DEVELOPMENT OF THE HIGHVELD SOLAR PV FACILITY AND ASSOCIATED INFRASTRUCTURE, NORTH WEST PROVINCE

Avifauna Baseline and Impact Assessment Report

October 2022

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

PO Box 72847
Lynwood Ridge
Pretoria
0040

Prepared for:
Savannah Environmental (Pty) Ltd

PO Box 148
Sunninghill
Gauteng
2157
0040

EXECUTIVE SUMMARY

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of WKN Windcurrent SA (Pty) to compile an avifauna baseline and impact assessment report for the proposed Highveld Solar PV facility and associated infrastructure on the Remainder of Portion 10 and Portions 56 and 79 of Farm Rietfontein 388 as well as the Remainder of Farm Rietfontein 3, near Stilfontein, North West Province.

The objectives of the avifaunal study were to: (a) describe the avifauna associations in the project area according to species composition and richness prior to construction activities; (b) provide an inventory of bird species occurring in the project area including species prone towards collisions with the proposed infrastructure; (c) provide an impact assessment; and (d) provide an indication of the occurrence of species of concern (e.g. threatened and near threatened species).

Baseline avian data was obtained from point count sampling techniques during two independent sampling sessions (April/May 2022 and September 2022).

Three prominent avifaunal habitat types were identified on the development area, which consisted of open savannoid grassland with bush clump mosaics, artificial livestock watering points and the Kromdraaispruit floodplain. The highest number of bird species and bird individuals were observed from the artificial livestock watering points and from bush clump habitat consisting of a prominent (tall) canopy. Approximately 245 bird species were expected to occur in the wider study area, of which 106 species were observed on the development area during the respective surveys. The expected richness included nine threatened or near threatened species, 16 southern African endemics and 21 are near-endemic species. The critically endangered White-backed Vulture (*Gyps africanus*) and endangered Cape Vulture (*G. coprotheres*) were observed as foraging individuals soaring overhead. In addition, a pair of vulnerable Lanner Falcons (*Falco biarmicus*) occurred within the study area. The nearby Kromdraaispruit floodplain west of the development area provided potential suitable foraging habitat for the regionally endangered African Marsh Harrier (*Circus ranivorus*), although this species was not observed during the respective surveys. Although the African Marsh Harrier was not recorded on the study area during the survey period, it was recommended that all potential habitat be conserved (as a precautionary principle) by applying a 500m buffer to the edge of the Kromdraaispruit floodplain. Thirteen southern African endemics and 15 near-endemic species were confirmed on the development area.

The main impacts associated with the proposed PV solar facility includes the following:

- The loss of habitat and subsequent displacement of bird species due to the ecological footprint required during construction.

- Direct interaction (collision trauma) by birds with the surface infrastructure (photovoltaic panels) caused by polarised light pollution and/or colliding with the panels (as they are mistaken for waterbodies).
- Collision with associated infrastructure (mainly overhead power lines).

An evaluation of potential and likely impacts on the avifauna revealed that the impact significance was moderate to low after mitigation (depending on the type of impact). However, the risk for certain waterbirds (mainly large-bodied waterfowl such as the South African Shelduck *Tadorna cana*, Egyptian Goose *Alopochen aegyptiacus* and members of the genus *Anas*) colliding with the PV infrastructure remained eminent due to the presence of the nearby Kromdraaispruit. It was strongly recommended that the proposed mitigation measures and monitoring protocols (e.g. post construction monitoring) be implemented during the construction and operational phase of the project.

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DECLARATION OF INDEPENDENCE

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

- I act as the independent specialist in this application to Savannah Environmental (Pty) Ltd and WKN Windcurrent SA (Pty);
- 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)
16 October 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 countries.

1. INTRODUCTION

1.1. Background

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of WKN Windcurrent SA (Pty) to compile an avifauna impact assessment report for the proposed Highveld Solar PV facility (herewith referred to as the "study site") and associated infrastructure with a contracted capacity of 240MW located on a site approximately 15km north-east of the town of Stilfontein in the North West Province (Figure 1). The development area is situated within the JB Marks Local Municipality within the Dr Kenneth Kaunda District Municipality. The site will be accessible via the N12, which is located to the south of the development area and the R30, which is located to the west of the proposed Highveld Solar PV Facility.

The infrastructure of the facility will consist of the following components (Figure 2):

- Solar PV arrays, modules and mounting structures.
- Inverters and transformers.
- A Battery Energy Storage System (BESS).
- On-site facility substation.
- Cabling between the project components.
- Site and internal access roads and fencing around the development area. The proposed site access road will be approximately 3.4km in length from the existing Rietfontein Road turnoff.
- Temporary and permanent laydown areas and O&M buildings.

The total extent of the project site[1] will cover approximately 1 400ha, while the total extent of the development area[2] will be up to 1 300ha in extent. The total extent of the development footprint[3] is up to 433ha in extent. The proposed access road coincides with an existing road which will be widened to 6m.

The project site is located within the Klerksdorp Renewable Energy Development Zones (REDZ), and therefore, a Basic Assessment (BA) process will be undertaken in accordance with GN R114 (as formally gazetted on 16 February 2018).

The Highveld Solar PV facility intends to connect to the National Grid via the switching substation located on the Highveld Solar PV Facility and a point of connection on the Hermes DS - Potchefstroom DS 1 and Buffels East 1 -

[1] The project site is an identified area located within which development area and development footprint. It is the broader geographic area assessed as part of the BA process, within which indirect and direct effects of the project may occur.

[2] The development area is an identified area where the 240MW PV facility is planned to be located. This area has been selected as a practicable option for the facility, considering technical preference and constraints.

[3] The development footprint is an area (located within the development area) where the PV panel arrays and other associated infrastructure for the Highveld Solar PV facility is planned to be constructed. This is the actual footprint of the facility, and the area which would be disturbed

Potchefstroom 132kV Feeder lines located east of Khuma and the R502. The grid connection infrastructure associated with this grid solution is being assessed as part of a separate BA process.

1.2. Objectives and Terms of Reference

The main objectives of the avifaunal study were to: (a) describe the avifauna associations in the project development area according to species composition and richness prior to construction activities; (b) provide an inventory of bird species occurring in the development area including species prone towards collisions with the proposed infrastructure; (c) provide an impact assessment; and (d) provide an indication of the occurrence of species of concern (e.g. threatened and near threatened species; sensu IUCN, 2022; Taylor et al., 2015; Marnewick et al., 2015).

A bird assessment is required as part of the Basic Assessment process to investigate the impacts of the proposed solar facility on the avian attributes at the study site and its immediate surroundings. The avifaunal attributes at the proposed PV facility will be determined by means of a desktop analysis of GIS based information, third-party datasets and a number of site surveys. It also provides the results from two independent pre-construction surveys as per the best practice guidelines of Jenkins *et al.* (2017).

The terms of reference are to:

- conduct a baseline bird assessment based on available information pertinent to the ecological and avifaunal attributes on the development area and habitat units;
- conduct an assessment of all information on a BA level in order to present the following results:
    - typify the regional and site-specific avifaunal macro-habitat parameters that will be affected by the proposed project;
    - provide a shortlist of bird species present as well as highlighting dominant species and compositions;
    - 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 development area;
    - highlight areas of concern or "hotspot" areas;
    - identify and describe impacts that are considered pertinent to the proposed development;
    - highlight gaps of information in terms of the avifaunal environment; and
    - recommend additional surveys and monitoring protocols (*sensu* Jenkins et al., 2017).

1.3. Scope of Work

The following aspects form part of the Scope of Work:

- A desktop study of bird species expected to occur (e.g. species that could potentially be present), as well as species recorded in the past (e.g. SABAP1);
- A baseline survey of observed bird species according to ad hoc observations and during two independent sampling surveys;
- A list of bird species historically recorded within the relevant quarter degree grid in which the study site occurs (SABAP1);
- Any protected or threatened bird species recorded in the past within the relevant quarter degree grid, their scientific names and colloquial names, and protected status according to IUCN red data lists; and
- The potential of these protected or threatened species to persist within the study area.

The following aspects will be discussed during this avifaunal assessment:

- Collision-prone bird species expected to be present and/or observed;
- A list of the dominant bird species;
- A list of observed and expected threatened and near threatened species (according to IUCN red data list);
- Possible migratory or nomadic species;
- Potential important flyways/congregatory sites and/or foraging sites; and
- Avian impacts associated with the PV solar facility.

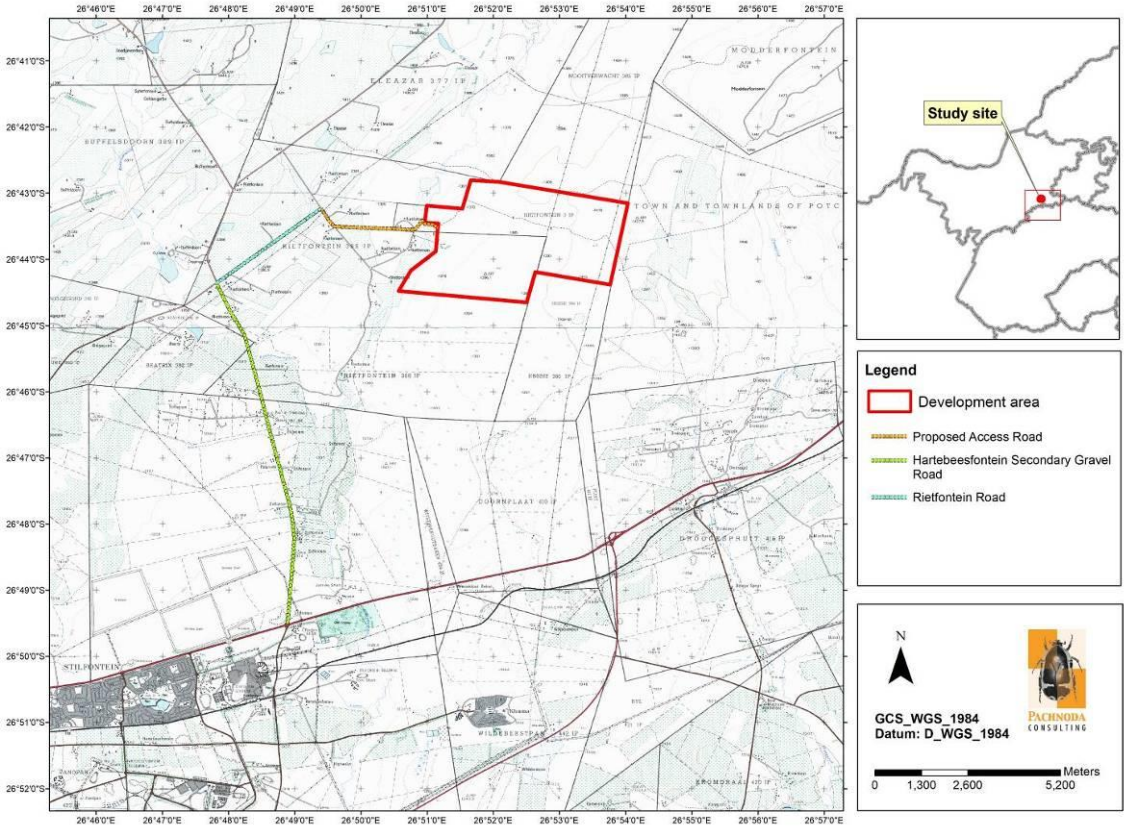

Figure 1: A topo-cadastral image illustrating the geographic position of the Highveld Solar PV facility.

