, Tanzania, Kenya, Republic of Congo, Ethiopia and Saudi Arabia).

1. INTRODUCTION

1.1 Project Description

Pachnoda Consulting cc was requested by Environamics (Pty) Ltd on behalf of Luckhoff Solar 1 (Pty) Ltd, Luckhoff Solar 2 (Pty) Ltd and Luckhoff Solar 3 (Pty) Ltd to compile an avifauna scoping report for the proposed Luckhoff Solar 1, 2 and 3 Photovoltaic Solar Energy Facilities, each with a contracted capacity of up to 240MW. The Luckhoff PV facilities are based approximately 3-10km north of the town of Luckhoff, within the Letsemeng Local Municipality, and within the Xhariep District Municipality, Free State Province (Figure 1, Figure 2, and Figure 3).

The solar facilities will each be located on a development footprint of up to 480 ha, which will include the PV arrays, associated infrastructure and grid connection infrastructure. The infrastructure associated with each PV facility includes:

- PV modules and mounting structures;
- Inverters and transformers;
- Battery Energy Storage System (BESS);
- Site and internal access roads (up to 8m wide);
- Operation and Maintenance buildings including a gate house and security building, control centre, offices, warehouses and workshops for storage and maintenance; and
- Temporary and permanent laydown area.

The PV facilities will be located on the following farms (Figure 1, Figure 2 and Figure 3):

Solar Facility	Farm Name	Nearest Town
Luckhoff Solar 1	Rorich's Hulp No. 505	The town of Luckhoff is located approximately 3km south
Luckhoff Solar 2	Mooidoorns No. 1224	The town of Luckhoff is located approximately 5km south
Luckhoff Solar 3	Farm Rorich's Hulp No. 505, Farm Vijeboom No. 714 Farm Klein Palmietfontein No. 370	The town of Luckhoff is located approximately 3km south

In order to evacuate the energy generated by the facilities to the national grid, Luckhoff Solar 1 (Pty) Ltd is proposing to develop the following Electrical Grid Infrastructure (EGI):

- A collector switching station (up to 132kV);

- A ~2.5 km 132 kV single/double circuit overhead powerline linking the collector switching station to the proposed Luckhoff Main Transmission Substation (MTS)(see below);
- A new 132 kV / 400 kV MTS; and
- Three 400kV Loop-in-Loop Out power lines from the existing Eskom powerlines (Hydra/Perseus 2, Hydra/Perseus 3 and Beta/Hydra 1) to the MTS.

To avoid areas of potential sensitivity and to ensure that potential detrimental environmental impacts are minimised as far as possible, the developer will identify a suitable development footprint within a 300m wide assessment corridor (expanding up to ~ 1 km at the proposed Luckhoff MTS and LILO's) to site the EGI.

1.2 Terms of Reference

The main aim of this scoping exercise was to investigate the avifaunal attributes of the proposed PV facilities by means of a desktop analysis of GIS based information and third-party datasets.

The terms of reference for this scoping report are to:

- conduct an assessment on a screening level based on available information pertinent to the ecological and avifaunal attributes on the study area and immediate surroundings;
- conduct an assessment of all information on a screening level in order to present the following results:
    - typify the regional vegetation and avifaunal macro-habitat parameters that will be affected by the proposed project;
    - provide an indication on the occurrence of threatened, near-threatened, endemic and conservation important bird species likely to be affected by the proposed project;
    - provide an indication of sensitive areas or bird habitat types corresponding to the study site and immediate surroundings;
    - highlight areas of concern or "hotspot" areas;
    - identify potential impacts that are considered pertinent to the proposed development footprints;
    - highlight gaps of information in terms of the avifaunal environment; and
    - recommend further studies to be conducted as part of the Environmental Impact Assessment (EIA) phase.

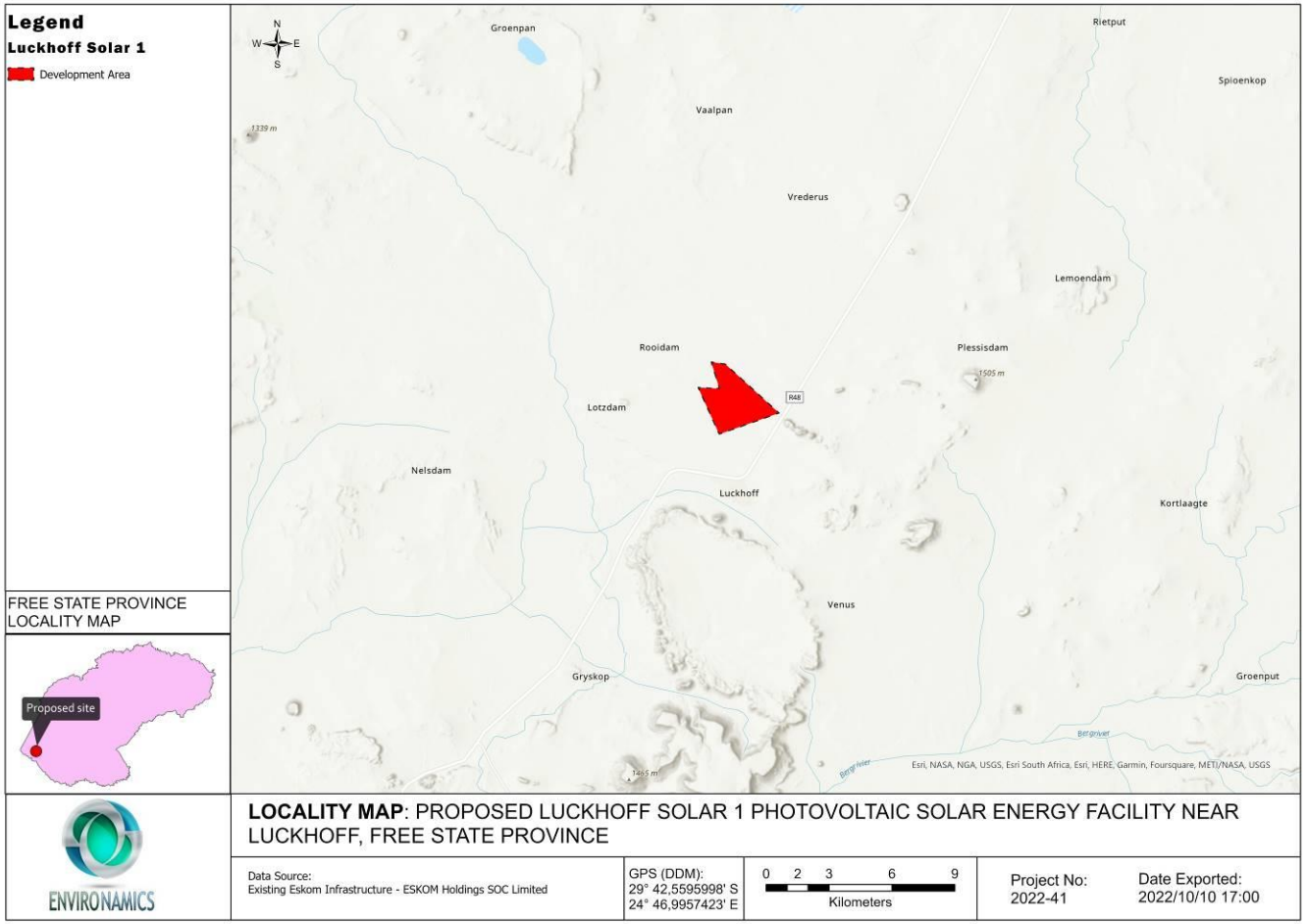

Figure 1: A map illustrating the geographic position of the proposed Luckhoff Solar 1 Energy facility.

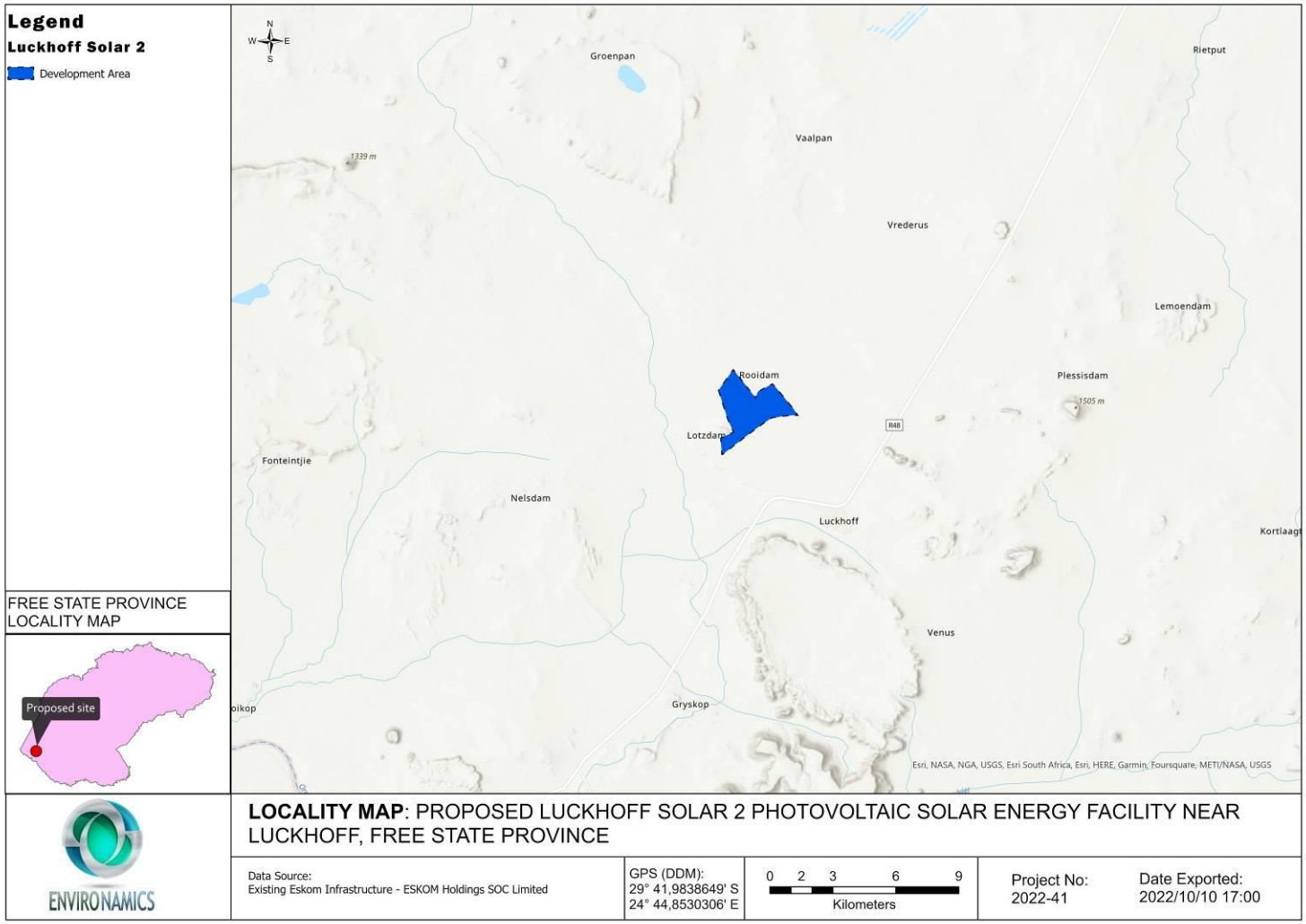

Figure 2: A map illustrating the geographic position of the proposed Luckhoff Solar 2 Energy facility.

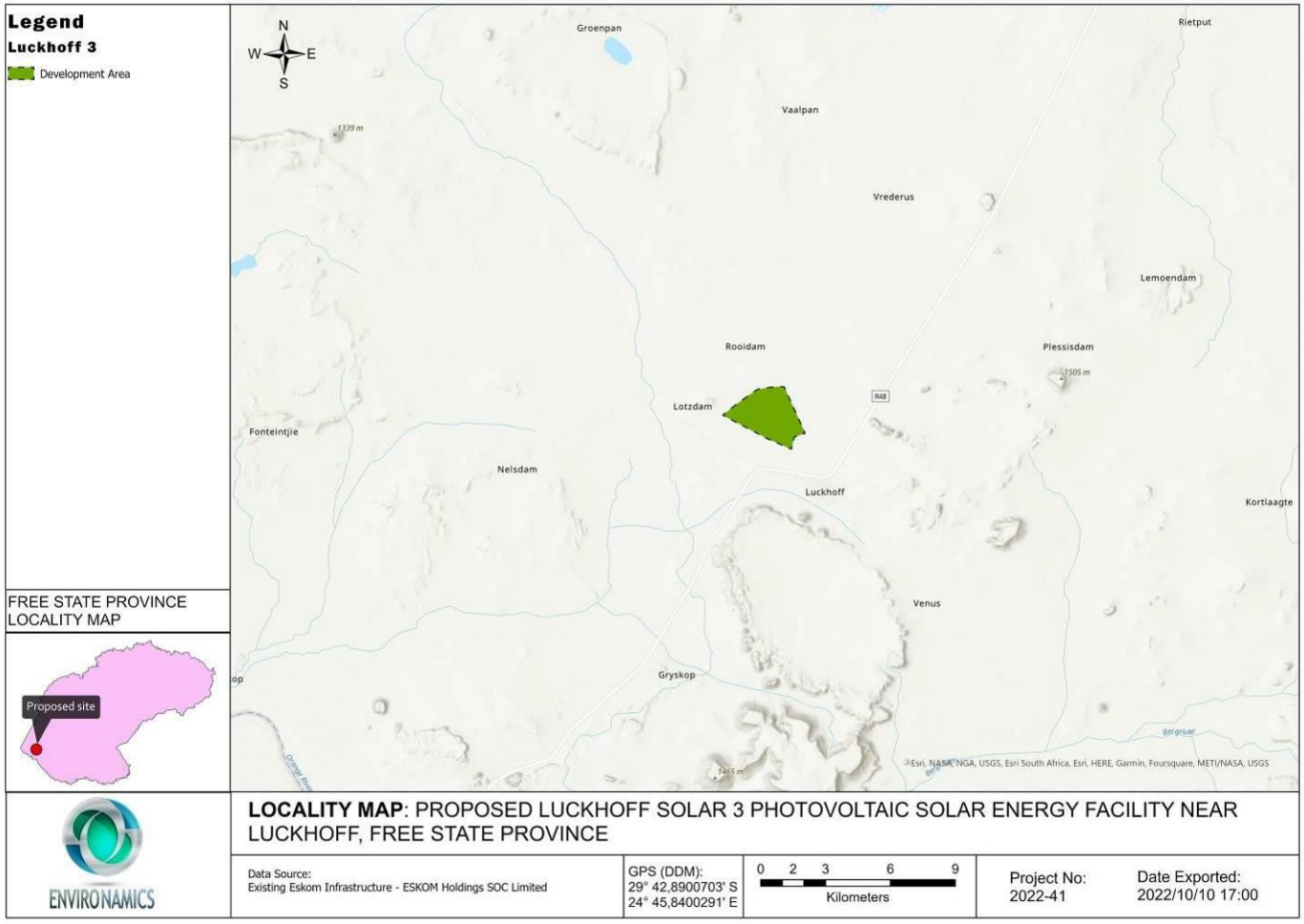

Figure 3: A map illustrating the geographic position of the proposed Luckhoff Solar 3 Energy facility.