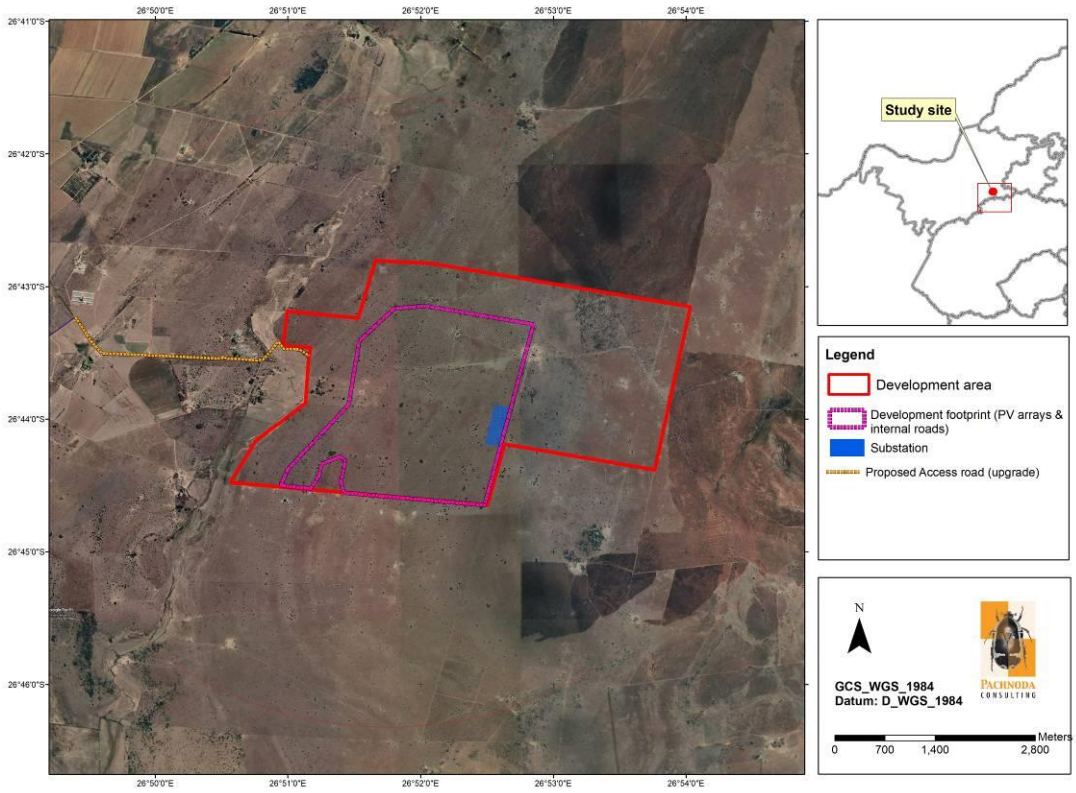

Figure 2: A satellite image illustrating the geographic position of the proposed Highveld Solar PV facility and associated infrastructure.

2. METHODS & APPROACH

The current report places emphasis on the avifaunal community as a key indicator group on the proposed study site, thereby aiming to describe the conservation significance of the ecosystems in the area. Therefore, the occurrence of certain bird species and their relative abundances may determine the outcome of the ecological sensitivity of the area and the subsequent proposed layouts of the solar facility infrastructure.

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

- relevant literature – see section below;
- observations made during two site visits (27-28 April and 04-05 May 2022 and 11-12 and 21-23 September 2022); and
- personal observations from similar habitat types in proximity to the study 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), Harrison *et al.* (1997) and Del Hoyo *et al.* (1992-2011) for general information on bird identification and life history attributes.
- Marnewick *et al.* (2015) was consulted for information regarding the biogeographic affinities (e.g. biome-restricted bird species) of selected bird species that could be present on the development 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 the quarter-degree grid cell (QDGC) 2626DB (Eleasar) and 2626DD (Stilfontein). The information was then modified according to the prevalent habitat types present on the study site. 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 site. 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 grid relevant to the current project is 2640_2650 (although information from all eight surrounding pentad grid was also scrutinised; Figure 3).
- The choice of scientific nomenclature, taxonomy and common names were recommended by the International Ornithological Committee (the IOC World

Bird List v. 12.2), unless otherwise specified (see www.worldbirdnames.org as specified by Gill et al, 2022).

- All observations obtained during the site visits were submitted to the South African Bird Atlas Project (SABAP2).
- The best practice guidelines for solar facilities by BirdLife South Africa (Jenkins et al., 2017).

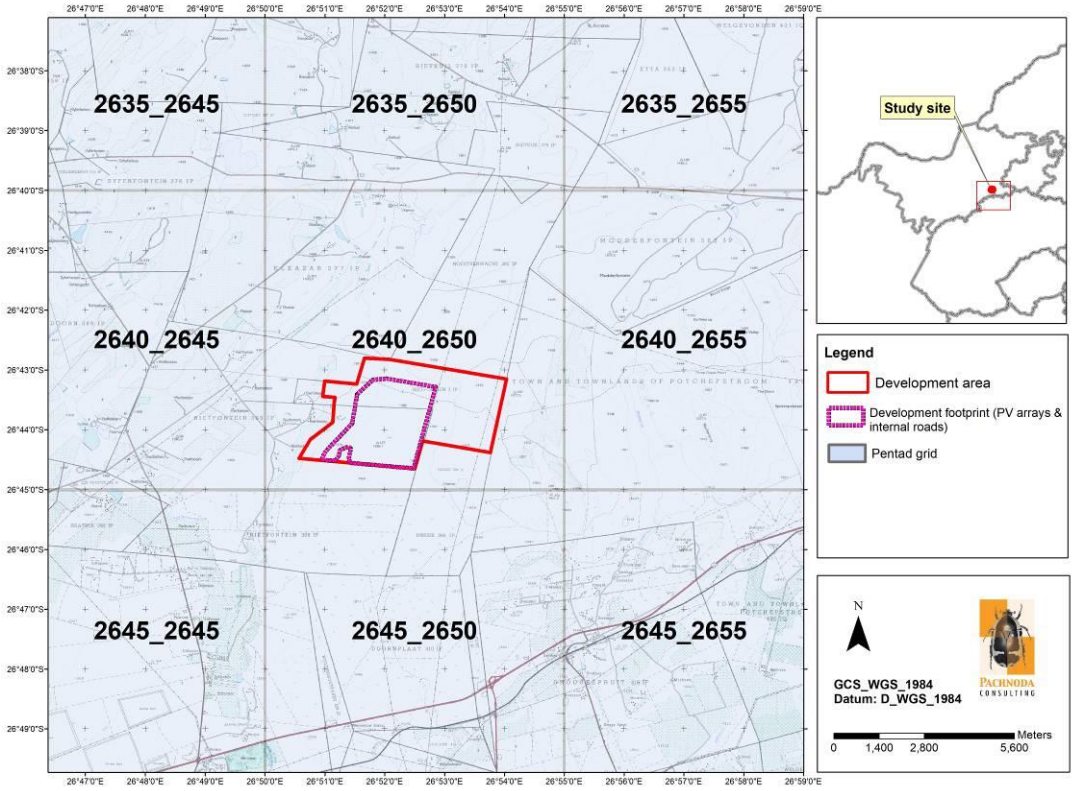

Figure 3: A map illustrating the pentad grids that were investigated for this project.

2.2. Field Methods

The avifauna of the study site was surveyed during two independent site visits representing a late wet season (April 2022) and a late dry season survey (September 2022).

The baseline avifaunal survey was conducted by means of the following survey techniques:

2.2.1. Point Counts

Bird data was collected by means of 33 point counts (as per Buckland et al. 1993) from the development area where all birds seen and heard from a specific point over a set period of time was recorded. Data from the point counts has been analysed to

determine dominant and indicator bird species (so-called discriminant species), relative densities and to delineate the different bird associations present.

The use of point counts is advantageous since it is the preferred method to use for skulking or elusive species. In addition, it is the preferred method to line transect counts where access is problematic, or when the terrain appears to be complex (e.g. mountainous). It is considered to be a good method to use, and very efficient for gathering a large amount of data in a short period of time (Sutherland, 2006). The spatial position of each point count is illustrated in Figure 4. The spatial placement of the point counts was determined through a stratified random design which ensures coverage of each habitat type and/or macro-habitat (Sutherland et al., 2004).

Therefore, the sampling approach was adapted so that all the bird species seen within approximately 50m from the centre of the point were recorded (resulting in an area of 0.78 ha) along with their respective abundance values (a laser rangefinder was used to delineate the area to be surveyed at each point). Each point count lasted approximately 20-30 minutes, while the area within the 50 m radius of homogenous habitat was slowly traversed to ensure that all bird species were detected and or flushed (as proposed by Watson, 2003). To ensure the independence of observations, points were positioned at least 200 m apart. Observations were not truncated, and in order to standardise data collection, the following assumptions were conformed to (according to Buckland *et al.*, 1994):

- All birds on the point must be seen and correctly identified. This assumption is in practice very difficult to meet in the field as some birds in the nearby vicinity may be overlooked due to low visibility or were obscured by vegetation (e.g. graminoid cover). Therefore, it is assumed that the portion of birds seen on the point count represents the total assemblage on the point.
- All birds must be recorded at their initial location. All movements of the birds are random and therefore natural in relation to the movements of the observer. None of the birds moved in response to the presence of the observer, and birds flying past without landing were omitted from the analysis. In other words, no bird is recorded more than once.

2.2.2. Random (ad hoc) surveys

To obtain an inventory of bird species present (apart from those observed during the point counts), all bird species observed/detected while moving between point counts were identified and noted. Particular attention was devoted to suitable roosting, foraging and nesting habitat for species of conservation concern (e.g. threatened or near threatened species). In addition, the fly patterns of large non-passerine and birds of prey were recorded, as well as the locality of collision-prone birds.

2.2.3. Analyses

Data generated from the point counts was 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. Hierarchical Agglomerative Clustering (a cluster analysis-based group-average linkages; Clarke & Warwick 1994) was performed on calculated Bray-Curtis coefficients derived from the data. A cluster analysis is used to assign "species associations" between samples with the aim to objectively delineate groups or assemblages. Therefore, sampling entities that group together (being more similar) are believed to have similar compositions.

The species richness and diversity of each bird association was analysed by means of richness measures (such as the total number of species recorded (S) and Shannon Wiener Index) were calculated to compare the associations with each other.

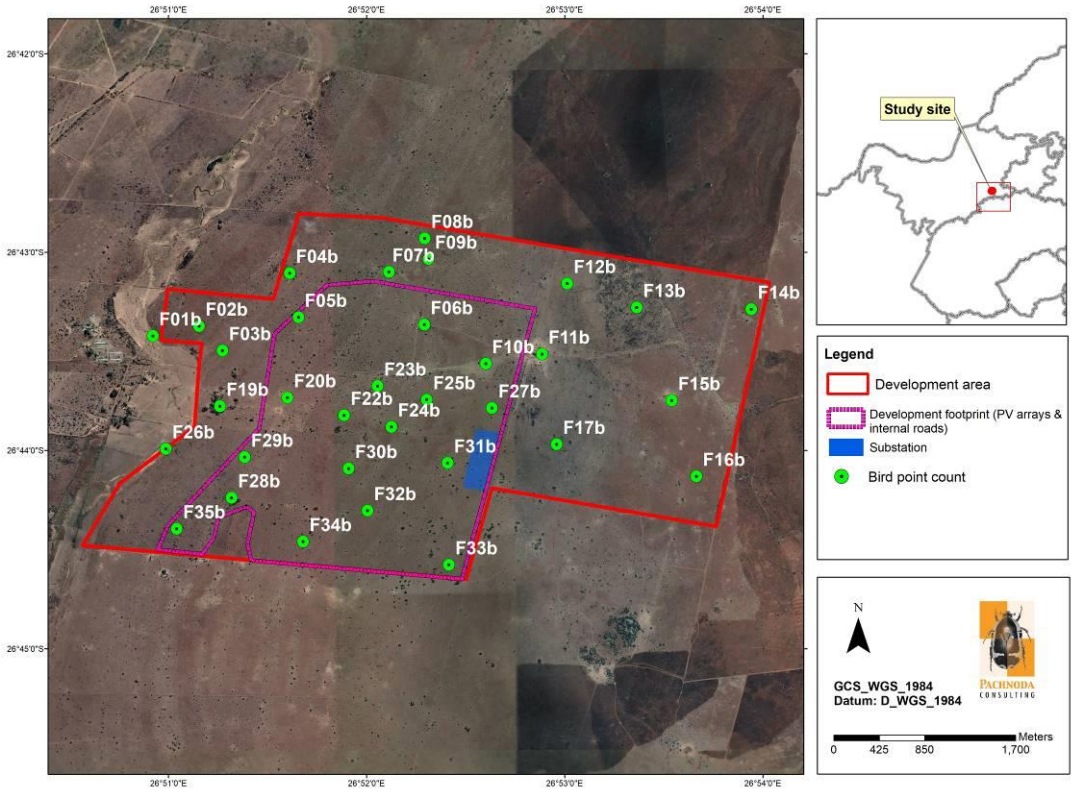

Figure 4: A map illustrating the spatial position of 33 bird point counts located within the development area.

2.3. Sensitivity Analysis

A sensitivity map was compiled based on the outcome of the baseline results.

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 services (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 contain high numbers of threatened, endemic or rare bird species. These areas should preferably be protected;
- *Moderately high* - Untransformed or productive habitat units (which can also be artificial) which contain high bird numbers and/or bird richness values. These areas are often fragmented OR azonal, and hence of small surface area that are often surrounded by habitat of moderate or low sensitivity. These habitat units also include potential habitat for threatened species. Development is often considered permissible on these areas if there is enough reason to believe that these areas are widespread in the region and future planned developments are unlikely to result in the widespread loss (>50 %) of similar habitat at a regional scale.
- *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 bird species diversity (most species are usually exotic or weeds).

2.4. Limitations

- 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 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. artificial livestock watering points). In addition, these datasets encompass surface areas larger than the study area, which could include habitat types and species that are not present on the study site. Therefore the potential to overestimate species richness is highly likely while it is also possible that certain cryptic or specialist species could have been be overlooked in the past.
- Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town were recently initiated and therefore incomplete.
- Results presented in this report are based on a "snapshot" investigation of the development area and not based on long-term investigations (e.g. several weeks or months) of all the environmental attributes and the varying degrees of bird diversity that may be present in development area. Although, as much as possible data was obtained from ad hoc observations and point counts during the survey period, these surveys are customarily limited by budgetary and time constraints whereby results presented in this report need to be interpreted with these limitations in mind.
- Rare and endemic species normally do not occur in great densities and, because of customary limitations in the search and identification of Red Listed species, any detailed autecological investigations of these species was not possible. Results are ultimately based on inferred estimations and specialist interpretation of survey data.
- 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.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. Locality

The proposed Highveld Solar PV facility and associated infrastructure will be located on Remainder of Portion 10 and Portions 56 and 79 of Farm Rietfontein 388 as well as the Remainder of Farm Rietfontein 3. The project site is approximately 15km north-east of Stilfontein in the North West Province (Figure 1). The site coordinates at the centre of the development area is 26°43'39.92"S, 26°52'36.12"E.

3.2. Regional Vegetation Description

The study site corresponds to the Grassland Biome and more particularly to the Dry Highveld Grassland Bioregion as defined by Mucina & Rutherford (2006). It consists of two ecological types known as Vaal Reefs Dolomite Sinkhole Woodland and Klerksdorp Thornveld (Mucina & Rutherford, 2006; updated 2012) (Figure 5).

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. Grasslands 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 Grassland Biome and severe habitat transformation, many of the bird species that are restricted to the grasslands are also threatened or experiencing declining population sizes. Bushveld and woodland habitat consist of higher floristic structure (owing to the presence of tree and shrub species) with a subsequent increase in vertical heterogeneity. The increase in vertical heterogeneity also increase niche space and allow for niche-packing by species which often share the same prey resource. Therefore, bushveld and woodland habitat is often rich in bird species numbers, but often lacks the high endemicity observed in Highveld grassland habitat.

1. Vaal Reefs Dolomite Sinkhole Woodland

Vaal Reefs Dolomite Sinkhole Woodland is confined to a small area associated with dolomite sinkholes in the Stilfontein and Orkney areas corresponding to the North West and Free State Provinces. It is located on the western part of the study site. It occurs on slightly undulating landscapes dissected by prominent chert ridges, thereby supporting a grassland-woodland floristic mosaic. A prominent floristic structure of this vegetation type is woodland formations in the form of bush clumps around sinkholes and dolomite outcrops.

The Vaal Reefs Dolomite Sinkhole Woodland is a threatened (**Vulnerable**) ecosystem with only a small patch conserved in the statutorily conservation area of the Sterkfontein Caves (part of the Cradle of Humankind World Heritage Site). In addition, the proposed "Highveld National Park" is supposed to conserve a large section of this vegetation type, which is considered to be one of the most aesthetically pleasing and scenic landscapes in the western Grassland Biome. Approximately 25% of this vegetation type has been transformed due to mining activities and cultivation, and it corresponds to an area with the highest concentration of mines when compared to other vegetation types. In addition, the Vaal Reefs Dolomite Sinkhole Woodland is a Threatened Ecosystem (as per Section 52 of National Environmental Management Biodiversity Act, (Act No. 10 of 2004)) and a Critical Biodiversity Area as per the Free State Conservation Plan (DESTEA, 2015).

2. Carletonville Dolomite Grassland

Carletonville Dolomite Grassland is confined to the dolomite plains that stretch from Lichtenburg in the North West Province to sections of rocky grassland in Gauteng, especially between altitudes of 1 350 m and 1 450 m. It is located on the central and eastern parts of the study site. It occurs on slightly undulating plains dissected by prominent chert ridges, thereby containing a grassland composition rich in floristic species forming a complex mosaic dominated by many plant species.

The Carletonville Dolomite Grassland is a threatened (**Vulnerable**) ecosystem with 2 % of the remaining 76 % of the untransformed composition formally protected within the Cradle of Humankind World Heritage Site and various nature reserves such as Abe Baily and Krugersdorp Nature Reserves.

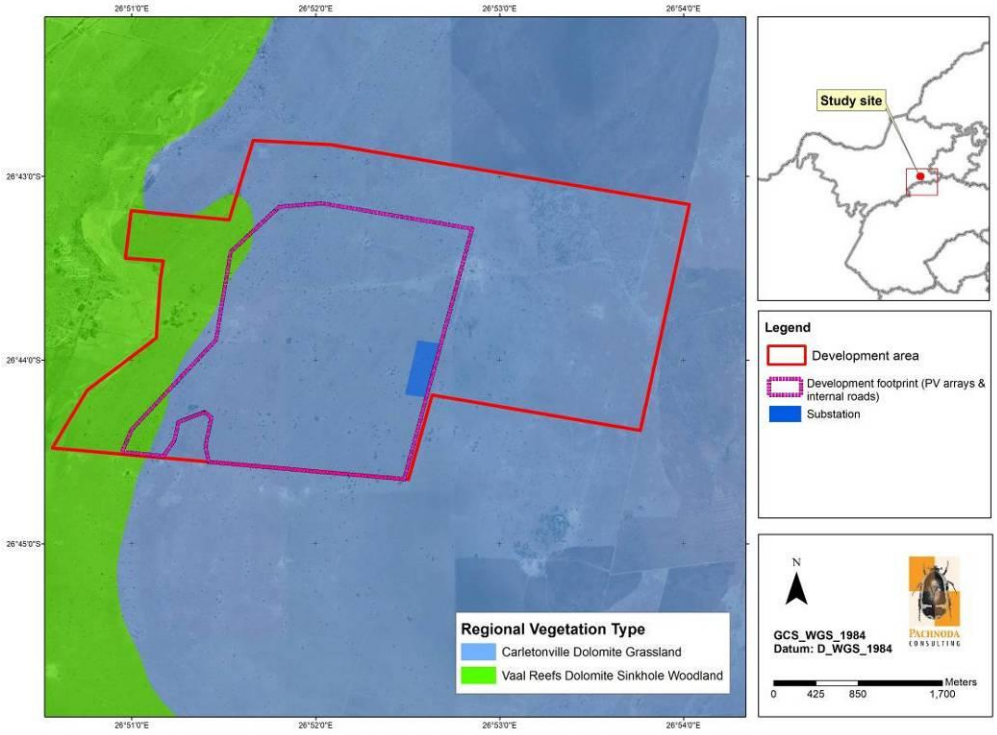

Figure 5: A topographic image illustrating the regional vegetation type corresponding to the study site. Vegetation type categories were identified according to Mucina & Rutherford (2006).

3.3. Land cover, land use and existing infrastructure.

According to the South African National dataset of 2013-2014 (Geoterrainimage, 2015) the project area comprehends the following land cover categories (Figure 6):

Natural areas:

- Grassland;
- Low shrubland;
- Wetlands; and
- Woodland and open bush.

From the land cover dataset it is evident that most of the study site is covered by natural grassland and low shrubland. The study site is primarily used for livestock production and livestock grazing. Existing infrastructure includes powerline servitudes located on the eastern part of the development area. A natural drainage line and floodplain habitat (the Kromdraaispruit) of the Koekemoerspruit are located to the west of the development area.

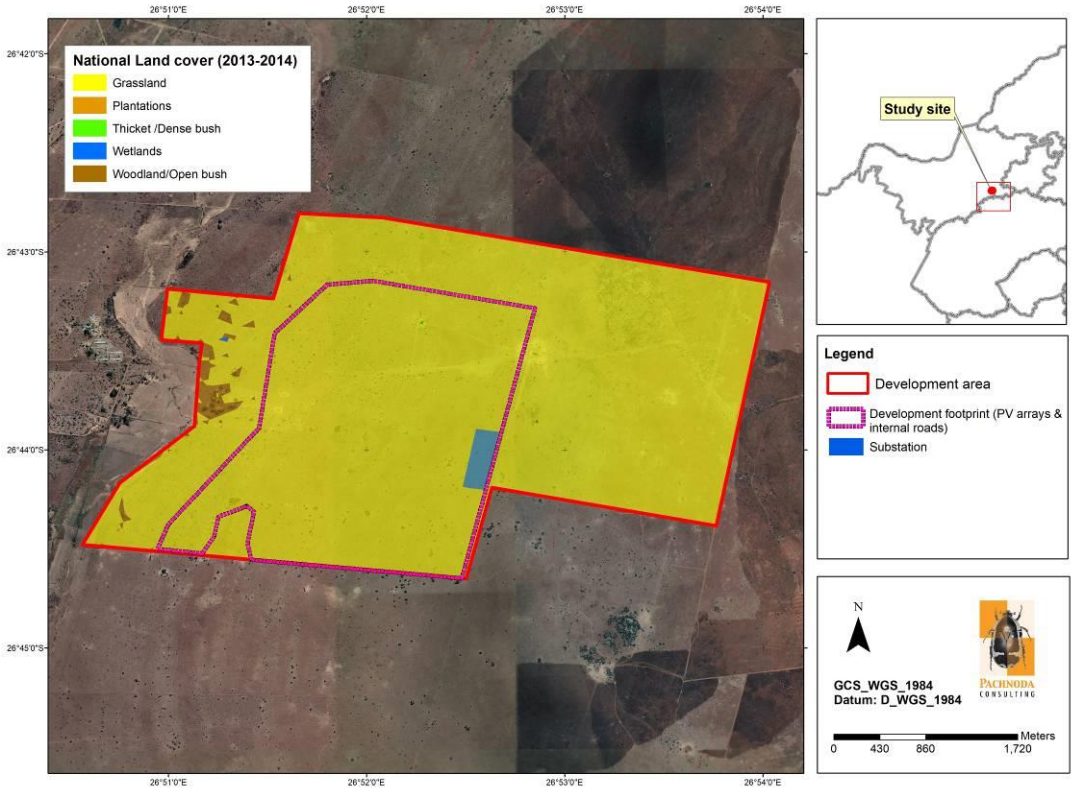

Figure 6: A map illustrating the land cover classes (Geoterrainimage, 2015) corresponding to the proposed study area.

3.4. Conservation Areas, Protected Areas and Important Bird Areas

The study site is located approximately 13km east of the Faan Meintjies Nature Reserve (and within 10km of the reserve's 3km buffer area) (Figure 7). This conservation area is a municipal reserve under management of the City of Matlosana Local Municipality. In addition, the study area is located within the confines (west) of the "un-proclaimed" Highveld Nature Reserve (also often referred to as the Highveld National Park). Although little information is available about the exact boundaries and management of the reserve, it is known as a "Community reserve" claimed by the Barolong Bo Modiboa. The "reserve" is situated west of the town of Potchefstroom on the N12 route near the Ikageng township and Matlwang village. It is an area of high conservation value as it conserves a portion of the western grassland biome. Popular attractions include an annual hiking event and community outreach programmes.

There are no other formal protected areas or any Important Bird and Biodiversity Areas in close proximity to the study site.