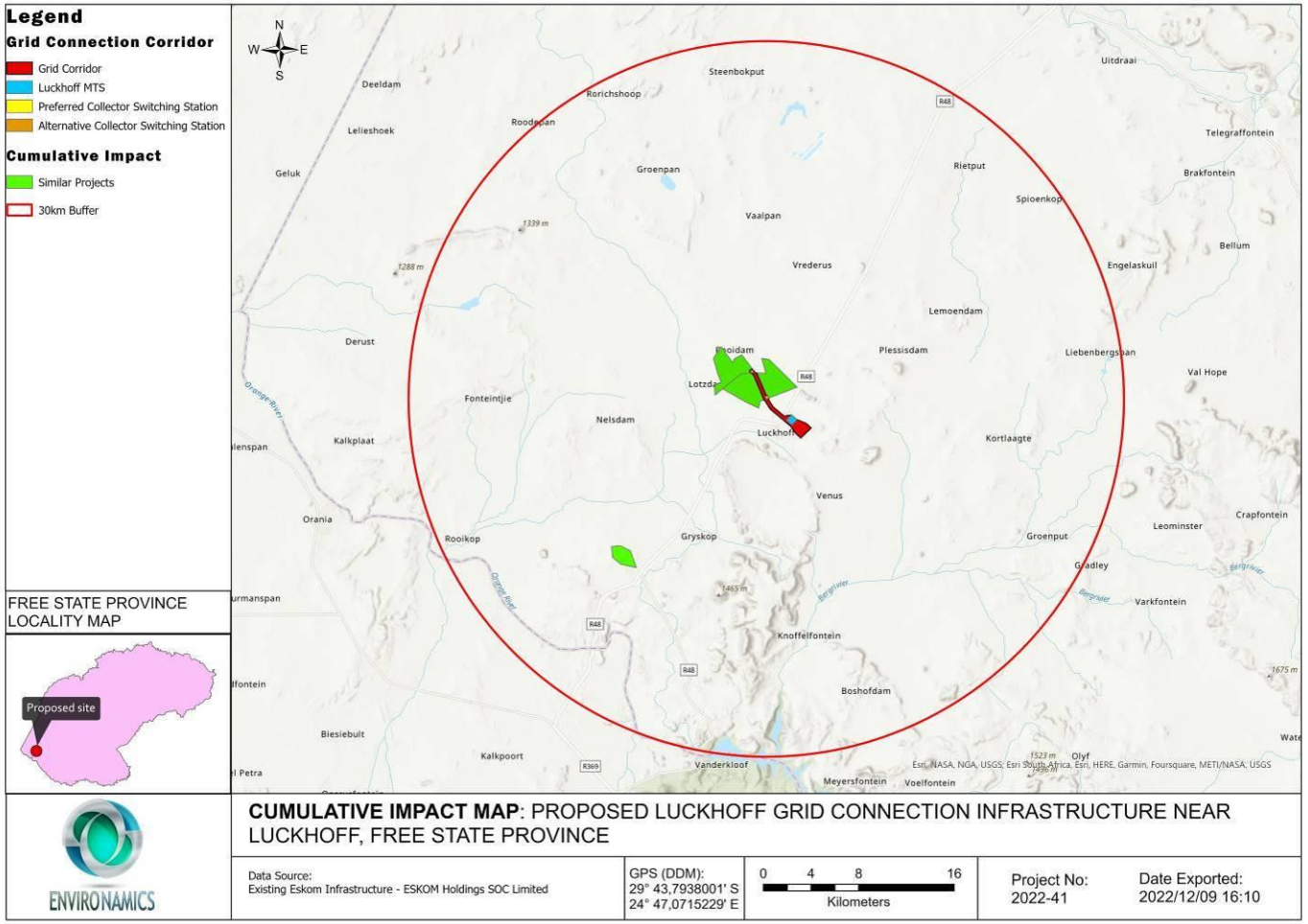

Figure 4: A map illustrating the proposed Luckhoff grid connection infrastructure.

2. METHODS & APPROACH

The objectives of this phase of the project were to obtain a basic overview of the variation and general status of the avifaunal habitat types and expected bird species likely to be affected by the proposed project.

Also take note that the current report put emphasis on the avifaunal community as a key indicator group on the proposed study site and immediate surroundings, thereby aiming to describe the preliminary conservation significance of the ecosystems in the area. Therefore, the occurrence of certain bird species and their relative abundances (to be determined during the EIA although herewith deduced from reporting rates) could determine the outcome of the ecological sensitivity of the area and the subsequent layout of the proposed solar facility infrastructure.

The information provided in this report was principally sourced from the following sources/observations:

- relevant literature – see section below;
- personal observations from similar habitat types in close proximity to the project area.

2.1 Literature survey and Database acquisition

A desktop and literature review of the area under investigation was commissioned to collate as much information as possible prior to the detailed baseline survey. Literature consulted primarily makes use of small-scale datasets that were collected by citizen scientists and are located at various governmental and academic institutions (e.g. Animal Demography Unit & SANBI). These include (although are not limited to) the following:

- Hockey *et al*. (2005) for general information on bird identification and life history attributes.
- Marnewick *et al.* (2015) was consulted for information regarding the biogeographic affinities of selected bird species that could be present on the study area.
- The conservation status of bird species was categorised according to the global IUCN Red List of threatened species (IUCN, 2022) and the regional conservation assessment of Taylor *et al.* (2015).
- Distributional data was sourced from the South African Bird Atlas Project (SABAP1) and verified against Harrison et al. (1997) for species corresponding to quarter-degree grid cells (QDGCs) 2924DA (Rooipanville) and 2924DB (Luckhoff North) (Figure 5). The information was then modified according to the prevalent habitat types present on the study area. The SABAP1 data provides a “snapshot” of the abundance and composition of species recorded within a quarter degree grid cell (QDGC) which was the sampling unit chosen (corresponding to an area of approximately 15 min

latitude x 15 min longitude). It should be noted that the atlas data makes use of reporting rates that were calculated from observer cards submitted by the public as well as citizen scientists. It therefore provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991.

- Additional distributional data was also sourced from the SABAP2 database (http://www.sabap2.birdmap.africa). The information was then modified according to the prevalent habitat types present on the study area. Since bird distributions are dynamic (based on landscape changes such as fragmentation and climate change), SABAP2 was born (and launched in 2007) from SABAP1 with the main difference being that all sampling is done at a finer scale known as pentad grids (5 min latitude x 5 min longitude, equating to 9 pentads within a QDGC). Therefore, the data is more site-specific, recent and more comparable with observations made during the site visit (due to increased standardisation of data collection). The pentad grids relevant to the current project are 2940_2440 and 2940_2445 (although the surrounding grids were also scrutinised to obtain information relevant to the potential occurrence of threatened and near threatened species; Figure 6).
- The choice of scientific nomenclature, taxonomy and common names were recommended by the International Ornithological Committee (the IOC World Bird List v. 12.1), unless otherwise specified (see www.worldbirdnames.org as specified by Gill et al, 2022).
- The best practice guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa were also consulted (Jenkins *et al.,* 2017).
- Additional information regarding bird-power line interactions was provided by the author's own personal observations.

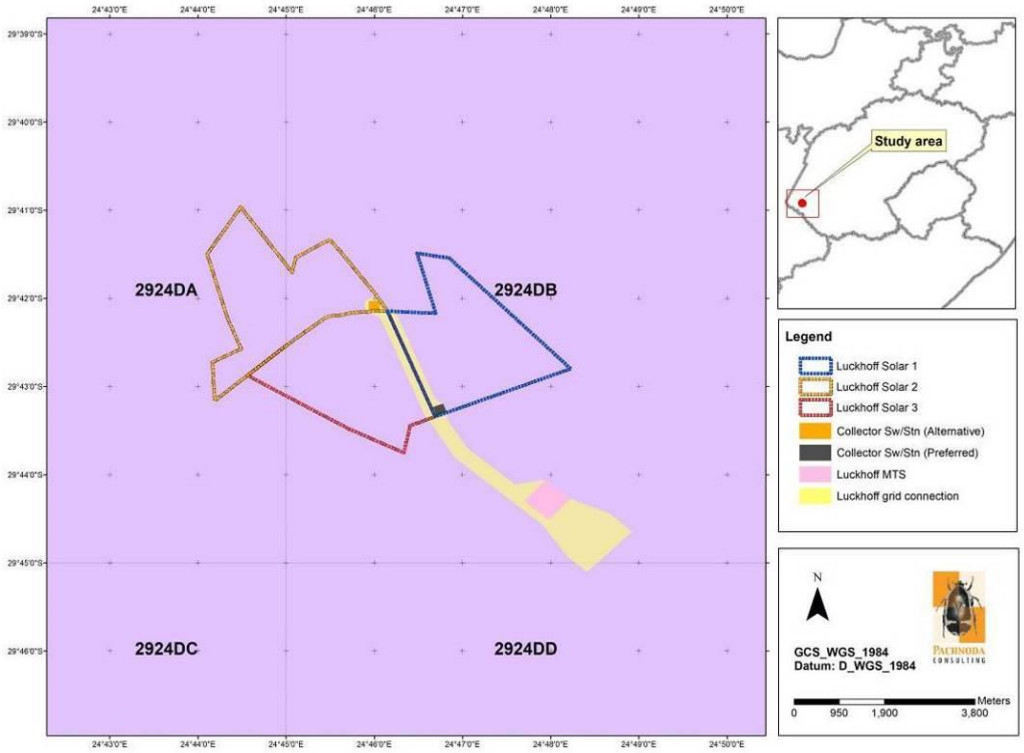

Figure 5: A map illustrating the quarter-degree grid cells that were investigated for this project.

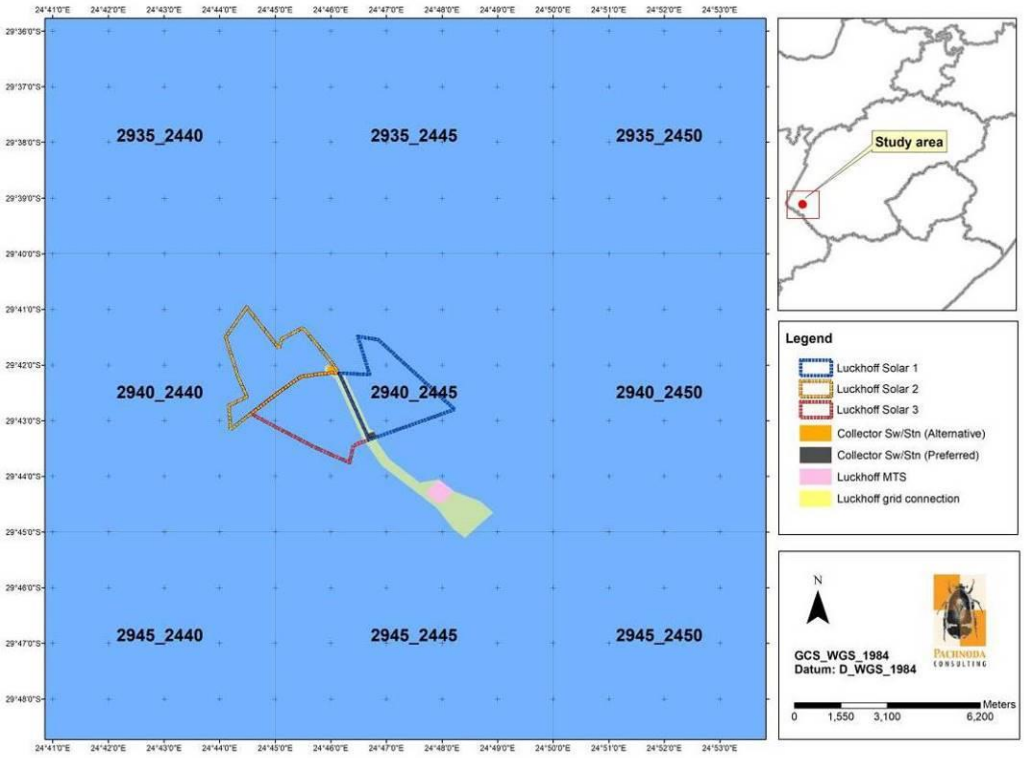

Figure 6: A map illustrating the pentad grids that were investigated for this project.