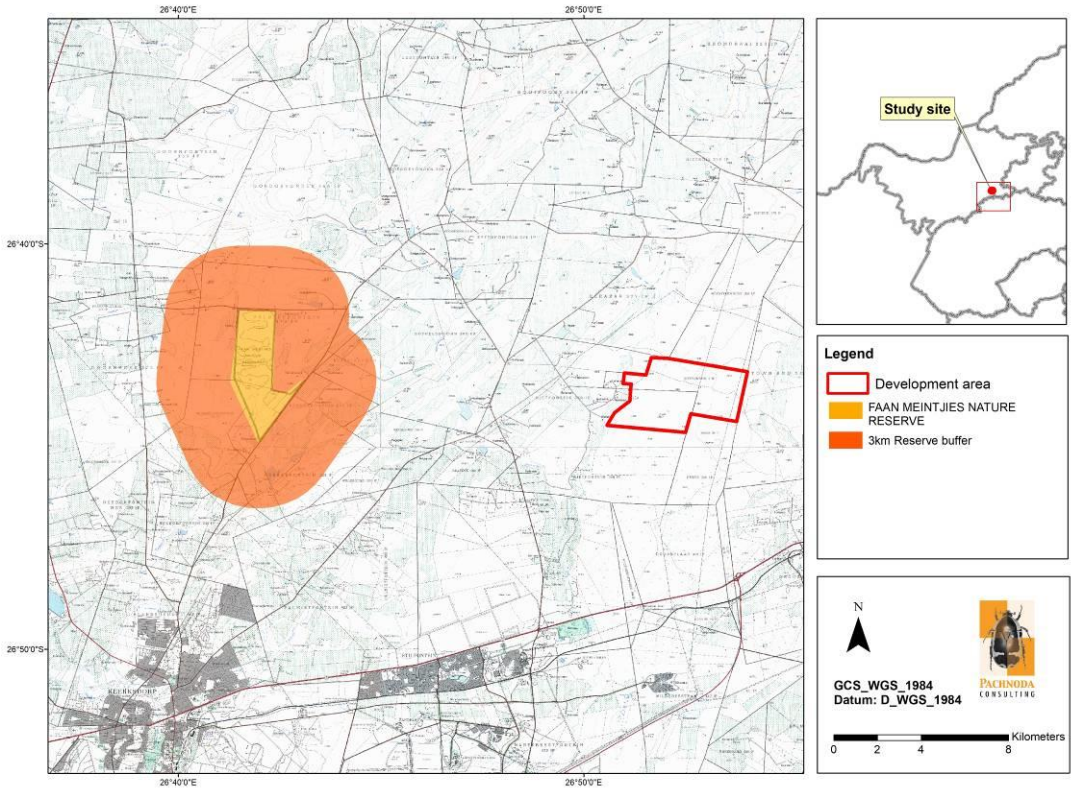

Figure 7: A map illustrating the locality of a conservation area in close proximity to the study site.

3.5. Annotations on the National Web-Based Environmental Screening Tool

Regulation 16(1)(v) of the Environmental Impact Assessment Regulations, 20145 (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 area holds a medium sensitivity with respect to the relative animal species protocol (Figure 8) (report generated 23/09/2022):

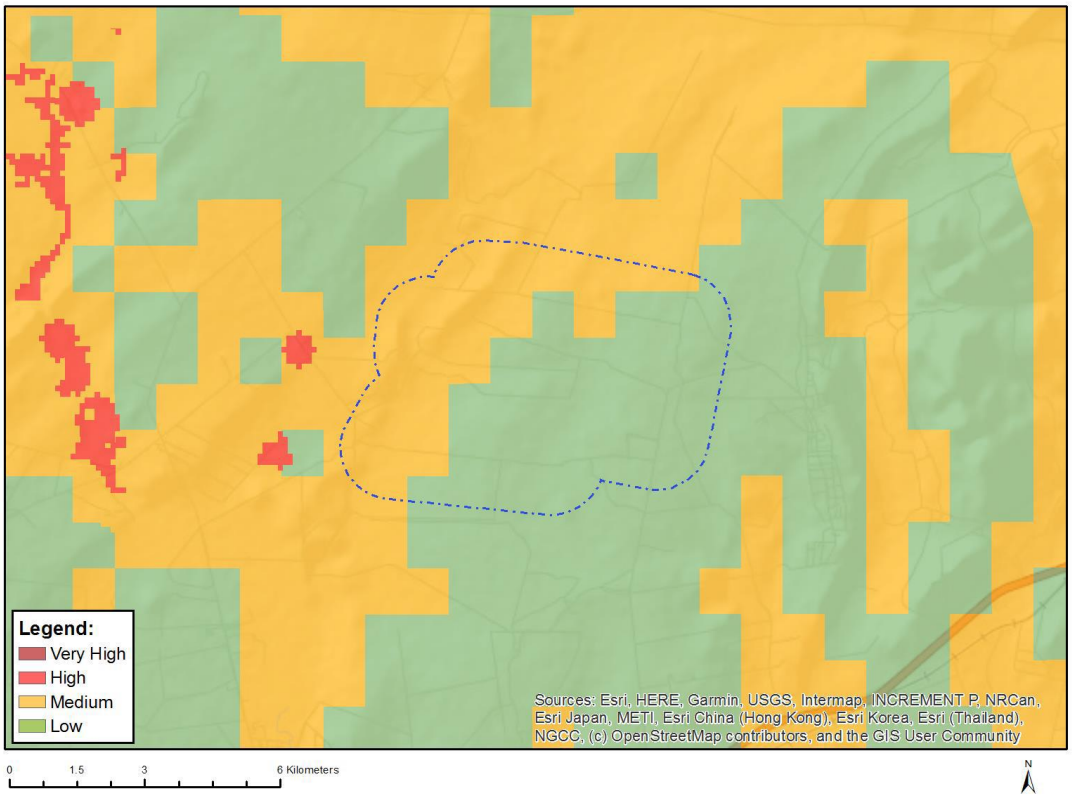

Figure 8: The animal species sensitivity of the study area according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	Subject to confirmation
Medium	Aves-*Circus ranivorus*
Medium	Mammalia-*Crocidura maquassiensis*
Medium	Mammalia-*Hydrictis maculicollis*

It is evident from the results of the Screening Tool report that the study area contains potential habitat (of medium sensitivity) for the endangered African Marsh Harrier (*Circus ranivorus*) along with two mammal species

The study area holds a low sensitivity with respect to the relative avian theme (Figure 9) (report generated 23/09/2022):

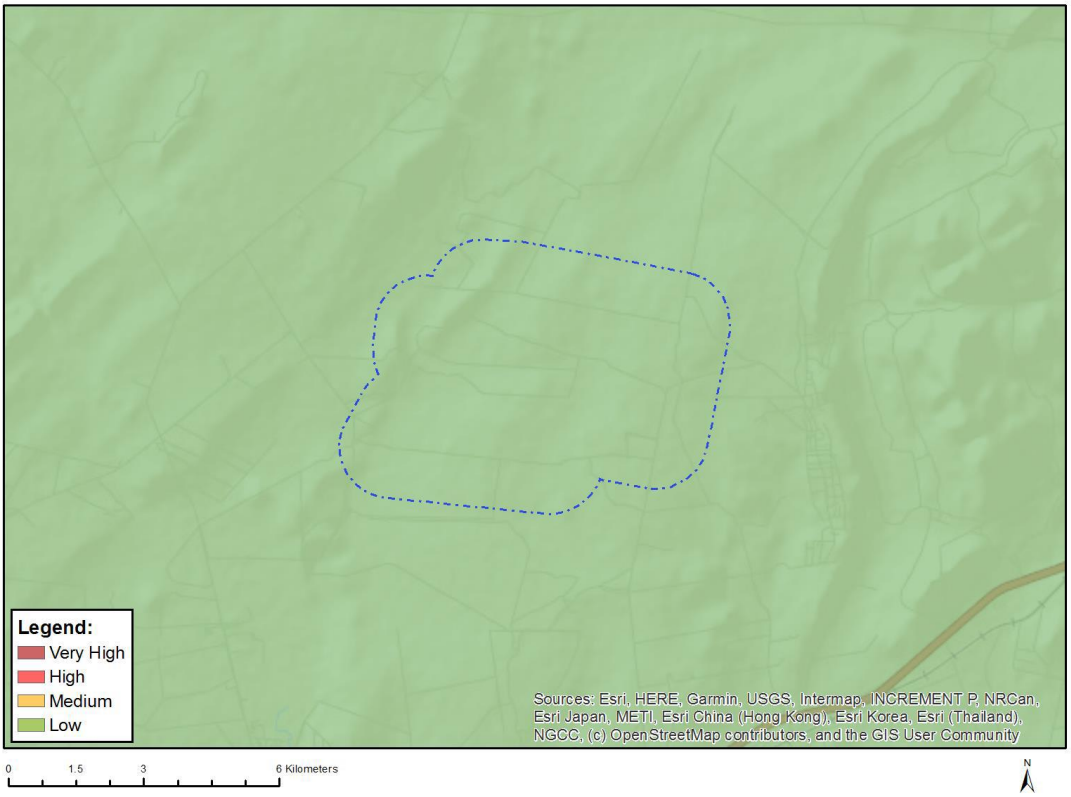

Figure 9: The relative avian sensitivity of the study site according to the Screening Tool.

It is evident from the results of the Screening Tool report that the study area is potentially not an important area for bird species with a high probability to interact with the solar infrastructure and that the site does not potentially overlap with important avian flyways.

However, the study area holds a very high sensitivity with respect to the relative terrestrial biodiversity theme (Figure 10) (report generated 23/09/2022):

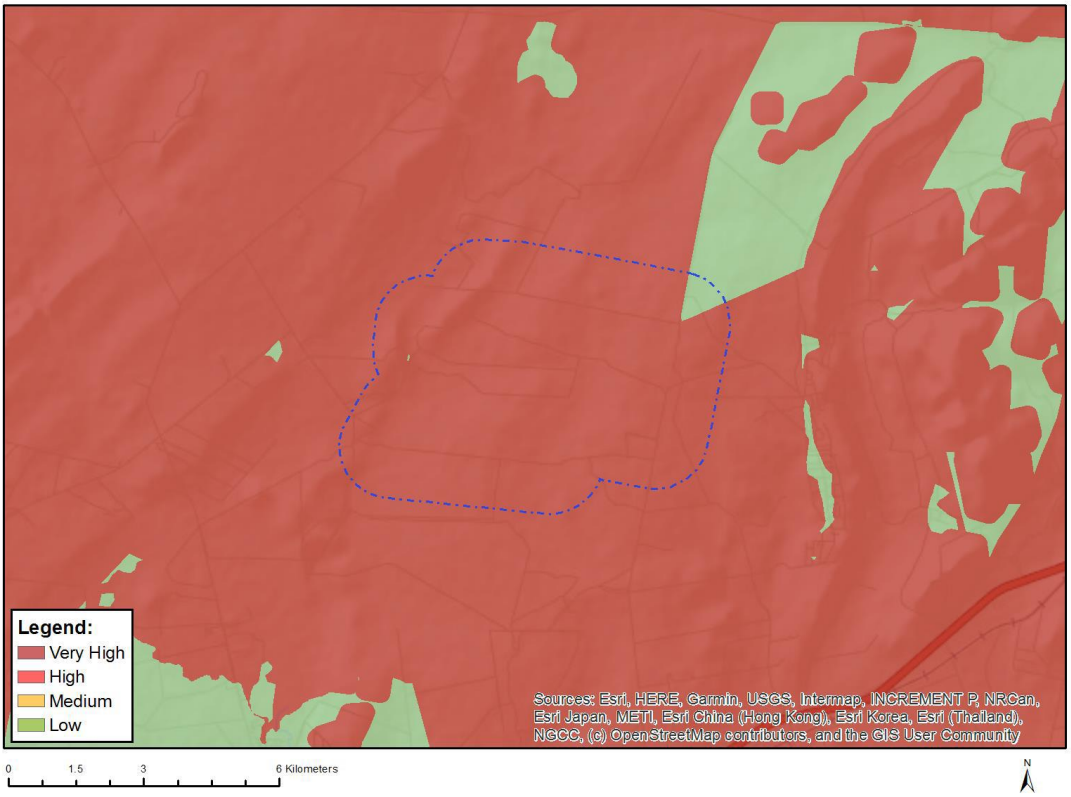

Figure 10: The relative terrestrial biodiversity sensitivity of the study area according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	Low Sensitivity
Very High	Critical biodiversity area 1
Very High	Critical biodiversity area 2
Very High	Ecological support area 1
Very High	Ecological support area 2
Very High	Protected Areas Expansion Strategy

It is evident from the results of the Screening Tool report that the study area coincides with Critical Biodiversity Areas (CBA 1 and CBA 2) and Ecological Support Areas (ESA 1 & 2) as per the North West Biodiversity Sector Plan (READ, 2015). It is also considered to be part of the Protected Areas Expansion Strategy, which include part of the "Highveld Nature Reserve".