2.2 Preliminary Sensitivity Analysis

A preliminary sensitivity map was compiled based on the outcome of a desktop analysis.

The ecological sensitivity of any piece of land is based on its inherent ecosystem service (e.g. wetlands) and overall preservation of biodiversity.

2.3.1 Ecological Function

Ecological function relates to the degree of ecological connectivity between systems within a landscape matrix. Therefore, systems with a high degree of landscape connectivity amongst one another are perceived to be more sensitive and will be those contributing to ecosystem service (e.g. wetlands) or the overall preservation of biodiversity.

2.3.2 Avifaunal Importance

Avifaunal importance relates to species diversity, endemism (unique species or unique processes) and the high occurrence of threatened and protected species or ecosystems protected by legislation.

2.3.3 Sensitivity Scale

- *High* – Sensitive ecosystems with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered important for the maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems OR with high species diversity and usually provide suitable habitat for a number of threatened or rare species. These areas should preferably be protected;
- *Medium* – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems OR ecosystems with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species; and
- *Low* – Degraded and highly disturbed/transformed systems with little ecological function and are generally very poor in species diversity (most species are usually exotic or weeds).

2.3 Limitations

To obtain a comprehensive understanding of the diversity and dynamics of avifaunal community on the study area, as well as the status of endemic, rare or threatened species in the area, detailed assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to the fact that the findings in this report were based on a scoping/screening assessment, long-term studies were not feasible and inferred interpretations were mostly based on ad hoc observations.

It should also be realised that bird distribution patterns fluctuate widely in response to environmental conditions (e.g. local rainfall patterns, nomadism, migration patterns, seasonality), meaning that a composition noted at a particular moment in time will differ during another time period at the same locality. For this reason two surveys will be conducted during the data collection (corresponding to the austral wet and dry season).

Due to the scope of the work presented during a scoping assessment, a detailed investigation of the avifaunal community in the area were not possible and is not perceived as part of the Terms of Reference for a scoping/screening level exercise.

Furthermore, additional information may become known during a later stage of the process or development. This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from the surveys or requests made to them at the time of this report.

The following assumptions are relevant to the literature survey and database acquisition phase:

- It is assumed that third party information (obtained from government, academic/research institution, non-governmental organisations) is accurate and true;
- Some of the datasets are out of date and therefore extant distribution ranges may have shifted although these datasets could provide insight into historical distribution ranges of relevant species;
- The datasets are mainly small-scale and could not always consider azonal habitat types that may be present on the study area (e.g. small dams, pans and depressions). In addition, these datasets encompass surface areas larger than the study area that could include habitat types and species that is not present on the study area. Therefore, the potential to overestimate species richness is highly likely while it is also possible that certain cryptic or specialist species could have been overlooked in the past;

- Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town were only recently initiated and therefore incomplete; and
- In addition, the study site is under private ownership and primarily inaccessible to the public. Since most of the species distribution ranges concerning the relevant datasets are subject to observations made by the public, it is likely that many bird species are overlooked or not formally catalogued for the area.

3. PRELIMINARY RESULTS AND DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Locality

The proposed solar energy facilities (hereafter referred to as “the cluster”) will be located north of the town of Luckhoff in the south-western part of the Free State Province (see Figure 1, Figure 2 and Figure 3).

3.2 Regional Vegetation Description

The proposed cluster corresponds to the Nama-Karoo Biome and more particularly to the Upper Karoo Bioregion as defined by Mucina & Rutherford (2006). It comprehends an ecological type known as the Northern Upper Karoo (Mucina & Rutherford, 2006) (Figure 7).

From an avifaunal perspective it is evident that bird diversity is positively correlated with vegetation structure, and floristic richness is not often regarded to be a significant contributor of patterns in bird abundance and their spatial distributions. Although grassland and dwarf karroid vegetation are generally poor in woody plant species, and subsequently support lower bird richness values, it is often considered as an important habitat for many terrestrial bird species such as larks, pipits, korhaans, cisticolas, widowbirds including large terrestrial birds such as Secretarybirds, cranes and storks. Many of these species are also endemic to South Africa and display particularly narrow distribution ranges. Due to the restricted spatial occurrence of the Nama-Karoo Biome and severe habitat transformation, many of the bird species that are restricted to arid grasslands and open karroid vegetation are also threatened or experiencing declining population sizes.

Northern Upper Karoo is confined to the Northern Cape and Free State Provinces from Prieska, Vosburg and Carnavon in the west to Petrusville and Petrusberg in the east. It is typified by shrubland dominated by dwarf karoo shrubs and grasses including *Senegalia mellifera* and some other low trees.

The Northern Upper Karoo is **Least Concern** with none conserved within statutory conservation areas. Approximately 4% of this vegetation has been cleared for cultivation, which is also the highest proportion of a vegetation type that has been cleared in the Nama-Karoo. *Prosopis glandulosa* is regarded as one of the most important invasive plant species in the region, which is also widely distributed within the Northern Upper Karoo.

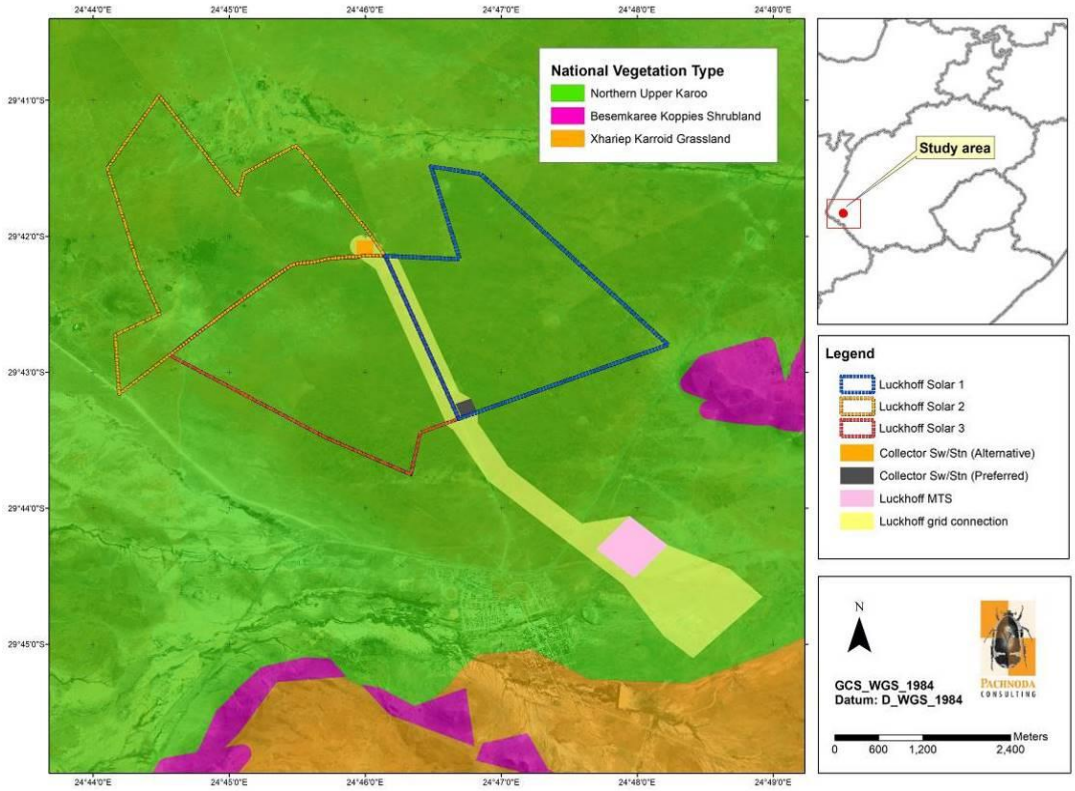

Figure 7: A satellite image illustrating the regional vegetation type corresponding to the study site and immediate surroundings. Vegetation type categories were defined by Mucina & Rutherford (2006; updated 2012).

3.3 Land cover, land use and existing infrastructure.

According to the South African National dataset of 2013-2014 (Geoterrainimage, 2015) the study site comprehends the following land cover categories (Figure 8):

Natural areas:

- Grassland;
- Low shrubland; and
- Thicket.

Transformed areas:

- Bare and none vegetated.
- Built-up land; and
- Alien Plantations.

From the land cover dataset it is evident that most of the study area is predominantly covered in natural shrubland which is part of the Northern Upper Karoo vegetation type. However, some build-up areas occur in near the Luckhoff MTS with dense thicket and alien plantations (mainly Eucalyptus groves) located on the proposed

Luckhoff Solar 3 facility. The majority of the study area (consisting of natural grassland and shrubland) is primarily vacant and used for livestock grazing. Note that a number of large ephemeral depressions and drainage lines are located west and south of the study area, which could attract large number of waterbird numbers when inundated.

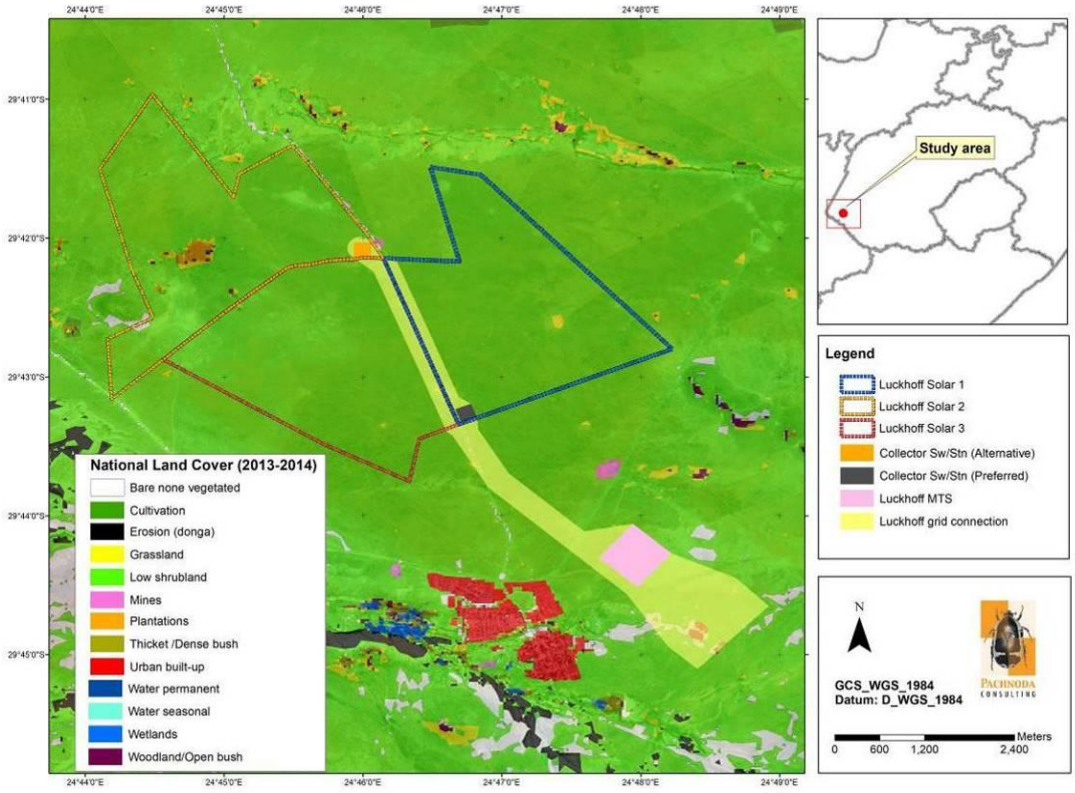

Figure 8: A map illustrating the land cover classes (Geoterrainimage, 2015) corresponding to the proposed study area.

3.4 Conservation Areas, Protected Areas and Important Bird Areas

The study area does not coincide with any statutory/formal conservation area or Important Bird and Biodiversity Area (IBA). The nearest formal conservation areas to the proposed study area is the Platberg-Karoo Conservancy (IBA SA 037), which is located 22 km south of the project area. The entire conservancy is located in the Northern Cape Province south of the Orange River. In addition, the Rolfontein Nature Reserve which lies along the Vanderkloof Dam is located approximately 25km south of the study area.

3.5 Annotations on the National Web-Based Environmental Screening Tool

Regulation 16(1)(v) of the Environmental Impact Assessment Regulations, 2014 (EIA Regulations) provides that an applicant for Environmental Authorisation is required to submit a report generated by the Screening Tool as part of its application. On 5 July

2019, the Minister of Environmental Affairs, Forestry and Fisheries published a notice in the Government Gazette giving notice that the use of the Screening Tool is compulsory for all applicants to submit a report generated by the Screening Tool from 90 days of the date of publication of that notice.

The Screening Tool is intended to allow for pre-screening of sensitivities in the landscape to be assessed within the EA process. This assists with implementing the mitigation hierarchy by allowing developers to adjust their proposed development footprint to avoid sensitive areas. The Screening Tool report will indicate the (preliminary) environmental sensitivities that intersect with the proposed development footprint as defined by the applicant as well as the relevant Protocols.

As the Screening Tool contains datasets that are mapped at a national scale, there may be areas where the Screening Tool erroneously assigns, or misses, environmental sensitivities because of mapping resolution and a high paucity of available and accurate data. Broad-scale site investigations will provide for an augmented and site-specific evaluation of the accuracy and 'infilling' of obvious and large-scale inaccuracies. Information extracted from the National Web-based Environmental Screening Tool (Department of Environmental Affairs, 2020), indicated that the study site and immediate surroundings hold a **medium to high** sensitivity with respect to the relative animal species protocol for all three proposed solar facilities (Figure 9) (report generated 16/01/2023):

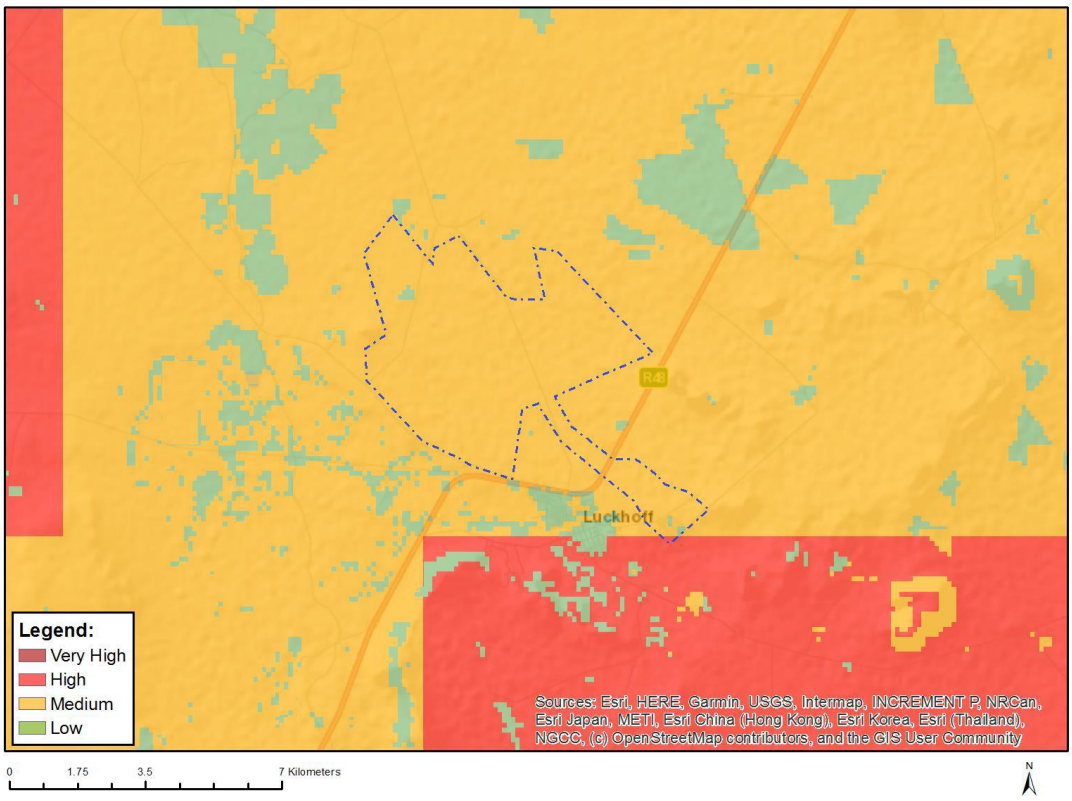

Figure 9: The animal species sensitivity of the study area and immediate surroundings according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	To be confirmed
High	Aves-*Neotis ludwigii*
Medium	Aves-*Neotis ludwigii*

According to the results of the screening tool, a medium probability of occurrence is evident for the endangered Ludwig's Bustard (*Neotis ludwigii*), which could potentially occur on all three of the proposed solar facilities. The probability for this species to occur along the Doring river systems, as well as the study site will be assessed during a detailed baseline (EIA) survey.

It is evident that the study area and immediate surroundings correspond to a **low** avian theme sensitivity for all three proposed solar facilities (see Figure 10).

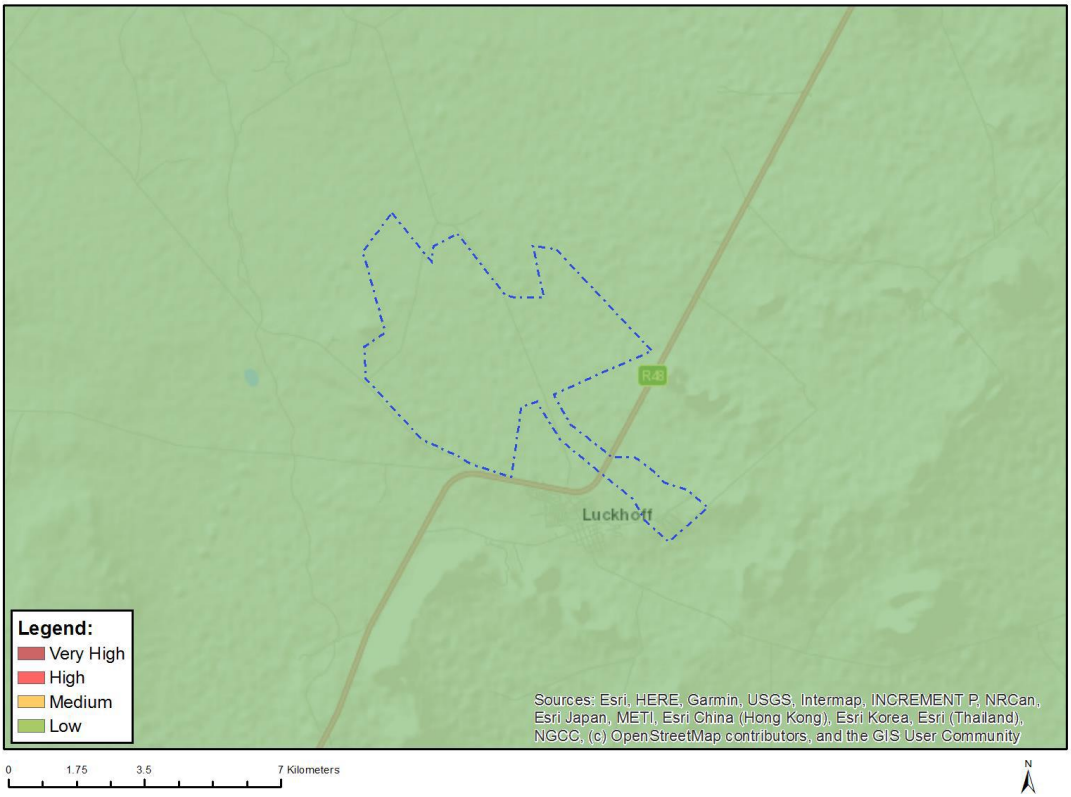

Figure 10: The relative avian sensitivity of the study site and immediate surroundings according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	Low sensitivity

However, the tudy area and immediate surroundings hold a **very high** sensitivity with respect to the relative terrestrial biodiversity theme for all three solar facilities (Figure 11):

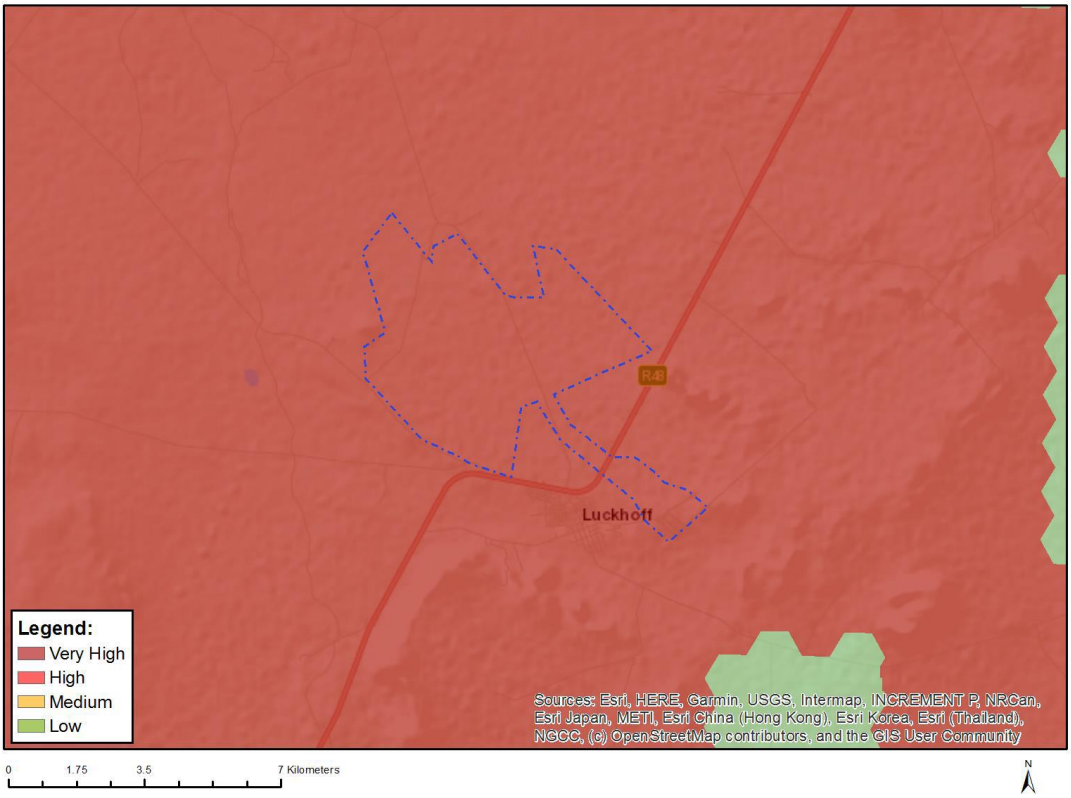

Figure 11: The relative terrestrial biodiversity sensitivity of the study site and immediate surroundings according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)	Proposed Solar Facility
Very High	Critical Biodiversity Area 1	Luckhoff Solar 2 & 3
Very High	Critical Biodiversity Area 12	Luckhoff Solar 2 & 3
Very High	Ecological Support Area 1	Luckhoff Solar 1, 2 & 3
Very High	Ecological Support Area 2	Luckhoff Solar 1 & 2
Very High	Thanda Tula Reserve	Luckhoff Solar 1 & 2

It is evident from the results of the Screening Tool report that most of the proposed solar facilities coincide with a Critical Biodiversity Area 1 and 2 (CBA 1 & 2) and an Ecological Support Are 1 and 2 (ESA 1 & 2) as per the Free State Biodiversity Plan (DESTEA, 2015). In addition, the proposed Luckhoff Solar 1 and 2 facilities are also located adjacent or near the Thanda Tula Reserve (it is uncertain at this stage if the labelling/name of this reserve is valid according to the Screening Report).

3.6 Preliminary avifaunal habitat types

Apart from the regional vegetation type, the local composition and distribution of the vegetation associations on the study area are a consequence of a combination of factors simulated by soil type, anthropogenic activities and grazing intensity (presence of livestock) which have culminated in three major broad-scale habitat units that deserve further discussion (Figure 12):

1. *Natural Northern Upper Karoo shrubland:* This unit is prominent on the study area and covers a significant extent in surface area of the proposed development footprint areas. It provides habitat for small passerine species, most notably that of Black-chested Prinia (*Prinia flavicans*), Southern Masked Weaver (*Ploceus velatus*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Yellow Canary (*Crithagra flaviventris*), Cape sparrow (*Passer melanurus*) and Rufous-eared Warbler (*Malcorus pectoralis*). Large-terrestrial species are expected to occur at low densities and comprise of Northern Black Korhaan (*Afrotis afraoides*), with typical non-passerine birds represented by Acacia Pied Barbet (*Tricholaema leucomelas*), Pied Crow (*Corvus albus*) and Laughing Dove (*Spilopelia senegalensis*).

2. *Mixed microphyllus and Eucalyptus bush clumps*: This habitat type features the presence of tall microphyllous trees as well as the presence of *Eucalyptus* groves and is prominent on the central part of Luckhoff Solar 2. The former includes a distinct canopy consisting of scattered *Vachellia/Senegalia* trees, and the increase in vertical heterogeneity is positively correlated with species richness. Typical species expected to be present could include Ring-necked Dove (*Streptopelia capicola*), Pale-chanting Goshawk (*Melierax canorus*), White-browed Sparrow-weaver (*Plocepasser mahali*), Chestnut-vented Warbler (*Curruca subcoerulea*) and Bokmakierie (*Telophorus zeylonus*) which are normally uncommon from the adjacent shrubland. The microphyllous trees also provide perching and potential nesting sites for small to medium-sized birds of prey. The latter (*Eucalyptus* groves) are expected to be poor in bird species richness although it may provide roosting and breeding opportunities for widespread non-passerine species (e.g. Pied Crow *C. albus* and Hadeda Ibis *Bostrychia hagedash*).

3. *Ephemeral drainage lines and unchanneled seeps:* These units are associated with ill-defined drainage system which are highly ephemeral and only inundated for a short period after the first austral summer rains. It is confined to the Luckhoff Solar 2 development footprint and the proposed Luckhoff gird connection. Surface water is a scarce commodity in arid environments and expected to attract many bird species, both passerines and non-passerines. Therefore, when inundated, these systems provide ephemeral foraging habitat for a number of nomadic waterbirds and shorebirds which under normal environmental conditions, are absent from the study area (e.g. South African Shelduck *Tadorna cana,* Yellow-billed Duck *Anas undulata* and Egyptian Goose *Alopochen aegyptiaca*). In most instances these systems are bordered by dense shrubland vegetation, thereby providing refuge and perching opportunities for a variety of bird species.

4. *Artificial livestock watering points*: These are represented by artificial water troughs and reservoirs with the purpose to provide drinking water to livestock.

However, they act as focal congregation areas for many granivore passerine species including daily visits by sandgrouse. This habitat feature sustains high bird richness values and also provides foraging habitat for bird of prey.