4. RESULTS AND DISCUSSION

4.1. Avifaunal habitat types

Apart from the regional vegetation types, the local composition and distribution of the vegetation associations on the study area are a consequence of a combination of factors simulated by historical disturbances, the presence of drainage lines and grazing intensity (presence of livestock) which have culminated in a number of habitat types that deserve further discussion (Figure 11 and Figure 12):

1. *Open savannoid grassland with bush clump mosaics:* This unit is dominant on the study area and covers a large surface area of the development area. It is represented by two discrete floristic variations which also provide habitat for two discrete avifaunal associations. The first floristic variation is predominantly represented by both untransformed and grazed grassland, depending on grazing intensity, and dominated by "late-successional" graminoids such a *Themeda triandra, Cymbopogon caesius, C. pospischilii, Trachypogon spicatus, Schizachyrium sanguineum* and *Diheteropogon amplectens*. It is occupied by a typical grassland bird composition dominated by insectivorous and granivore passerine bird species such as Desert Cisticola (*Cisticola aridulus*), Cloud Cisticola (*C. textrix*), Rufous-naped Lark (*Mirafra africana*), Eastern Clapper Lark (*Mirafra fasciolata*) and Red-billed Quelea (*Quelea quelea*). When the grass is burned, large numbers of Capped Wheatear (*Oenanthe pileata*) occur. Prominent non-passerine species include Orange River Francolin (*Scleroptila gutturalis*), Swainson's Spurfowl (*Pternistis swainsonii*), Northern Black Korhaan (*Afrotis afraoides*), Crowned Lapwing (*Vanellus coronatus*) and Helmeted Guineafowl (*Numida meleagris*). Some parts of this habitat, especially on higher-lying areas provide potential foraging habitat for large terrestrial bird species such as the Secretarybird (*Sagittarius serpentarius*) due to the large distances of open ground between adjacent grass culms.

   The bush clumps form a prominent mosaic characterised by the dominance of a woody layer of *Searsia lancea, Grewia flava, Celtis africana, Asparagus laricinus, Vachellia erioloba* and *V. karoo* forms canopy constituents in some areas. Some parts of the bush clumps show extensive signs of grazing disturbances which resulted in the proliferation of agrestal weed species and secondary graminoids such as *Bidens pilosa, Tagetes minuta, Nidorella resedifolia, Eragrostis* spp. The eminent increase in vertical heterogeneity provided by the woody layer is colonised by a "Bushveld" bird association consisting of insectivorous and frugivore passerines such as Black-chested Prinia (*Prinia flavicans*), Chestnut-vented Warbler (*Curruca subcoerulea*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Kalahari Scrub-robin (*Cercotrichas paena*) as well as granivores such as Southern Masked Weaver (*Ploceus velatus*). Non-passerine bird taxa are represented by Ring-necked

Dove (*Streptopelia capicola*), Acacia Pied Barbet (*Tricholaema leucomelas*) and Red-faced Mousebird (*Urocolius indicus*).

2. *Artificial livestock watering points*: These are represented by cattle kraal features containing artificial water troughs and reservoirs with the purpose to provide drinking water to livestock. However, they act as focal congregation areas for many of granivore passerine and non-passerine species, including Cape Sparrow (*Passer melanurus*), Laughing Dove (*Spilopelia senegalensis*), Black-throated Canary (*Crithagra atrogularis*), Speckled Pigeon (*Columba guinea*), Pied Crow (*Corvus albus*), Cape Starling (*Lamprotornis nitens*) and large numbers of Red-billed Quelea (*Quelea quelea*). Due to the congregation of passerine species at these features, they could invariably attract small to medium sized bird of prey species (members of the genera *Falco, Micronisus* and *Accipiter*).

3. *Kromdraaispruit floodplain and avian flyway*: This area is represented by the Kromdraaispruit and associated floodplain (a tributary of the Koekemoerspruit) which is located along the western boundary of the development area. It is earmarked by a well-defined channel and an extensive floodplain that is located on heavy clay soils. Although the boundaries of the development area does not coincide with Kromdraaspruit system, the latter does provide important foraging, roosting and potentially also breeding habitat for waterfowl and a variety of waterbird taxa such as Yellow-billed Duck (*Anas undulata*), Red-billed Teal (*A. erythrorhyncha*), Egyptian Goose (*Alopochen aegyptiacus*), South African Shelduck (*Tadorna cana*), Reed Cormorant (*Microcarbo africanus*) and Hamerkop (*Scopus umbretta*). The moist and/or inundated grassland of the floodplain is colonised by facultative grassland species such as Levaillant's Cisticola (*Cisticola tinniens*), African Stonechat (*Saxicola torquatus*) and Southern Red Bishop (*Euplectes orix*). Certain parts of the Kromdraaispruit system downstream of the development area tend to retain surface water for extended periods of time during the austral dry season (areas that are covered by *Phragmites australis* reedbeds and *Populus x canescens* groves) which tend to provide foraging habitat for waterbirds over long periods of time.

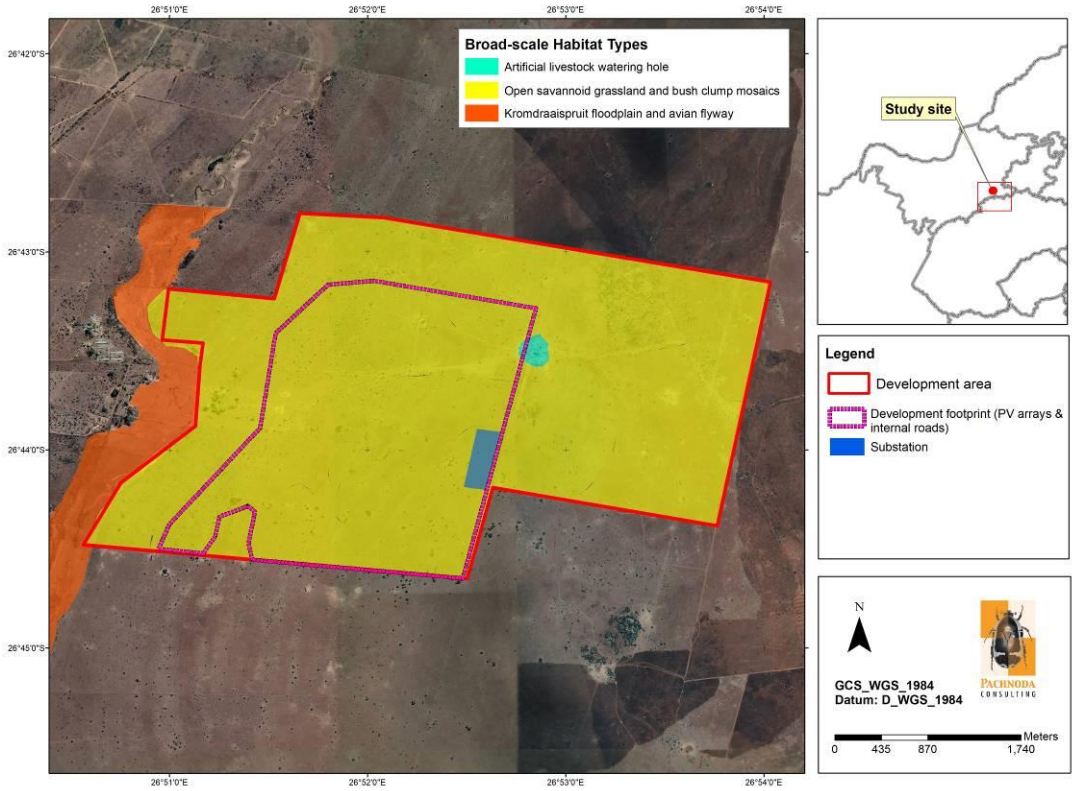

Figure 11: A habitat map illustrating the important avifaunal habitat types on the study area.

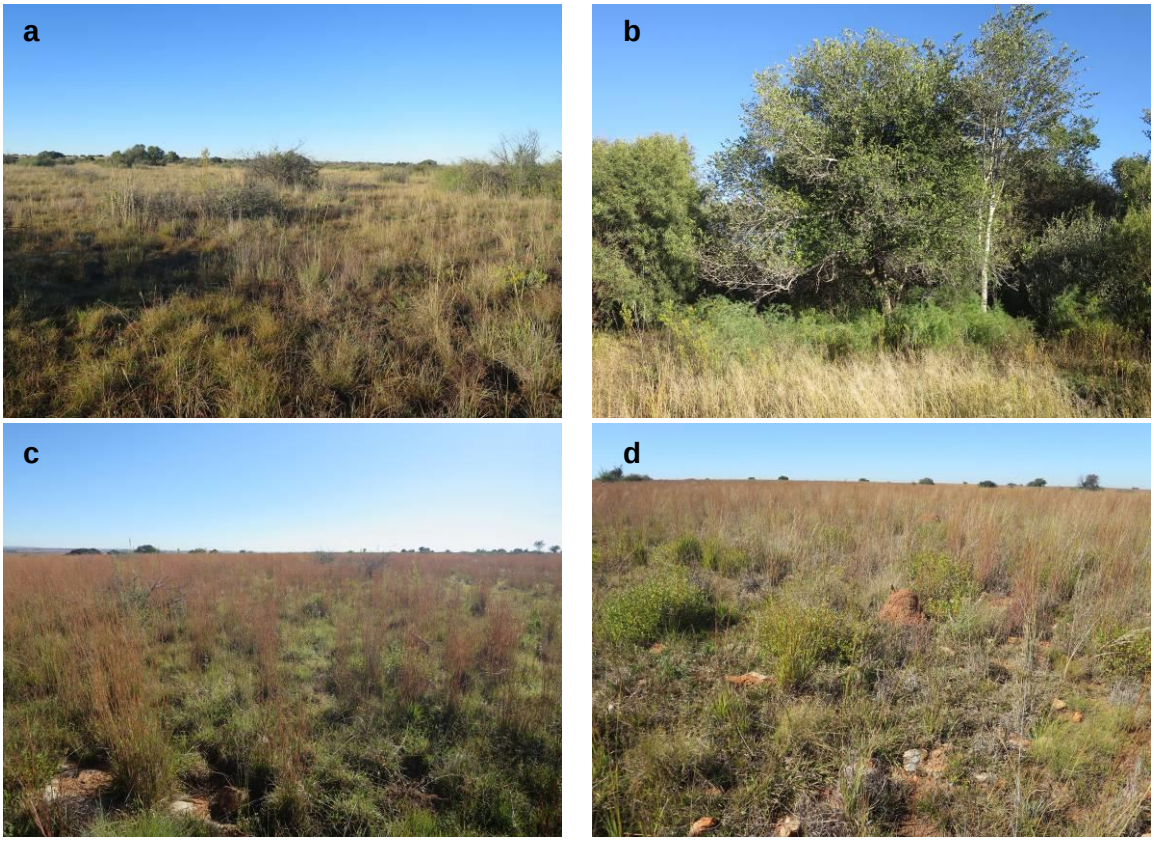


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Figure 12: A collage of images illustrating examples of avifaunal habitat types observed on the study area and the immediate surroundings: (a - l) open savannoid grassland with bush clump mosaics, (m - p) artificial livestock watering points and (q - t) the Kromdraai floodplain.

4.2. Species Richness and Summary statistics

Approximately 245 bird species are expected to occur in the wider study area (refer to Appendix 1 and Table 1). The expected richness was inferred from the South African Bird Atlas Project (SABAP1 & SABAP2)[4] (Harrison et al., 1997; www.sabap2.birdmap.africa) and the presence of suitable habitat in the study area. The expected richness is also strongly correlated with favourable environmental conditions (e.g. during good rains) and seasonality (e.g. when migratory species are present). This equates to 25 % of the approximate 990[5] species listed for the southern African subregion[6] (and approximately 28 % of the 871 species recorded within South Africa[7]). However, the species richness obtained[8] from the pentad grid 2640_2650 corresponding to the project area was lower than the expected number of species, with 178 species recorded. According to field observations, the total number of species observed on the development area is *ca*. 106 species (see Appendix 1). However, an average number of 56.4 species is recorded for each full protocol card submitted for the pentad grid corresponding to the study site 2640_2650 (for observations of two hours or more), which shows that the current surveys produced a higher tally and were regarded as sufficient. On a national scale, the species richness per pentad on the study area is considered to be high (refer to Figure 13).