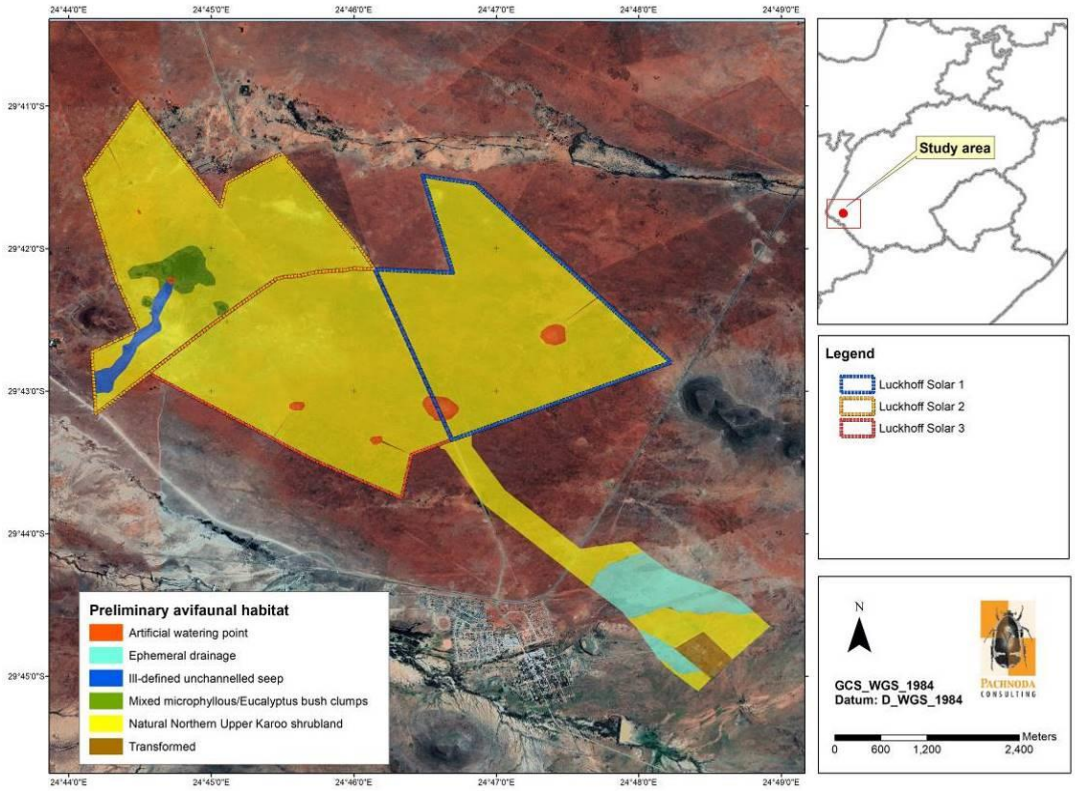

Figure 12: A preliminary habitat map illustrating the avifaunal habitat types on the study area and immediate surroundings (the habitat types are subject to change pending the outcome of a detailed baseline surveys).

3.7 Species Richness and Predicted summary statistics

Approximately ~152 bird species have been recorded within the study area (refer to Appendix 1 & Table 1), although it is more likely that between 80-100 bird species could occur within the physical boundaries of the proposed solar development footprints (according to the habitat types and the ecological condition thereof). The richness was inferred from the South African Bird Atlas Project (SABAP2)[1] (Harrison et al., 1997; www.sabap2.birdmap.africa) and the presence of suitable habitat in the study area. This equates to 15 % of the approximate 990[2] species listed for the southern African subregion[3] (and approximately 17.5 % of the 871 species recorded

[1] The expected richness statistic was derived from pentad grids 2935_2440, 2935_2445, 2935_2450, 2940_2440, 2940_2445, 2940_2450, 2945_2440, 2945_2445 and 2945_2450, totalling 152 bird species (based on 15 full protocol cards).

2 *sensu* www.zestforbirds.co.za (Hardaker, 2022), including four recently confirmed bird species (vagrants).

3 A geographical area south of the Cunene and Zambezi Rivers (includes Namibia, Botswana, Zimbabwe, southern Mozambique, South Africa, eSwatini and Lesotho).

within South Africa[4]). However, the species richness obtained from the pentad grids corresponding to the proposed footprint sites (c. 2940_2440 and 2940_2445) is lower and range between 41 and 67 species, with an average number of 54 species for each full protocol card submitted (for observation of two hours or more; range= 32-59 species).

According to Table 1, the study area is poorly represented by biome-restricted[5] species (see Table 2), although local and regional endemic and near-endemic bird species are expected to be well represented (between 20-40 % respectively).

Table 1: A summary table of the total number of species, Red listed species (according to Taylor et al., 2015 and the IUCN, 2022), endemics and biome-restricted species (Marnewick et al., 2015) expected (*sensu* SABAP2) to occur in the study site and immediate surroundings.

Description	Expected Richness Value
Total number of species*	152 (15 %)
Number of Red Listed species*	7 (5 %)
Number of biome-restricted species – Namib-Karoo and Kalahari-Highveld Biomes)*	5 (20 %)
Number of local endemics (BirdLife SA, 2022)*	4 (10 %)
Number of local near-endemics (BirdLife SA, 2022)*	7 (23 %)
Number of regional endemics (Hockey *et al.,* 2005)**	22 (21 %)
Number of regional near-endemics (Hockey *et al.,* 2005)**	24 (39 %)

* only species in the geographic boundaries of South Africa (including Lesotho and eSwatini) were considered.

** only species in the geographic boundaries of southern Africa (including Namibia, Botswana, Zimbabwe and Mozambique south of the Zambezi River) were considered

*** Percentage values in brackets refer to totals compared against the South African avifauna (*sensu* BirdLife SA, 2022).

Table 2: Expected biome-restricted species (Marnewick *et al*, 2015) likely to occur on the study site and immediate surroundings.

Species	Kalahari-Highveld	Namib-Karoo	Expected Frequency of occurrence
Kalahari Scrub Robin (*Cercotrichas paena)*	X		Common
Ludwig's Bustard (*Neotis ludwigii)*		X	Uncommon
Layard's Warbler (*Curruca layardi*)		X	Common
Pale-winged Starling (*Onychognathus nabouroup)*		X	Uncommon
Sickle-winged Chat (*Emarginata sinuata*)		X	Fairly Common

3.8 Bird species of conservation concern

Table 3 provides an overview of bird species of conservation concern that could occur on the study site and immediate surroundings based on their historical

4 With reference to South Africa (including Lesotho and eSwatini (BirdLife South Africa, 2022).

5 A species with a breeding distribution confined to one biome. Many biome-restricted species are also endemic to southern Africa.

distribution ranges and the presence of suitable habitat. According to Table 3, a total of seven species could occur on the study area which include six globally threatened species and one globally near threatened species.

It is evident from Table 3 that the occurrence of threatened species on the study site was low (sensu SABAP2). It is evident that suitable habitat for the occurrence of the globally endangered Secretarybird (*Sagittarius serpentarius*) and the globally endangered Ludwig's Bustard (*Neotis ludwigii*) was absent, thereby suggesting that the probability that these species could occur within the physical boundaries of the study site is high. The status of these two endangered species (in particular their breeding status) will be verified during the EIA/baseline survey of the project phase.

In addition, the nearby "koppies" and outcrops provide suitable habitat for the globally near threatened African Rock Pipit (*Anthus crenatus*) to occur. However, this species is probably absent on the proposed development footprint sites due to the absence of suitable habitat. The remainder of the species (according to Table 3) is regarded as highly irregular visitors to the study area.

Table 3: Bird species of conservation concern that could utilise the study area and immediate surroundings based on their historical distribution range and the presence of suitable habitat. Red list categories according to the IUCN (2022)* and Taylor et al. (2015)**.

Species	Global Conservation Status*	National Conservation Status**	SABAP2 reporting rate	Preferred Habitat	Potential Likelihood of Occurrence
Anthropoides paradiseus (Blue Crane)	Vulnerable	Near threatened	6.25 (based on a single record)	Prefers open grasslands. Also forages in wetlands, pastures and agricultural land.	Highly irregular foraging visitor although recently (22/08/2022) observed on the study area
Anthus crenatus (African Rock Pipit)	Near threatened	Near threatened	25.00 (based on four records)	Exposed rock and cliffs in arid mountainous terrain or isolated koppies.	Probably absent on the physical development footprint sites due to the absence of suitable habitat. It is a fairly common resident to the nearby Besemkaree Koppies shrubveld.
Oxyura maccoa (Maccoa Duck)	Endangered	Vulnerable	6.25 (based on a single record)	Large saline pans and shallow impoundments.	Probably absent on the physical study site due to the absence of suitable habitat. It was last recorded during 04 November 2010 in the wider

Species	Global Conservation Status*	National Conservation Status**	SABAP2 reporting rate	Preferred Habitat	Potential Likelihood of Occurrence
					study region (sensu SABAP2).
Gyps coprotheres (Cape Vulture)	Vulnerable	Endangered	5 (based oon a single record)	Mainly confined to mountain ranges, especially near breeding site. Ventures far afield in search of food.	An irregular foraging/scavenging visitor to the study area pending the presence of food. It was last observed during 2019 on the study area
Gyps africanus (White-backed Vulture)	Critically Endangered	Critically Endangered	6.25 (based on a single record)	Breed on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	An irregular foraging/scavenging visitor to the study area pending the presence of food. It was last observed during 2015 on the study area
Neotis ludwigii (Ludwig's Bustard)	Endangered	Endangered	10.00 (based on two independent records)	Open savannoid and arid grassland and open karroid to semi-desert plains.	An uncommon foraging visitor and potential breeding resident. It was last recorded during 2018 on the study area. The breeding status of this species on the study area will be verified during the EIA/baseline survey.
Sagittarius serpentarius (Secretarybird)	Endangered	Endangered	10.00 (known from two independent ad hoc observations)	Prefers open grassland or lightly wooded habitat.	Potentially a regular foraging visitor and breeding resident on the study area – the breeding status of this species on the study area will be verified during the EIA/baseline survey. It was also recently observed on the study area (07/07/2022)

3.9 Preliminary avifaunal sensitivity

A preliminary sensitivity map[6] was compiled, illustrating habitat units comprising of potential sensitive elements based on the following arguments (Figure 13):

Areas of high sensitivity

Areas of high sensitivity include the ephemeral drainage and seep systems and the artificial watering points.

The ephemeral systems provide potential foraging opportunities for waterbirds and shorebird taxa when inundated, which are rare or absent in the area when these systems are dry. Many of these species are highly nomadic in the area and may become disorientated by the "lake effect" caused by the PV panels which may result in bird colliding with the panels (and also the associated powerlines). These systems are also important from a functional and dynamic perspective at the landscape level since these are "stepping stones" within the regional context, thereby contributing towards avian dispersal and nomadism.

The artificial livestock watering points are expected to attract large numbers of granivore passerine and non-passerine bird species, of which many need to drink water on a daily basis (e.g. sandgrouse). The placement of electrical and PV infrastructure in close proximity to these areas could increase potential avian collisions with the infrastructure. These areas are of artificial origin, and could be relocated to other areas.

Areas of medium sensitivity

Areas of medium sensitivity represent habitat units of natural Northern Upper Karoo vegetation and the mixed microphyllous bush clumps. These habitat types provide foraging habitat for certain threatened bird species (e.g. Secretarybird and Ludwig's Bustard), as well as terrestrial bird species (e.g. Northern Black Korhaan) with the potential to interact (e.g. collide) with the proposed electrical infrastructure. However, reporting rates for threatened bird species was relatively low, thereby suggesting a medium sensitivity rating instead of a high sensitivity even though the majority of the habitat units is natural.

Areas of low sensitivity

Areas of low sensitivity include habitat units represented by transformed habitat, thereby contributing little towards local biodiversity.

[6] Please note that the sensitivity ratings are subject to changes during the outcome of the baseline/EIA surveys.

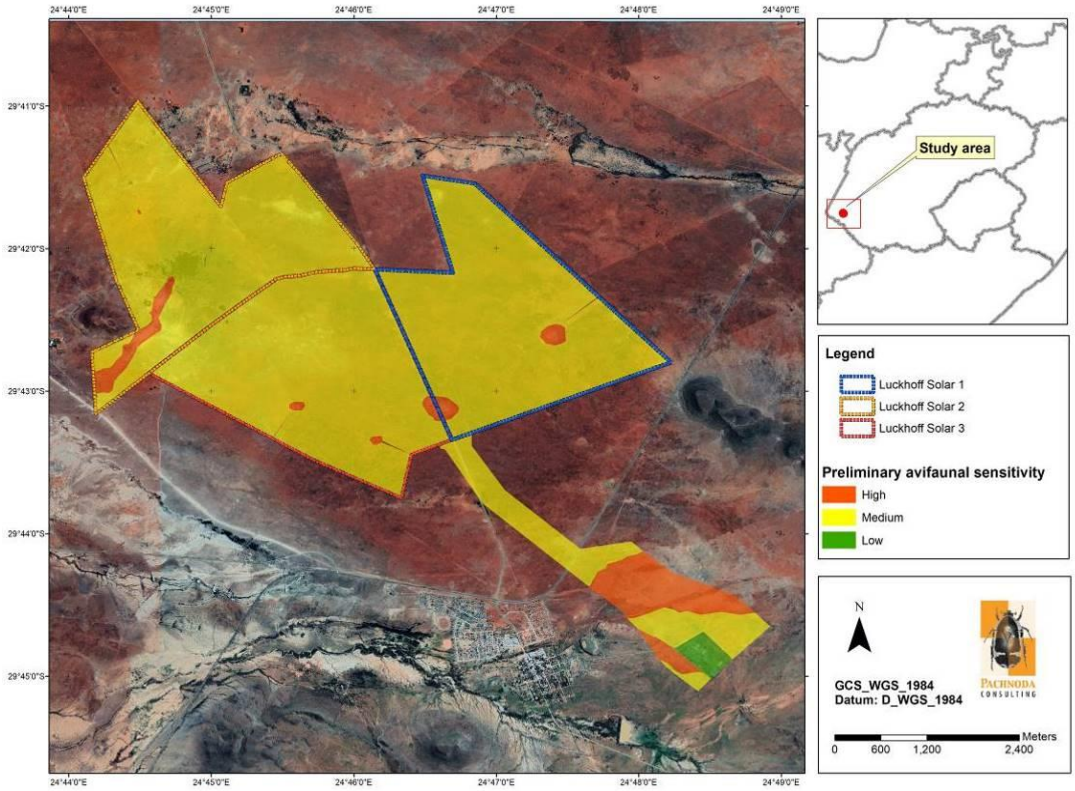

Figure 13: A map illustrating the preliminary avifaunal sensitivity of the area based on habitat types supporting bird taxa of conservation concern and important ecological function.