According to Table 1, the study area is poorly represented by biome-restricted[9] (see Table 2) and local endemic bird species. It also supports *ca*. 34 % of the near - endemic species present in the subregion. Of the 245 bird species expected to occur in the project area, nine are threatened or near threatened species, 16 are southern African endemics and 21 are near-endemic species. In addition, three threatened species (c. White-backed Vulture *Gyps africanus*, Cape Vulture *G. coprotheres* and Lanner Falcon *Falco biarmicus*) was observed on the study area (Table 3). Furthermore, 13 southern African endemics and 15 near-endemic species were confirmed on the study site and the immediate surroundings (Table 3).

[4] The expected richness statistic was derived from the pentad grid 2640_2650 (including adjacent grids) totalling 312 bird species (based on 485 full protocol cards).

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

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

7 With reference to South Africa (including Lesotho and Swaziland (BirdLife South Africa, 2022).

8 Including observations made during the April/May 2022 and September 2022 surveys.

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

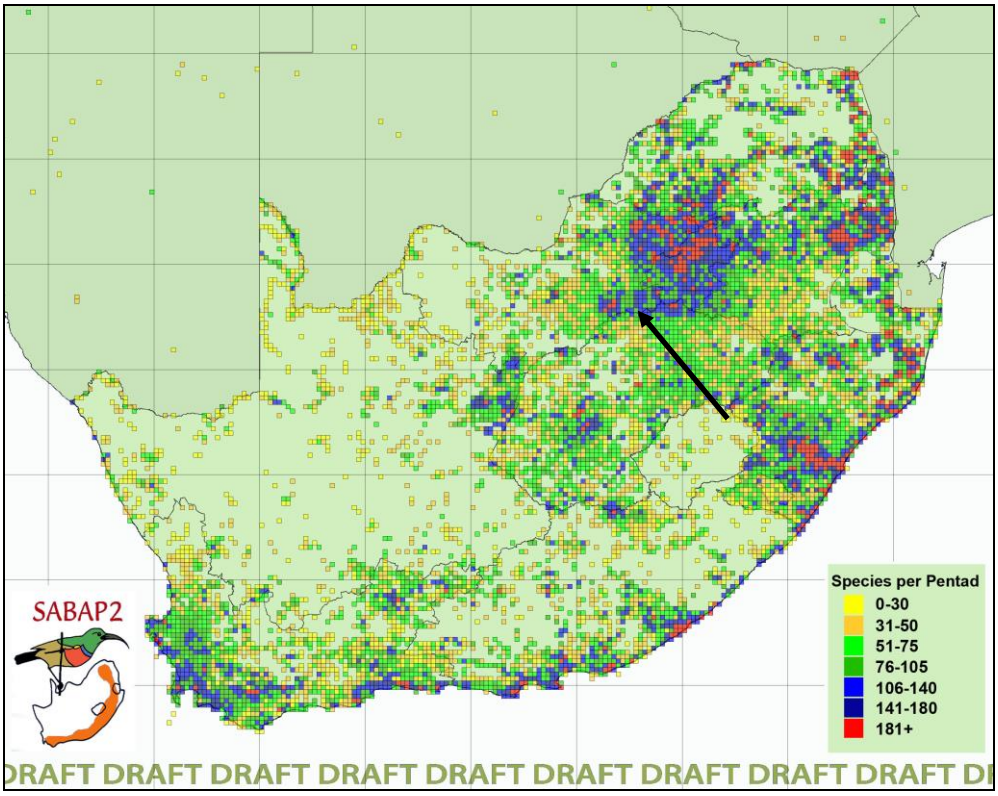

Figure 13: The bird species richness per pentad grid in comparison to the broader study area (see arrow) (map courtesy of SABAP2 and the Animal Demography Unit). According to the SABAP2 database, the study area hosts over 181 bird species.

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* SABAP1 and SABAP2) to occur in the study site and immediate surroundings.

Description	Expected Richness Value (project area and surroundings)***	Observed Richness Value (project area)****
Total number of species*	245 (28 %)	106 (43 %)
Number of Red Listed species*	9 (6 %)	3 (33 %)
Number of biome-restricted species – Zambezian and Kalahari-Highveld Biomes*	3 (21 %)	3 (100 %)
Number of local endemics (BirdLife SA, 2022)*	2 (5 %)	2 (100 %)
Number of local near-endemics (BirdLife SA, 2022)*	6 (20 %)	4 (67 %)
Number of regional endemics (Hockey *et al.,* 2005)**	16 (15 %)	13 (81 %)
Number of regional near-endemics (Hockey *et al.,* 2005)**	21 (34 %)	15 (71 %)

* only species in the geographic boundaries of South Africa (including Lesotho and Swaziland) 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).
**** Percentage values in brackets refer to totals compared against the expected number of species in the project area.

Table 2: Expected biome-restricted species (Marnewick *et al*, 2015) observed on the study area and immediate surroundings.

Species	Kalahari-Highveld	Zambezian	Expected Frequency of occurrence
Kalahari Scrub-robin (*Cercotrichas paena)*	X		Common
White-throated Robin-chat (*Cossypha humeralis*)		X	Common
White-bellied Sunbird (*Cinnyris talatala*)		X	Common

Table 3: Important bird species occurring in the broader study area which could collide and/or become displaced by the proposed PV infrastructure.

Common Name	Scientific name	Regional Status	Global Status	Observed (April & Sept. 2022)	Collision with power lines	Displacement (disturbance & loss of habitat)
White-backed Vulture	*Gyps africanus*	CR	CR	1	1	
Cape Vulture	*Gyps coprotheres*	EN, End	VU	1	1	
Secretarybird	*Sagittarius serpentarius*	EN	EN		1	1
Martial Eagle	*Polemaetus bellicosus*	EN	EN		1	
African Marsh Harrier	*Circus ranivorus*	EN	EN		1	1
South African Shelduck	*Tadorna cana*	End		1	1	1
Cape Shoveler	*Anas smithii*	End			1	1
Northern Black Korhaan	*Afrotis afraoides*	End		1	1	1
White-backed Mousebird	*Colius colius*	End		1		1
Melodious Lark	*Mirafra cheniana*	End		1		1
Karoo Thrush	*Turdus smithi*	End				1
Ant-eating Chat	*Myrmecocichla formicivora*	End		1		1
White-throated Robin-chat	*Cossypha humeralis*	End		1		1
Fiscal Flycatcher	*Sigelus silens*	End		1		1
Fairy Flycatcher	*Stenostira scita*	End				1
Cape Longclaw	*Macronyx capensis*	End		1		1
Pied Starling	*Lamprotornis bicolor*	End		1		1
Cape White-eye	*Zosterops virens*	End		1		1
Orange River White-eye	*Zosterops pallidus*	End		1		1
South African Cliff Swallow	*Petrochelidon spilodera*	End		1		1
Pale Chanting Goshawk	*Melierax canorus*	N-end		1	1	1
Orange River Francolin	*Scleroptila gutturalis*	N-end		1	1	1
Acacia Pied Barbet	*Tricholaema leucomelas*	N-end		1		1
Natal Spurfowl	*Pternistis natalensis*	N-end			1	1
Eastern Clapper Lark	*Mirafra fasciolata*	N-end		1		1
Pink-billed Lark	*Spizocorys conirostris*	N-end				1
Ashy Tit	*Parus cinerascens*	N-end		1		1
Cape Penduline-tit	*Anthoscopus minutus*	N-end		1		1

Common Name	Scientific name	Regional	Global	Observed	Collision	Displacement
African Red-eyed Bulbul	*Pycnonotus nigricans*	N-end		1		1
Kalahari Scrub Robin	*Cercotrichas paena*	N-end		1		1
Chestnut-vented Warbler	*Curruca subcoerulea*	N-end		1		1
Marico flycatcher	*Bradornis mariquensis*	N-end				1
Pririt Batis	*Batis pririt*	N-end				1
Crimson-breasted Shrike	*Laniarius atrococcineus*	N-end		1		1
Bokmakierie	*Telophorus zeylonus*	N-end		1		1
Cape Sparrow	*Passer melanurus*	N-end		1		1
Scaly-feathered Weaver	*Sporopipes squamifrons*	N-end		1		1
Red-headed Finch	*Amadina erythrocephala*	N-end				1
Shaft-tailed Whydah	*Vidua regia*	N-end				1
Yellow Canary	*Crithagra flaviventris*	N-end		1		1
Cloud Cisticola	*Cisticola textrix*	N-end		1		1
Abdim's Stork	*Ciconia abdimii*	NT			1	
Yellow-billed Stork	*Mycteria ibis*	EN			1	
Black-winged Pratincole	*Glareola normdanni*	NT	NT		1	1
Falcon, Lanner	*Falco biarmicus*	VU		1	1	
	Totals:	**45**	**6**	**30**	**15**	**39**

Threatened and near threatened species are indicated in red
CR - Critically endangered, EN - endangered, VU - vulnerable, NT - near threatened
End - southern African endemic
N-end - southern African near-endemic

Prior to further analyses where species richness values are considered, it is imperative to determine if all bird species present were sufficiently sampled. Species accumulation curves (SAC) provide a means to examine data and sampling efficacy. For this project the species accumulation curves (SAC) for the point count data were generated using the software program Estimates S (version 9) with 100 randomizations (as recommended in Colwell, 2013). Curves were generated for the full data set (all point counts). Sampling sufficiency was determined by establishing whether a point had been reached where a line representing one new sample adding one new species was tangent to the curve (Brewer & McCann, 1982). The Michaelis-Menten equation (Soberôn & Llorente 1993) was fitted to the predicted number of species using Estimates S (Raaijmakers, 1987). A satisfactory level of sampling was achieved if 90 % of the bird species were detected, and hence predicted by the model (Moreno & Halffter, 2000).

The species accumulation curve (SAC) reached an asymptote at approximately 23 point counts (Figure 14). The sampling captured approximately 75% of the number of species predicted by the Michaelis-Menten model at 23 point counts. Approximately 90% of the predicted species that could occur on the study area was captured by 66 counts. Therefore, sampling effort was considered sufficient and recorded 90% the species present on the project area during the respective survey sessions.

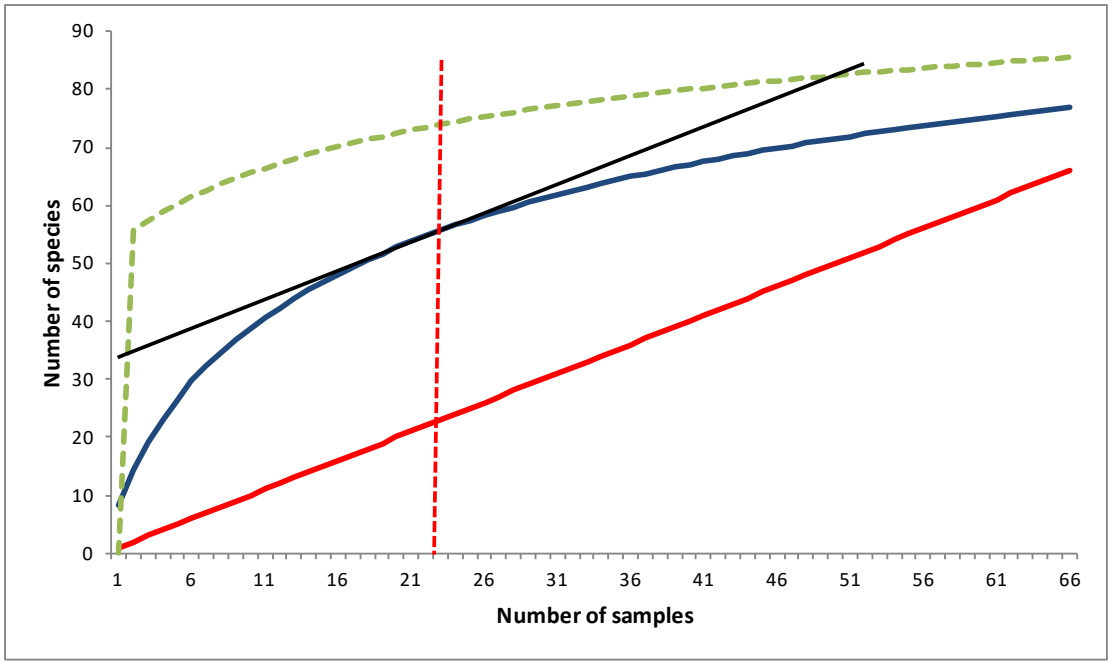

Figure 14: The species accumulation curve (SAC) (red line) for bird points sampled during the April/May and September 2022 survey sessions. The blue line represents an accumulation of one species for every additional point count. The black line is parallel to the blue one and is tangent to the SAC approximately after 23 counts (as represented by the vertical red stippled line). The green stippled line represents the Michaelis-Menten curve.