3.10 Overview of Avian Impacts at Solar Facilities

Table 4 provides a preliminary summary of the impacts anticipated.

3.10.1 Background to solar facilities and their impact on birds

Birds are mobile, and are therefore also more readily affected by solar facilities than other taxonomic groups (e.g. mobile mammals that could move away from the facilities due to displacement). In fact, birds are also vulnerable to impacts caused by other types of energy facilities such as overhead power lines and wind farms. Little information is available on the impacts of solar energy facilities on birds although Gunerhan *et al.* (2009), McCrary *et al.* (1986), Tsoutsos *et al.* (2005) and the recent investigation reports on bird fatalities in the USA by Kagen *et al*. (2014) and Walston *et al*. (2016) provide discussions thereof. These studies have shown that avian fatalities vary greatly between the geographic positions of the solar facilities and also depend on the type of solar facility. In addition, very few of the large solar facilities in operation undertake systematic monitoring of avian fatalities, which explains the lack of detailed information of avian impacts. According to these studies conducted at both Concentrated Solar Power (CSP) and PV facilities, avian incidental fatalities range from 14 to over 180 birds which were summarised over a survey period

conducted during one to three years. According to the Walston *et al.* (2016) assessment, the average annual mortality rate for known utility-scale solar facilities (the annual number of estimated bird deaths per megawatt of electrical capacity) is 2.7, and 9.9 for known and unknown fatalities (which include carcasses found on the project site of which the death is not known). McCrary *et al.* (1986) found an average rate of mortality of 1.9-2.2 birds per week affecting 0.6-0.7 % of the local bird population. However, most of the avian fatalities at these solar facilities are also probably underestimated since 10-30 % of dead birds are removed by scavengers before being noted. From these analyses and assessments, it was evident that:

- Medium levels of bird fatalities occur at PV sites when compared to CSP sites (when taking powerline collisions into account).
- Approximately 81 % of all avian mortalities were caused by collisions, including collisions with electrical distribution lines.
- Most of the mortalities were small passerines (especially swallows).
- Fatalities at these solar facilities also include waterbirds (e.g. grebes, herons and gulls) which were probably attracted by the apparent "lake effect" caused by the reflective surface of the PV panels.
- Approximately 10-11 % of the fatalities consists of waterbirds, but could be as high as 49 % at certain facilities.
- It is unclear if the "lake effect" caused by the panels (at PV facilities) or mirrors (at CSP facilities) are the main cause of birds colliding or interacting with the infrastructure (since both waterbirds and other passerines are colliding with the infrastructure).
- Most of the fatalities are of resident birds as opposed to migratory species.

In a review report by Harrison *et al.* (2016), an attempt was made to provide evidence of the impacts caused by solar PV facilities alone (not combined with CSP facilities) on birds in the UK. These authors reviewed approximately 420 scientific documents, including 37 so-called "grey" literature from non-government and government organisations for any evidence relating to the ecological impacts of solar PV facilities. Their main findings were as follows:

- The majority of the documents were not relevant and peer-reviewed documents of experimental scientific evidence on avian fatalities were non-existent.
- Results based on carcass searches suggest that the bird collision risk at PV developments are low, although these studies did not take collision by overhead power lines into account.
- Many of the documents recommended that PV developments in close proximity to protected areas should be avoided.
- The PV panels reflect polarised light, which can attract polarotactic insects with potential impact to their reproductive biology. In addition, the polarising effect of the PV panels may also induce drinking behaviour in some birds, which may mistake the panels for water.

They conclude that impact assessment reports should consider taxon-specific requirements of birds and their guilds.

3.10.2 Potential impacts of PV solar facilities on birds

The magnitude and significance of impacts to birds caused by solar facilities will depend on the following factors:

- The geographic locality of the planned solar facility;
- The size or surface extent of the solar facility;
- The type of solar facility (according to the technologies applied, e.g. PV or Concentrated Solar Power (CSP)); and
- The occurrence of collision-prone bird species (which are often closely related to the locality of the solar facility).

Any planned solar facility corresponding to an area with many threatened, range-restricted or collision-prone species will have a higher impact on these birds. In addition, any planned solar facility located in close proximity to important flyways, wetland systems or roosting/nesting sites used by the aforementioned species will have a higher impact.

The main impacts associated with PV solar facilities include (Jenkins *et al*., 2017):

- The loss of habitat and subsequent displacement of bird species due to the ecological footprint required during construction;
- Disturbances caused to birds during construction and operation;
- Direct interaction (collision trauma) by birds with the surface infrastructure (photovoltaic panels) caused by polarised light pollution and/or waterbirds colliding with the panels (as they are mistaken for waterbodies);
- Collision with associated infrastructure (mainly overhead powerlines and reticulation);
- Attracting novel species to the area (owing to the artificial provision of new habitat such as perches and shade) which could compete with the residing bird population.

3.11 Potential Impacts associated with the proposed PV Solar Facilities

3.11.1 Loss of habitat and displacement of birds

Approximately 480ha will be cleared of vegetation and habitat to accommodate the panel arrays and associated infrastructure for each solar facility (approximately 1440ha will be cleared in total). Clearing of vegetation will inevitably result in the loss of habitat and displacement of bird species. From the preliminary results it is evident that smaller passerine species are more likely to become displaced. It is particularly endemic species that are likely to become displaced, as well as large-bodied terrestrial bird species (e.g. bustards) which will disappear from the area.

To quantify the impact it is necessary to calculate the number of birds (density) lost or displaced by the activity, including estimated density values of important species per unit area of habitat. This will be conducted during a baseline survey of the proposed study area. From a preliminary analysis, the following bird species are most likely to be impacted by the loss of habitat due to their habitat requirements, fecundity and conservation status (although not limited to) due to the proposed development:

- Secretarybird (*Sagittarius serpentarius*);
- Ludwig's Bustard (*Neotis ludwigii*); and to a lesser extent also
- Northern Black Korhaan (*Afrotis afraoides*).

3.11.2 Collision trauma caused by photovoltaic panels (the "lake-effect")

The presence of ephemeral drainage systems (especially on Luckhoff Solar 2), as the nearby depressions and drainage systems to the south and west of the study area increase the risk of waterbirds and shorebird taxa interacting with the PV panels.

The fitment of bird deterrent devices such as a combination of rotating flashers/reflectors are proposed are highly recommended. Post construction monitoring to quantify mortalities will is also recommended, especially during the early operational phase in order to determine "hotspot" areas which may require additional mitigation measures.

Desktop results and site observations show that the following species could interact with the panel infrastructure:

- South African Shelduck (*Tadorna cana*);
- Hamerkop (*Scopus umbretta*);
- Egyptian Goose (*Alopochen aegyptiaca*);
- Spur-winged Goose (*Plectropterus gambiensis*);
- Yellow-billed Duck (*Anas undulata*);
- Red-billed Teal (*Anas erythrorhynchus*);
- Cape Teal (*Anas capensis*);
- Cape Shoveller (*Spatula smithii*);
- Black-winged Stilt (*Himantopus himantopus*);
- Three-banded Plover (*Charadrius tricollaris*); and potentially also
- Reed Cormorant (*Microcarbo africanus*);
- African Sacred Ibis (*Threskiornis aethiopicus*) and potentially also
- Little Grebe (*Tachybaptus ruficollis*);
- Grey Heron (*Ardea cinerea*);
- Black-headed Heron (*Ardea melanocephala*);
- Red-knobbed Coot (*Fulica cristata*);
- African Darter (*Anhinga rufa*);

- Common Moorhen (*Gallinula chloropus*)

3.11.3 Interaction with overhead powerlines and reticulation

The proposed grid connection will consist of a 2.5km 132kV single/double circuit overhead powerline which will link the collector switching station to the proposed Luckhoff Main Transmission Substation. The proposed overhead power line will traverse habitat of medium avifaunal sensitivity as well as potential habitat with a high sensitivity near the Main Transmission Substation corresponding to ephemeral drainage systems. The anticipated impact will increase when the powerline corresponds to areas consisting of ephemeral drainage lines.

Birds are impacted in three ways by means of overhead powerlines (described below). It is however a common rule that large and heavy-bodied terrestrial bird species are more at risk of being affected in a negative way when interacting with powerlines in general. These include the following:

- *Electrocution*

Electrocution happens when a bird bridges the gap between the live components or a combination of a live and earth component of a power line, thereby creating a short circuit. This happens when a bird, mainly a species with a fairly large wingspan attempts to perch on a tower or attempts to fly-off a tower. Many of these species include vultures (of the genera *Gyps* and *Torgos*) as well as other large birds of prey such as the Martial Eagle (*Polemaetus bellicosus*) (Ledger & Annegarn, 1981; Kruger, 1999; Van Rooyen, 2000). These species will attempt to roost and even breed on the tower structures if available nesting platforms are a scarce commodity in the area. Other types of electrocutions happen by means of so-called “bird-streamers”. This happens when a bird, especially when taking off, excretes and thereby causes a short-circuit through the fluidity excreta (Van Rooyen & Taylor, 1999).

Large transmission lines (from 220 kV to 765 kV) are seldom a risk of electrocution, although smaller distribution lines (88 – 132kV) pose a higher risk. However, for this project, the design of the pylon is an important consideration in preventing bird electrocutions. **The proposed pylon design should incorporate the following design parameters**:

- The clearances between the live components should exceed the wingspan of any bird species;
- The height of the tower should allow for unrestricted movement of terrestrial birds between successive pylons;
- The live components should be “bundled” to increase the visibility for approaching birds;

- "Bird streamers" should be eliminated by discouraging birds from perching above the conductors.

It is therefore recommended that the pylon design incorporates "features as illustrated by Figure 14[7].

From Figure 14 it is clear that perching of birds is discouraged by the addition of diagonal crossbars or by doing away with the crossbars that holds the conductors in place. Bird "streamers" are also eliminated by fitting the poles with bird guards/spikes above the conductors. However, safe perching is facilitated by the fitment of a horizontal bar on top of the pole structure without the risk of electrocution (due to the perpendicular orientation of the bar relative to the conductors).

Figure 14: Two bird-friendly tower designs to be used for the current project.

- *Collision*

Collisions with earth wires have probably accounted for most bird-powerline interactions in South Africa. In general, the earth wires are much thinner in diameter when compared to the live components, and therefore less visible to approaching birds. Many of the species likely to be affected include heavy, large-bodied terrestrial species such as bustards, korhaans and a variety of waterbirds that are not very agile or manoeuvrable once airborne. These species, especially those with the habit of flying with outstretched necks (e.g. most species of storks) find it difficult to make a sudden change in direction while flying – resulting in the bird flying into the earth wires.

Areas where bird collisions are likely to be high could be ameliorated by marking the lines with appropriate bird deterrent devices such as "bird diverters" to increase the visibility of the lines. For the current project it is proposed that the overhead

[7] Please note that these are examples of recommended pylon designs. These are taken from steel monopole pylons.

powerlines (including existing lines) consider the fitment devices such as the "Viper live bird flapper" and/or the double loop bird flight diverter (see Figure 15).

Figure 15: Examples of bird flight diverters to be used on the power lines: Double loop bird flight diverter (left) and Viper live bird flapper (right).

- *Physical disturbances and habitat destruction caused during construction and maintenance*

It is anticipated that part of the powerline line servitude will be cleared of vegetation. In addition, construction activities go hand in hand with high ambient noise levels. Although construction is considered temporary, many species will vacate the area during the construction phase and will become temporarily displaced.

Table 4: A preliminary summery of impacts associated with the proposed PV facility and its infrastructure.

1. Impacts and the mitigation measures during the construction phase

SPECIALIST STUDY	IMPACT	PRE-MITIGATION RATING	POST MITIGATION RATING	SUMMARY OF MITIGATION MEASURES
Avifaunal Assessment	Displacement of priority avian species from important habitats (PV array and associated infrastructure)	Negative - High	Negative - Medium	• It is difficult to mitigate against the loss of habitat since clearing of vegetation (or habitat) will be required for the infrastructure associated with the project. The PV facilities and associated infrastructure occur predominantly on habitat types of medium sensitivity. The best practicable mitigation will be to consolidate infrastructure. • Avoid and buffer areas where threatened bird species occur (e.g. Secretarybird and Ludwig's Bustard – to be confirmed during the EIA/baseline surveys). • All road networks must be planned with care to minimise dissection or fragmentation of important avifaunal habitat type. Where possible, the use of existing roads is encouraged.
	Displacement of resident avifauna through increased disturbance (PV array and associated infrastructure)	Negative - High	Negative - Medium	• It is difficult to mitigate against the loss of habitat since clearing of vegetation (or habitat) will be required for the infrastructure associated with the project. The PV facilities and associated infrastructure occur predominantly on habitat types of medium sensitivity. The best practicable mitigation will be to consolidate infrastructure. • All road networks must be planned with care to minimise

				dissection or fragmentation of important avifaunal habitat type. Where possible, the use of existing roads is encouraged.
	Loss of important avian habitats (PV array and associated infrastructure)	Negative - High	Negative - Medium	• It is difficult to mitigate against the loss of habitat since clearing of vegetation (or habitat) will be required for the infrastructure associated with the project. The PV facilities and associated infrastructure occur predominantly on habitat types of medium sensitivity. The best practicable mitigation will be to consolidate infrastructure. • Avoid and buffer habitat with high preliminary avian sensitivities. Where necessary, relocate or remove artificial watering points.
	Displacement of priority avian species from important habitats (Power Line)	Negative - High	Negative - Medium	• It is difficult to mitigate against the loss of habitat since clearing of vegetation (or habitat) will be required for the infrastructure associated with the project. The grid connection infrastructure occurs predominantly on habitat types of medium sensitivity. The best practicable mitigation will be to consolidate infrastructure (e.g. proposed powerline) to areas where existing impacts occur (e.g. placing the proposed powerline alongside existing powerlines). • Conduct a “walk-through” of the powerline servitude to identify potential areas where threatened bird species utilise the area – either re-align the powerline or move pylon footprints. • All road networks must be planned with care to minimise dissection or fragmentation of important avifaunal habitat type. Where possible,

				the use of existing roads is encouraged.
	Displacement of resident avifauna through increased disturbance (Power Line)	Negative - medium	Negative - low	• It is difficult to mitigate against the loss of habitat since clearing of vegetation (or habitat) will be required for the infrastructure associated with the project. The grid connection infrastructure occurs predominantly on habitat types of medium sensitivity. The best practicable mitigation will be to consolidate infrastructure (e.g. proposed powerline) to areas where existing impacts occur (e.g. placing the proposed powerline alongside existing powerlines). • All road networks must be planned with care to minimise dissection or fragmentation of important avifaunal habitat type. Where possible, the use of existing roads is encouraged
	Loss of important avian habitats (Power Line)	Negative - medium	Negative - low	• Avoid and buffer habitat with high preliminary avian sensitivities. Where necessary, relocate or remove artificial watering points. • Conduct a "walk-through" of the powerline servitude to identify potential areas where threatened bird species utilise the area – either re-align the powerline or move pylon footprints.

2. Impacts and the mitigation measures during the operational phase

SPECIALIST STUDY	IMPACT	PRE-MITIGATION RATING	POST MITIGATION RATING	SUMMARY OF MITIGATION MEASURES
Avifaunal Assessment	Displacement of priority avian species from important habitats	Negative - medium	Negative - low	• Avoid and buffer habitat with high preliminary avian sensitivities.

	Displacement of resident avifauna through increased disturbance	Negative - medium	Negative - low	• Avoid and buffer habitat with high preliminary avian sensitivities.
	Collisions with PV panels leading to injury or loss of avian life	Negative - medium	Negative - medium	• Apply bird deterrent devices such as rotating flashers/reflectors to the panels for birds that may mistake the panels for open water and to prevent them from landing on the panels - these should especially be placed at panels nearest to pans and watering points. Security/CCTV cameras may be installed to quantify mortalities (cameras are also installed along the perimeter fence for security measures and may also prove effective to quantify mortalities). • Buffer ephemeral drainage systems (by at least 500m – buffer width will be re-evaluated pending the results obtained during the EIA/baseline surveys). • Implement additional pre-construction monitoring to evaluate important bird flyways/dispersal routes. • Implement post-construction monitoring. If post-construction monitoring predicts and/or confirms any bird mortalities, an option is to employ video cameras at selected areas to document bird mortalities and to conduct

				direct observations and carcass searches on a regular and systematic basis.
	Displacement of priority avian species from important habitats (Power Line)	Negative - medium	Negative - low	• Avoid and buffer habitat with high preliminary avian sensitivities.
	Displacement of resident avifauna through increased disturbance (Power Line)	Negative - medium	Negative - low	• Avoid and buffer habitat with high preliminary avian sensitivities.
	Collision when flying into power line infrastructure	Negative - high	Negative - medium	• Apply bird deterrent devices to the power lines and make use of "bird-friendly" pylon structures. • Avoid the placement of any watering points in close proximity to any overhead electrical infrastructure. • To aid post-construction monitoring and/or monitoring of bird mortality rates, it is advised to conduct direct observations and carcass searches on a regular and systematic basis. • Collisions will be reduced if the grid corridor is placed alongside existing powerlines.
	Electrocution when perched on power line infrastructure	Negative - medium	Negative - low	• Avoid the placement of watering points in close proximity to any overhead electrical infrastructure.

				• Make use of bird-friendly pylons and bird guards as recommended by EWT.

3. Impacts and the mitigation measures during the decommissioning phase

SPECIALIST STUDY	IMPACT	PRE-MITIGATION RATING	POST MITIGATION RATING	SUMMARY OF MITIGATION MEASURES
Avifaunal Assessment	Displacement of priority avian species from important habitats	Negative - low	Negative - low	• Avoid the temporary storage (laydown) of removed infrastructure on habitat with a high avian sensitivity. • Rehabilitation should make use of indigenous floristic species that are native to the study area.
	Displacement of resident avifauna through increased disturbance	Negative - low	Negative - low	• Avoid the temporary storage (laydown) of removed infrastructure on habitat with a high avian sensitivity. • Rehabilitation should make use of indigenous floristic species that are native to the study area.

3.12 Collision-prone bird species

A total of 43 collision-prone bird species have been recorded from the study area, of which 17 species are waterbird taxa and 16 species are birds of prey (Table 5). According to Table 5, it is evident that species with reporting rates of 12% of more (n=21 species) have a high probability to occur on the study site and immediate surroundings. Approximately 38 species could interact with powerlines, while 18 species could interact with the panel infrastructure.

Table 5: Collision-prone bird species and Red listed species expected to be present on the study area and immediate surroundings inferred from the South African Atlas Project (SABAP2).

Common Name	Scientific Name	SABAP2 Reporting Rate		Collision with PV panels	Collision with powerline
		Full Protocol (%)	Ad hoc Protocol (%)		
Pied Crow	*Corvus albus*	75.00	35.00		X
Northern Black Korhaan	*Afrotis afraoides*	68.75	15.00		X
Helmeted Guineafowl	*Numida meleagris*	62.50	10.00		X
Pale Chanting Goshawk	*Melierax canorus*	62.50	10.00		X
Speckled Pigeon	*Columba guinea*	62.50	5.00		X
Egyptian Goose	*Alopochen aegyptiaca*	56.25	5.00	X	X
Hadada Ibis	*Bostrychia hagedash*	37.50	0.00		X
Black-headed Heron	*Ardea melanocephala*	25.00	0.00	X	X
Spur-winged Goose	*Plectropterus gambensis*	25.00	0.00	X	X
Grey Heron	*Ardea cinerea*	18.75	0.00	X	X
South African Shelduck	*Tadorna cana*	18.75	0.00	X	X
Black-winged Kite	*Elanus caeruleus*	12.50	0.00		X
Black-winged Stilt	*Himantopus himantopus*	12.50	0.00	X	
Common (Steppe) Buzzard	*Buteo buteo vulpinus*	12.50	5.00		X
Greater Kestrel	*Falco rupicoloides*	12.50	0.00		X
Lesser Kestrel	*Falco naumanni*	12.50	10.00		X
Namaqua Sandgrouse	*Pterocles namaqua*	12.50	0.00	X	X
Orange River Francolin	*Scleroptila gutturalis*	12.50	0.00		X
Red-knobbed Coot	*Fulica cristata*	12.50	0.00	X	
Swainson's Spurfowl	*Pternistis swainsonii*	12.50	0.00		X
Western Barn Owl	*Tyto alba*	12.50	0.00		X
African Fish Eagle	*Haliaeetus vocifer*	6.25	0.00		X
Blue Crane	*Grus paradisea*	6.25	0.00		X
Cape Shoveler	*Spatula smithii*	6.25	0.00	X	X
Cape Teal	*Anas capensis*	6.25	0.00	X	X
Common Greenshank	*Tringa nebularia*	6.25	0.00	X	
Gabar Goshawk	*Micronisus gabar*	6.25	0.00		X
Hamerkop	*Scopus umbretta*	6.25	0.00	X	X
Little Grebe	*Tachybaptus ruficollis*	6.25	0.00	X	
Maccoa Duck	*Oxyura maccoa*	6.25	0.00	X	X

Common Name	Scientific Name	SABAP2 Reporting Rate		Collision with PV	Collision with
Red-billed Teal	*Anas erythrorhyncha*	6.25	0.00	X	X
Reed Cormorant	*Microcarbo africanus*	6.25	0.00	X	
Rock Dove	*Columba livia*	6.25	0.00		X
Rock Kestrel	*Falco rupicolus*	6.25	0.00		X
Spotted Eagle-Owl	*Bubo africanus*	6.25	0.00		X
White-backed Vulture	*Gyps africanus*	6.25	0.00		X
Yellow-billed Duck	*Anas undulata*	6.25	0.00	X	X
African Sacred Ibis	*Threskiornis aethiopicus*	0.00	5.00	X	X
Cape Vulture	*Gyps coprotheres*	0.00	5.00		X
Jackal Buzzard	*Buteo rufofuscus*	0.00	5.00		X
Ludwig's Bustard	*Neotis ludwigii*	0.00	10.00		X
Secretarybird	*Sagittarius serpentarius*	0.00	10.00		X
White Stork	*Ciconia ciconia*	0.00	5.00		X

4. PLAN OF STUDY FOR THE EIA PHASE

Due to the limited level of detail that is normally implemented during a scoping assessment, it is imperative that detailed avifaunal investigations be conducted on the study area at an appropriate season.

4.1 Proposed approach and methods

The following methods are proposed during an austral summer season survey:

- Active searching and the compilation of a bird inventory while traversing much of the available habitat types;
- The determination of the occurrence of Red Data species and collision-prone bird species, with emphasis on the breeding/roosting status of Ludwig's Bustard (*Neotis ludwigii*) and Secretarybird (*Sagittarius serpentarius*);
- The identification and mapping of suitable habitat for species of conservation concern while focussing on structural and topographical cues;
- A landscape analysis of important flyways or daily flight paths corresponding to important landscape features; and
- Density estimates will be collected by means of point counts to evaluate the dominant/typical species and their respective relative densities at each site. At each point the number of bird species seen will be recorded, as well as their respective abundances and distance from the observer (by means of a rangefinder). The data generated from the point counts will be analysed according to Clarke & Warwick (1994) based on the computed percentage contribution (%) of each species including the consistency (calculated as the similarity coefficient/standard deviation) of its contribution to each habitat type.

- Suitable bird repelling structures and bird diverters will be provided to avoid collision of birds with the PV facility and associated powerlines.

5. REFERENCES

Birdlife South Africa. 2022. *BirdLife South Africa Checklist of Birds in South Africa*, 2018.

Clarke, K.R. & Warwick, R.M. 1994. *Changes in marine communities: An approach to statistical analysis and interpretation*. Natural Environmental Research Council, United Kingdom.

DESTEA (2015). Free State Biodiversity Plan. compiled by Nacelle B. Collins.

Geoterrainimage. 2015. *The South African National Land cover Dataset*. Version 05.

Gill, F, D Donsker, & P Rasmussen (Eds). 2022. IOC World Bird List (v 12.1). Doi 10.14344/IOC.ML.10.2. http://www.worldbirdnames.org/.

Gunerhan, H., Hepbasli, A. & Giresunlu, U. 2009. Environmental impacts from the solar energy systems. Energy Sources, Part A: *Recovery, Utilization and Environmental Effects* 31: 131-138.

Hardaker, T. 2022. Southern African Bird List - Version 11 - 29 August 2022.

Harrison, C., Lloyd, H. & Field, C. 2016. *Evidence review of the impact of solar farms on birds, bats and general ecology*. NEER012 report, Manchester Metropolitan University, UK.

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

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (eds.) 2005. *Roberts – Birds of Southern Africa*, VIIth ed. The Trustees of the John Voelker Bird Book Fund, Cape Town.

IUCN Red List of Threatened Species. Version 2022. http://www.iucnredlist.org/.

Jenkins, A.R, Ralston-Paton, S & Smit-Robinson, H.A. 2017. Best practice guidelines: Birds and Solar Energy. Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa.

Kagen, R.A., Verner, T.C., Trail, PW & Espinoza, E.O. 2014. Avian mortality at solar energy facilities in southern California: A preliminary analysis. Unpublished report by the National Fish and Wildlife Forensics Laboratory, USA.

Kruger, R. 1999. *Towards solving raptor electrocutions on Eskom Distribution Structures in South Africa.* M. Phil. Mini-thesis. University of the Orange Free State. Bloemfontein. South Africa.

Ledger, J. & Annegarn, H.J. 1981. Electrocution Hazards to the Cape Vulture (*Gyps coprotheres*) in South Africa. *Biological Conservation* 20: 15-24.

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

McCrary, M.D., McKernan, R.L., Schreiber, R.W., Wagner, W.D. & Sciarotta, T.C. 1986. Avian mortality at a solar energy power plant. *Journal of Field Ornithology* 57: 135-141.

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

National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004).

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

Tsoutsos, T., Frantzeskaki, N. & Gekas, V. 2005. Environmental impacts from solar energy technologies. *Energy Policy* 33: 289-296.

Van Rooyen, C.S. 2000. An overview of Vulture Electrocutions in South Africa. *Vulture News* 43: 5-22.

Van Rooyen, C.S. & Taylor, P.V. 1999. *Bird streamers as probable cause of electrocutions in South Africa*. EPRI Workshop on Avian Interactions with Utility Structures, Charleston, South Carolina.