4.3. Bird species of conservation concern

Table 4 provides an overview of bird species of conservation concern that could occur on the development area based on their historical distribution ranges and the presence of suitable habitat. According to Table 4, a total of nine species have been recorded in the wider study area (sensu SABAP1 & SABAP2) which include four globally threatened species, one globally near threatened species, three regionally threatened species and one regionally near-threatened species[10].

The globally critically endangered White-backed Vulture (*Gyps africanus*) and the globally endangered Cape Vulture (*G. coprotheres*) were observed from the development area during the respective site visits and were respectively represented by five and six individuals (Figure 15). These two species are recorded as regular foraging visitors to the study area pending on the availability of carcasses. The presence of both species is also tied to practice of extensive livestock and game husbandry which often provide a readily supply of foraging opportunities (e.g. carcasses). These species also often utilise the nearby electricity pylons as roosting sites (pers. obs).

[10] Please note that an additional six species (e.g. flamingo species) were also confirmed from the wider study area (see Table 4), but the probability that these species could occur on the development itself is very low due to the absence of suitable foraging and/or breeding habitat.

In addition, a pair of the regionally vulnerable Lanner Falcons (*Falco biarmicus*) was confirmed from the south eastern part of the development area, and could potentially breed on the study area (buffered by 400m) (Figure 15).

The remaining species are regarded as irregular foraging visitors with low probabilities of occurrence due to the absence of suitable habitat on the development area itself. However, the Kromdraaispruit floodplain provides ephemeral foraging habitat for the occurrence of the endangered African Marsh-harrier (*Circus ranivorus*). According to SABAP2 data, it is known to occur downstream along the Kromdraaispruit from the study area (see Figure 16), whereby it is recommended that a 500m buffer be assigned to the Kromdraaispruit (based on Ruddock and Whitfield (2007) and references therein for breeding *Circus* sp.). In addition, during the site visits it was noticed that extensive areas of suitable foraging habitat persists for the globally endangered Secretarybird (*Sagittarius serpentarius*) to occur despite being ominously absent from the area. It is possible that the low reporting rates reflect the poor coverage of the study area by citizen scientists (e.g. birdwatchers), and this species could occur in higher numbers due to being overlooked

Table 4: Bird species of conservation concern that could utilise the study site 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**	Mean Reporting rate: SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
Ciconia abdimii (Abdim's Stork)	-	Near threatened	0.21 (single observation)	Open stunted grassland, fallow land and agricultural fields.	An uncommon summer foraging visitor to areas consisting of open grassland or arable land. It has not been observed on the study area since 2009.
Circus ranivorus (African Marsh Harrier)	-	Endangered	0.14 (two observations)	Restricted to permanent wetlands with extensive reedbeds.	Probably absent from the physical study site due to the absence of suitable habitat. Ephemeral foraging habitat observed along the Kromdraaispruit located near the western boundary of the site. Only known from two observations, with most recent observation during 2001. (sensu

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
					SABAP2).
Falco biarmicus (Lanner Falcon)	-	Vulnerable	3.93	Varied, but prefers to breed in mountainous areas.	A regular foraging visitor to the study area. Two adult individuals were observed hunting near the eastern boundary of the development area on 05 May 2022.
Glareola nordmanni (Black-winged Pratincole)	Near threatened	Near threatened	0.41 (two observations))	Varied, but forages over open short grassland, pastures and agricultural lands (especially when being tilled)	An irregular foraging visitor to the study area. Only known from two observations, most recent observation during 2019.
Gyps coprotheres (Cape Vulture)	Endangered	Endangered	0.41	Mainly confined to mountain ranges, especially near breeding site. Ventures far afield in search of food.	A regular foraging/scavenging visitor to the study area pending the presence of food (e.g. livestock/game carcasses). Approximately six Cape Vulture individuals were observed during the site visits.
Gyps africanus (White-backed Vulture)	Critically Endangered	Critically Endangered	0.83	Breed on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	A regular foraging/scavenging visitor to the study area pending the presence of food (e.g. livestock/game carcasses). Approximately four individuals were also observed utilising the pylon structures at the eastern section of the

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
					study area when roosting.
Polemaetus bellicosus (Martial Eagle)	Endangered	Endangered	0.21 (single observation)	Varied, from open karroid shrub to lowland savanna.	A highly irregular foraging visitor. It has not been observed on the study area since 2010.
Mycteria ibis (Yellow-billed Stork)	-	Endangered	0.83 (known from four individuals)	Wetlands, pans and flooded grassland.	Probably a highly irregular foraging visitor to the Kromdraaispruit (when inundated) adjacent to the study area (probably absent from the study site itself).
Sagittarius serpentarius (Secretarybird)	Endangered	Endangered	0.62 (three observations)	Prefers open grassland or lightly wooded habitat.	Probably a highly irregular foraging visitor to the study area even though the presence of optimal foraging habitat. It was not recently observed from the pentad grid 2640_2650 corresponding to the development area.

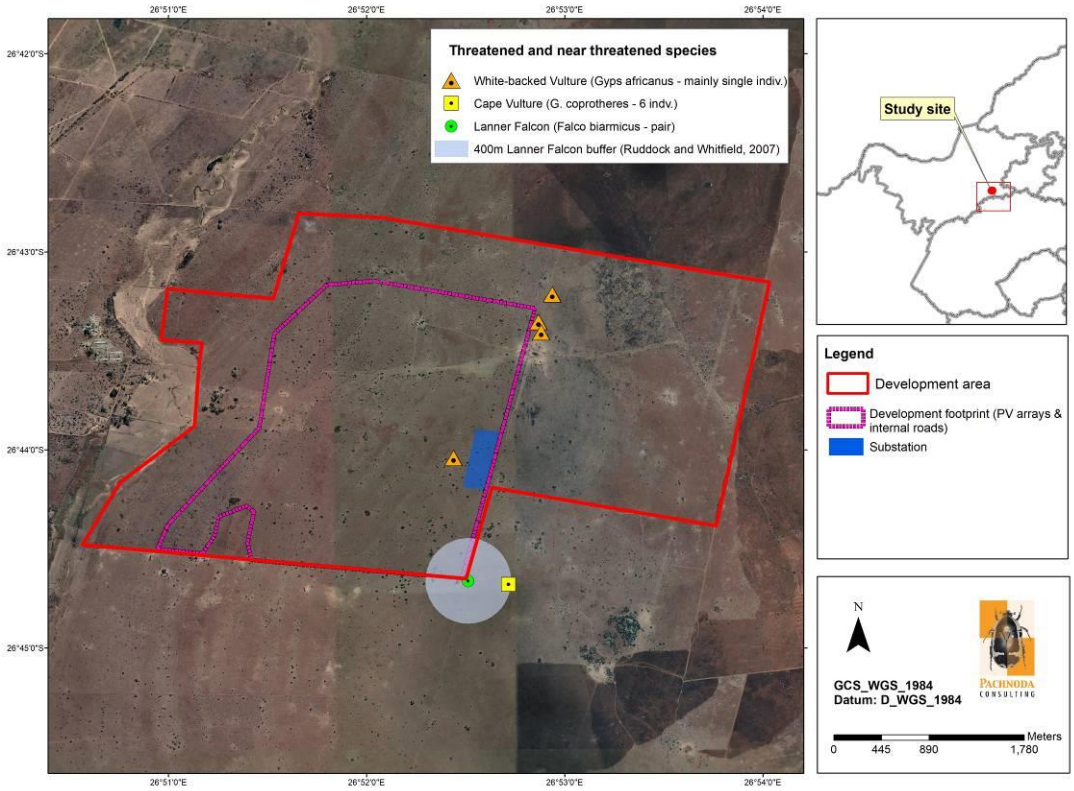

Figure 15: A map illustrating the occurrence of threatened and near threatened bird species observed on the development area and immediate surroundings during April/May 2022 and September 2022.

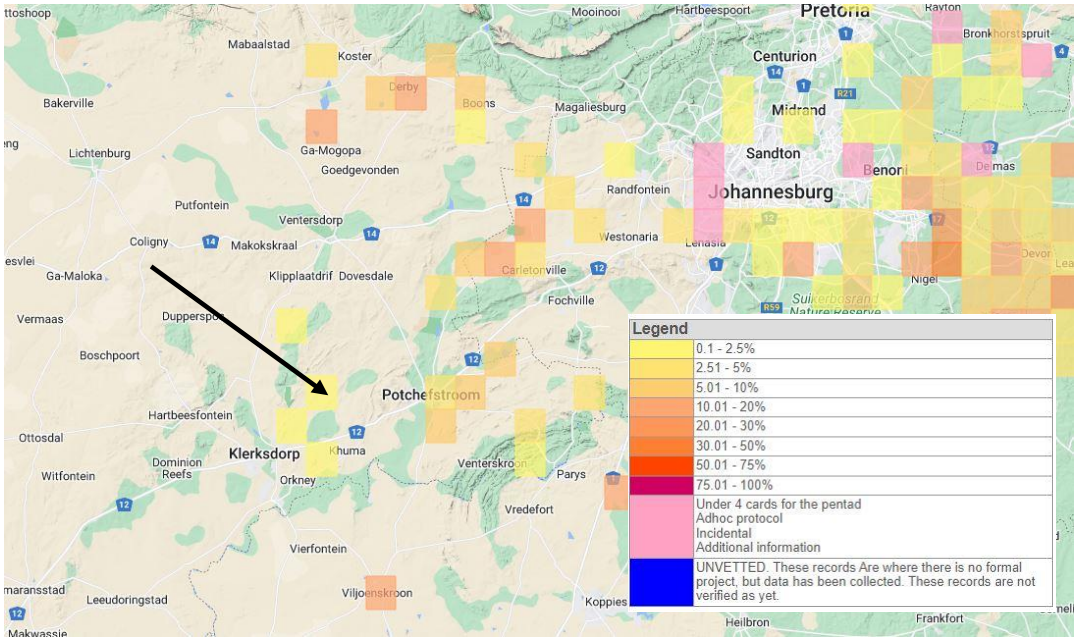

Figure 16: The extant (current) occurrence of African Marsh Harrier (*Circus ranivorus*) on the wider study area according to SABAP2 reporting rates (the arrow indicates the position of the study area). Note the presence of observations (c. low reporting rates) on the study area (map courtesy and copyright of SABAP2 and Animal Demography Unit).

4.4. Bird Assemblage Structure and Composition

4.4.1. Summary of point counts

A total of 77 bird species and an average abundance of 633 individuals were recorded from 33 bird points (representing two replicative counts) located on the development area. The data provides an estimate of the bird richness and their numbers on the study area and immediate surroundings obtained during two independent survey sessions. A mean of 11.97 species and 19.18 individuals were recorded per point count. The highest number of species recorded from a point count was between 26 - 29 species (from tall *Vachellia erioloba* and *Celtis africana* bush clumps). The highest number of individuals recorded from a point count was 55.5 individuals (from artificial watering points and floodplain habitat along the Kromdraaispruit). The lowest number of species and individuals was respectively one species and one individual (from tall untransformed grassland dominated by a near monotonous composition of *Schizachyrium sanguineum, Trachypogon spicatus* and *Triumfetta sonderi* on dolomite sheet rock). The mean frequency of occurrence of a bird species in the study area was 15.55 % and the median was 9.09 %, while the most common value (mode) was 3.03 %. The latter represents those species that were encountered in only one point count. Four species occurred in 50 % or more of the counts (Table 5), while two species (c. Black-chested Prinia *Prinia flavicans* and Chestnut-vented Warbler *Curruca subcoerulea*) occurred in >70% of all the counts (Table 5).

Table 5: Bird species with a frequency of occurrence greater than 50% observed on the study site and immediate surroundings (according to 33 counts).