Vosloo, H. 2003. Birds and power lines. *ESI Africa* 3: 38.

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

www.sabap2.birdmap.africa

Appendix 1: A shortlist of bird species recorded on the study area and immediate surroundings. The list provides an indication of the species occurrence according to SABAP2 reporting rates.

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
432	Acacia Pied Barbet	*Tricholaema leucomelas*	87.50	14	5.00	1
149	African Fish Eagle	*Haliaeetus vocifer*	6.25	1	0.00	0
418	African Hoopoe	*Upupa africana*	12.50	2	0.00	0
692	African Pipit	*Anthus cinnamomeus*	43.75	7	0.00	0
544	African Red-eyed Bulbul	*Pycnonotus nigricans*	81.25	13	5.00	1
697	African Rock Pipit	*Anthus crenatus*	25.00	4	0.00	0
81	African Sacred Ibis	*Threskiornis aethiopicus*	0.00	0	5.00	1
386	Alpine Swift	*Tachymarptis melba*	6.25	1	0.00	0
575	Ant-eating Chat	*Myrmecocichla formicivora*	87.50	14	40.00	8
514	Ashy Tit	*Melaniparus cinerascens*	6.25	1	0.00	0
493	Barn Swallow	*Hirundo rustica*	56.25	9	20.00	4
650	Black-chested Prinia	*Prinia flavicans*	93.75	15	5.00	1
841	Black-faced Waxbill	*Brunhilda erythronotos*	6.25	1	0.00	0
55	Black-headed Heron	*Ardea melanocephala*	25.00	4	0.00	0
245	Blacksmith Lapwing	*Vanellus armatus*	37.50	6	0.00	0
860	Black-throated Canary	*Crithagra atrogularis*	50.00	8	0.00	0
130	Black-winged Kite	*Elanus caeruleus*	12.50	2	0.00	0
270	Black-winged Stilt	*Himantopus himantopus*	12.50	2	0.00	0
216	Blue Crane	*Grus paradisea*	6.25	1	0.00	0
722	Bokmakierie	*Telophorus zeylonus*	56.25	9	0.00	0
381	Bradfield's Swift	*Apus bradfieldi*	6.25	1	0.00	0
714	Brown-crowned Tchagra	*Tchagra australis*	6.25	1	0.00	0

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
402	Brown-hooded Kingfisher	*Halcyon albiventris*	6.25	1	0.00	0
509	Brown-throated Martin	*Riparia paludicola*	37.50	6	0.00	0
695	Buffy Pipit	*Anthus vaalensis*	6.25	1	0.00	0
873	Cape Bunting	*Emberiza capensis*	31.25	5	0.00	0
703	Cape Longclaw	*Macronyx capensis*	12.50	2	0.00	0
531	Cape Penduline Tit	*Anthoscopus minutus*	18.75	3	0.00	0
581	Cape Robin-Chat	*Cossypha caffra*	31.25	5	0.00	0
94	Cape Shoveler	*Spatula smithii*	6.25	1	0.00	0
786	Cape Sparrow	*Passer melanurus*	81.25	13	20.00	4
737	Cape Starling	*Lamprotornis nitens*	37.50	6	0.00	0
98	Cape Teal	*Anas capensis*	6.25	1	0.00	0
316	Ring-necked Dove	*Streptopelia capicola*	62.50	10	5.00	1
106	Cape Vulture	*Gyps coprotheres*	0.00	0	5.00	1
686	Cape Wagtail	*Motacilla capensis*	68.75	11	0.00	0
568	Capped Wheatear	*Oenanthe pileata*	25.00	4	20.00	4
663	Chat Flycatcher	*Melaenornis infuscatus*	12.50	2	0.00	0
658	Chestnut-vented Warbler	*Curruca subcoerulea*	62.50	10	5.00	1
872	Cinnamon-breasted Bunting	*Emberiza tahapisi*	31.25	5	0.00	0
154	Common (Steppe) Buzzard	*Buteo buteo vulpinus*	12.50	2	5.00	1
263	Common Greenshank	*Tringa nebularia*	6.25	1	0.00	0
734	Common Myna	*Acridotheres tristis*	0.00	0	5.00	1
1	Common Ostrich	*Struthio camelus*	31.25	5	20.00	4
421	Common Scimitarbill	*Rhinopomastus cyanomelas*	12.50	2	0.00	0
843	Common Waxbill	*Estrilda astrild*	12.50	2	0.00	0
439	Crested Barbet	*Trachyphonus vaillantii*	31.25	5	0.00	0

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
711	Crimson-breasted Shrike	*Laniarius atrococcineus*	6.25	1	0.00	0
242	Crowned Lapwing	*Vanellus coronatus*	31.25	5	5.00	1
630	Desert Cisticola	*Cisticola aridulus*	43.75	7	0.00	0
352	Diederik Cuckoo	*Chrysococcyx caprius*	12.50	2	0.00	0
278	Double-banded Courser	*Rhinoptilus africanus*	6.25	1	5.00	1
1183	Eastern Clapper Lark	*Mirafra fasciolata*	37.50	6	0.00	0
4126	Eastern Long-billed Lark	*Certhilauda semitorquata*	6.25	1	0.00	0
89	Egyptian Goose	*Alopochen aegyptiaca*	56.25	9	5.00	1
404	European Bee-eater	*Merops apiaster*	25.00	4	0.00	0
678	Fairy Flycatcher	*Stenostira scita*	43.75	7	0.00	0
570	Familiar Chat	*Oenanthe familiaris*	50.00	8	5.00	1
459	Fawn-colored Lark	*Calendulauda africanoides*	37.50	6	0.00	0
665	Fiscal Flycatcher	*Melaenornis silens*	43.75	7	5.00	1
162	Gabar Goshawk	*Micronisus gabar*	6.25	1	0.00	0
122	Greater Kestrel	*Falco rupicoloides*	12.50	2	0.00	0
502	Greater Striped Swallow	*Cecropis cucullata*	43.75	7	0.00	0
54	Grey Heron	*Ardea cinerea*	18.75	3	0.00	0
638	Grey-backed Cisticola	*Cisticola subruficapilla*	12.50	2	0.00	0
485	Grey-backed Sparrow-Lark	*Eremopterix verticalis*	25.00	4	0.00	0
84	Hadada Ibis	*Bostrychia hagedash*	37.50	6	0.00	0
72	Hamerkop	*Scopus umbretta*	6.25	1	0.00	0
192	Helmeted Guineafowl	*Numida meleagris*	62.50	10	10.00	2
784	House Sparrow	*Passer domesticus*	68.75	11	5.00	1
152	Jackal Buzzard	*Buteo rufofuscus*	0.00	0	5.00	1
586	Kalahari Scrub Robin	*Cercotrichas paena*	31.25	5	0.00	0

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
583	Karoo Scrub Robin	*Cercotrichas coryphoeus*	68.75	11	0.00	0
1104	Karoo Thrush	*Turdus smithi*	12.50	2	5.00	1
463	Large-billed Lark	*Galerida magnirostris*	25.00	4	0.00	0
871	Lark-like Bunting	*Emberiza impetuani*	56.25	9	5.00	1
317	Laughing Dove	*Spilopelia senegalensis*	75.00	12	25.00	5
659	Layard's Warbler	*Curruca layardi*	31.25	5	0.00	0
125	Lesser Kestrel	*Falco naumanni*	12.50	2	10.00	2
604	Lesser Swamp Warbler	*Acrocephalus gracilirostris*	6.25	1	0.00	0
646	Levaillant's Cisticola	*Cisticola tinniens*	6.25	1	0.00	0
6	Little Grebe	*Tachybaptus ruficollis*	6.25	1	0.00	0
385	Little Swift	*Apus affinis*	37.50	6	5.00	1
621	Long-billed Crombec	*Sylvietta rufescens*	31.25	5	0.00	0
218	Ludwig's Bustard	*Neotis ludwigii*	0.00	0	10.00	2
103	Maccoa Duck	*Oxyura maccoa*	6.25	1	0.00	0
564	Mountain Wheatear	*Myrmecocichla monticola*	50.00	8	0.00	0
318	Namaqua Dove	*Oena capensis*	37.50	6	15.00	3
307	Namaqua Sandgrouse	*Pterocles namaqua*	12.50	2	0.00	0
637	Neddicky	*Cisticola fulvicapilla*	25.00	4	5.00	1
10877	Nicholson's Pipit	*Anthus nicholsoni*	6.25	1	0.00	0
1035	Northern Black Korhaan	*Afrotis afraoides*	68.75	11	15.00	3
179	Orange River Francolin	*Scleroptila gutturalis*	12.50	2	0.00	0
1171	Orange River White-eye	*Zosterops pallidus*	18.75	3	0.00	0
165	Pale Chanting Goshawk	*Melierax canorus*	62.50	10	10.00	2
744	Pale-winged Starling	*Onychognathus nabouroup*	6.25	1	5.00	1
498	Pearl-breasted Swallow	*Hirundo dimidiata*	6.25	1	0.00	0

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
522	Pied Crow	*Corvus albus*	75.00	12	35.00	7
746	Pied Starling	*Lamprotornis bicolor*	31.25	5	5.00	1
490	Pink-billed Lark	*Spizocorys conirostris*	0.00	0	10.00	2
846	Pin-tailed Whydah	*Vidua macroura*	25.00	4	0.00	0
694	Plain-backed Pipit	*Anthus leucophrys*	6.25	1	0.00	0
674	Pririt Batis	*Batis pririt*	25.00	4	0.00	0
844	Quailfinch	*Ortygospiza atricollis*	18.75	3	0.00	0
837	Red-billed Firefinch	*Lagonosticta senegala*	18.75	3	0.00	0
805	Red-billed Quelea	*Quelea quelea*	25.00	4	10.00	2
97	Red-billed Teal	*Anas erythrorhyncha*	6.25	1	0.00	0
501	Red-breasted Swallow	*Cecropis semirufa*	18.75	3	0.00	0
488	Red-capped Lark	*Calandrella cinerea*	6.25	1	0.00	0
314	Red-eyed Dove	*Streptopelia semitorquata*	25.00	4	0.00	0
392	Red-faced Mousebird	*Urocolius indicus*	43.75	7	0.00	0
820	Red-headed Finch	*Amadina erythrocephala*	18.75	3	5.00	1
212	Red-knobbed Coot	*Fulica cristata*	12.50	2	0.00	0
50	Reed Cormorant	*Microcarbo africanus*	6.25	1	0.00	0
940	Rock Dove	*Columba livia*	6.25	1	0.00	0
123	Rock Kestrel	*Falco rupicolus*	6.25	1	0.00	0
506	Rock Martin	*Ptyonoprogne fuligula*	62.50	10	0.00	0
619	Rufous-eared Warbler	*Malcorus pectoralis*	75.00	12	5.00	1
460	Sabota Lark	*Calendulauda sabota*	31.25	5	0.00	0
789	Scaly-feathered Weaver	*Sporopipes squamifrons*	31.25	5	0.00	0
105	Secretarybird	*Sagittarius serpentarius*	0.00	0	10.00	2
560	Sentinel Rock Thrush	*Monticola explorator*	6.25	1	0.00	0

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
561	Short-toed Rock Thrush	*Monticola brevipes*	18.75	3	5.00	1
572	Sickle-winged Chat	*Emarginata sinuata*	37.50	6	0.00	0
504	South African Cliff Swallow	*Petrochelidon spilodera*	43.75	7	0.00	0
90	South African Shelduck	*Tadorna cana*	18.75	3	0.00	0
707	Southern Fiscal	*Lanius collaris*	75.00	12	15.00	3
4142	Southern Grey-headed Sparrow	*Passer diffusus*	37.50	6	0.00	0
803	Southern Masked Weaver	*Ploceus velatus*	87.50	14	15.00	3
808	Southern Red Bishop	*Euplectes orix*	43.75	7	0.00	0
311	Speckled Pigeon	*Columba guinea*	62.50	10	5.00	1
474	Spike-heeled Lark	*Chersomanes albofasciata*	31.25	5	5.00	1
368	Spotted Eagle-Owl	*Bubo africanus*	6.25	1	0.00	0
654	Spotted Flycatcher	*Muscicapa striata*	6.25	1	0.00	0
88	Spur-winged Goose	*Plectropterus gambensis*	25.00	4	0.00	0
185	Swainson's Spurfowl	*Pternistis swainsonii*	12.50	2	0.00	0
411	Swallow-tailed Bee-eater	*Merops hirundineus*	6.25	1	0.00	0
238	Three-banded Plover	*Charadrius tricollaris*	18.75	3	0.00	0
735	Wattled Starling	*Creatophora cinerea*	31.25	5	5.00	1
359	Western Barn Owl	*Tyto alba*	12.50	2	0.00	0
80	White Stork	*Ciconia ciconia*	0.00	0	5.00	1
391	White-backed Mousebird	*Colius colius*	37.50	6	0.00	0
107	White-backed Vulture	*Gyps africanus*	6.25	1	0.00	0
763	White-bellied Sunbird	*Cinnyris talatala*	6.25	1	0.00	0
780	White-browed Sparrow-Weaver	*Plocepasser mahali*	62.50	10	10.00	2
409	White-fronted Bee-eater	*Merops bullockoides*	6.25	1	0.00	0
383	White-rumped Swift	*Apus caffer*	50.00	8	0.00	0

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
865	White-throated Canary	*Crithagra albogularis*	6.25	1	0.00	0
495	White-throated Swallow	*Hirundo albigularis*	6.25	1	0.00	0
866	Yellow Canary	*Crithagra flaviventris*	81.25	13	5.00	1
600	Yellow-bellied Eremomela	*Eremomela icteropygialis*	50.00	8	0.00	0
96	Yellow-billed Duck	*Anas undulata*	6.25	1	0.00	0