Species	Frequency (%)	Species	Frequency (%)
Black-chested Prinia (*Prinia flavicans*)	72.73%	African Red-eyed Bulbul (*Pycnonotus nigricans)*	57.58%
Chestnut-vented Warbler (*Curruca subcoerulea*)	72.73%	Kalahari Scrub-robin (*Cercotrichas paena*)	57.58%

4.4.2. Summary of richness and average abundance (per point count)

Displacement of birds by the proposed infrastructure is one of the impacts that is anticipated to occur. By mapping the spatial distribution of the number of species and average abundance values obtained from each point count, it is possible to predict where displacement of birds will be more intensive. According to Figure 17 and Figure 18 it is evident that high to very high bird numbers (as well bird species) occurs on habitat with tall canopy constituents (e.g. bush clumps with tall *Vachellia* and *Celtis* tree cover), at artificial watering points and along the Kromdraaispruit. The latter is located along the perimeter of the study area. In addition, low bird numbers (and low bird richness) was observed from late-successional grassland habitat of which the graminoid structure was tall and predominantly moribund. This means that

the potential displacement of birds due to the loss of habitat during construction is likely to occur at bush clumps with a tall habitat structure, at artificial watering points and along the floodplain of the Kromdraaispruit.

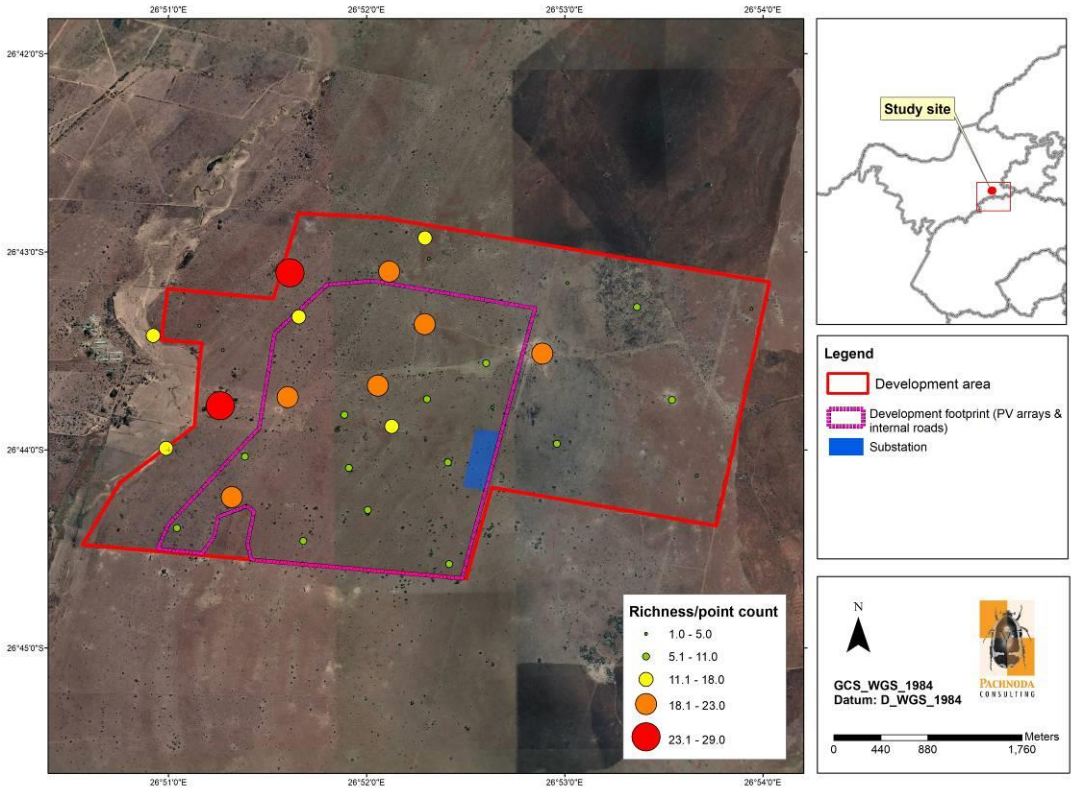

Figure 17: A map of the study area illustrating the spatial distribution of bird richness values (number of species) obtained for each point count.

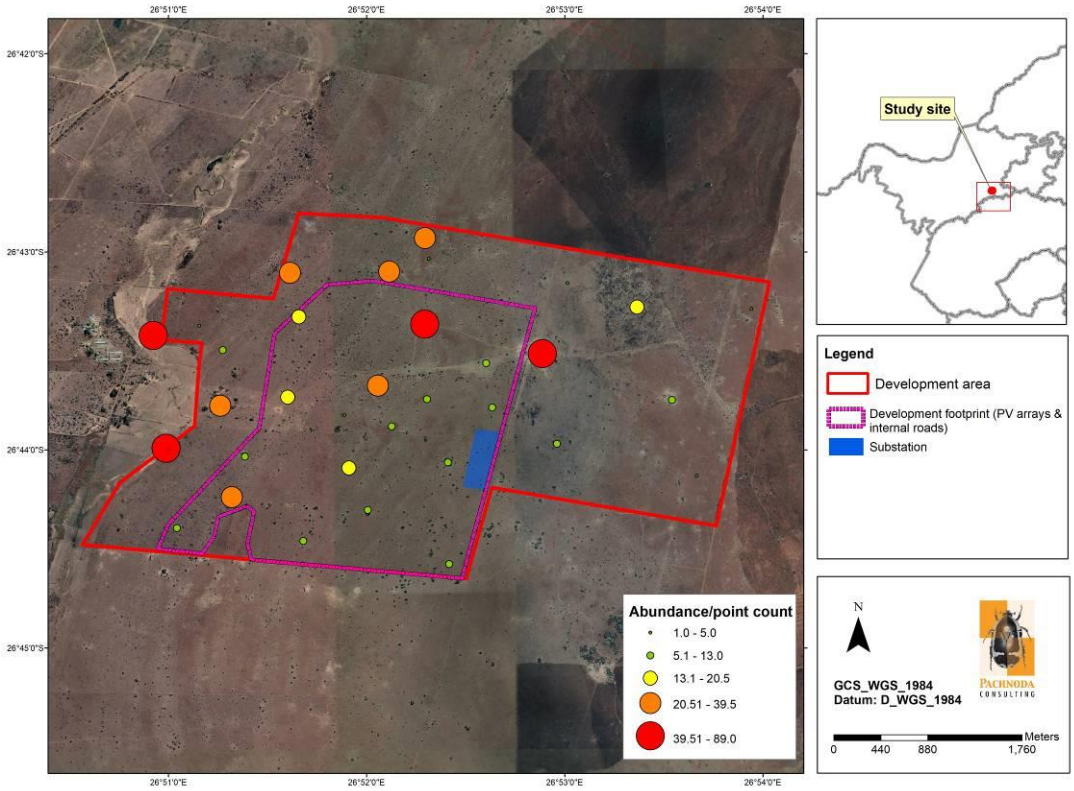

Figure 18: A map of the study area illustrating the distribution of bird abundance values (average number of individuals) obtained for each point count.

4.4.3. Dominance and typical bird species

The dominant (typical) species on the study area are presented in Table 6. Only those species that cumulatively contributed to more than 90% to the overall similarity between the point counts are presented.

The three most typical bird species on the study area include the Chestnut-vented Warbler (*Curruca subcoerulea*), Black-chested Prinia (*Prinia flavicans*) and Capped Wheatear (*Oenanthe pileata*). These species are considered widespread species in the broader study area and occur in most of the habitat types that are present. It is also evident from Table 6 that the typical bird assemblage is dominated by insectivores (insect-eating taxa) and to a lesser extent also granivores (seed-eating taxa), but includes other less common but functionally important guilds such as frugivores (fruit-eaters).

Table 6: Typical bird species on the study area.

Species	Av.Abundance	Consistency (Sim/SD)	Contribution (%)	Primary Trophic Guild
Chestnut-vented Warbler (*Curruca subcoerulea*)	1.38	0.91	16.27	Insectivore: upper canopy foliage gleaner
Black-chested Prinia (*Prinia flavicans*)	1.24	0.91	16.08	Insectivore: upper canopy foliage gleaner
Capped Wheatear (*Oenanthe pileata*)	0.42	0.46	9.27	Insectivore: upper canopy foliage gleaner
African Red-eyed Bulbul (*Pycnonotus nigricans*)	1.02	0.65	8.15	Frugivore (facultative): upper canopy foliage gleaner
Desert Cisticola (*Cisticola acidula*)	0.33	0.32	6.30	Insectivore: upper canopy foliage gleaner
Kalahari Scrub-robin (*Cercotrichas paena*)	0.61	0.54	6.16	Insectivore: upper canopy foliage gleaner
Acacia Pied Barbet (*Tricholaema leucomelas*)	0.47	0.48	4.15	Frugivore (facultative): upper canopy foliage gleaner
Sabota Lark (*Calendulauda sabota*)	0.30	0.44	4.01	Granivore and insectivore: ground gleaner
White-bellied sunbird (*Cinnyris talatala*)	0.26	0.37	3.65	Nectarivore and insectivore (facultative: upper canopy gleaner
Laughing Dove (*Spilopelia senegalensis*)	0.52	0.36	2.75	Granivore: ground gleaner

4.4.4. Composition and diversity

Multidimensional scaling and hierarchical agglomerative clustering ordination of bird abundance values obtained from 33 point counts on the project area differentiate between five discrete bird associations (Global R= 0.77, p<0.001; Figure 19), with statistically significant differences due to floristic structure and canopy cover (e.g. open grassland vs. bush clumps). The most significant differences occur between compositions on the floodplain habitat and those on bush clumps with tall woody elements. These include (1) an association on floodplain habitat, (2) an association confined to discrete bush clumps with tall woody elements (tall canopy), (3) tall untransformed monotonous grassland (mainly on crests), (4) short grazed grassland with secondary elements and (5) open mixed grassland with woody elements (short bush clumps).

The habitat fidelity between species is illustrated in Figure 19 by plotting the relative abundance values of Chestnut-vented Warbler (*Curruca subcaerulea*). It shows that the Chestnut-vented Warbler (a "bushveld" species) is widely distributed within the grassland with bush clump mosaics and within the bushveld units, thereby implying that "grassland' and "bushveld" compositions also integrate with each other.

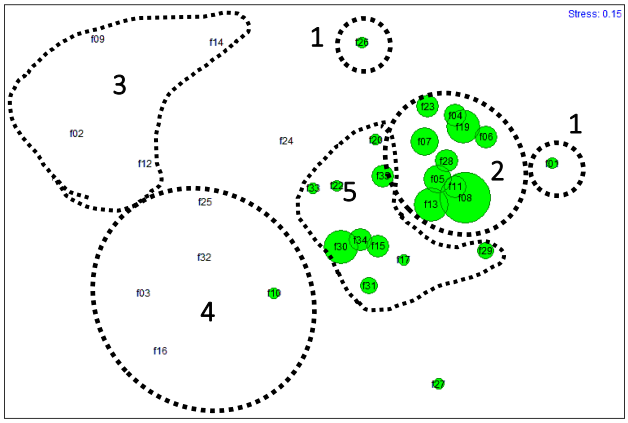

Figure 19: A two-dimensional non-metric multidimensional scaling ordination (stress=0.15) of the relative abundances of bird species based on Bray-Curtis similarities obtained from 33 point counts on the project area. It differentiates between four bird associations: (1) an association on floodplain habitat, (2) an association confined to discrete bush clumps with tall woody elements (tall canopy), (3) tall untransformed monotonous grassland (mainly on crests), (4) short grazed grassland with secondary elements and (5) open mixed grassland with woody elements (short bush clumps). The green circles represent the relative abundances of Chestnut-vented Warbler (*Curruca subcaerulea*).

The following bird associations are relevant to the study site and immediate surroundings:

1. Association on floodplain habitat

This association is restricted to the Kromdraaispruit and associated floodplain habitat.

Dominant species: Southern Red Bishop (*Euplectes orix*), Levaillant's Cisticola (*Cisticola tinniens*) and Zitting Cisticola (*C. juncidis*).

Indicator species[11]: Levaillant's Cisticola (*Cisticola tinniens*), Zitting Cisticola (*C. juncidis*), Hamerkop (*Scopus umbretta*), African Black Duck (*Anas sparsa*) and Yellow-billed Duck (*A. undulata*).

2. Association confined to discrete bush clumps with tall woody elements (tall canopy)

[11] Indicator species refers to a species with high numbers that is restricted to a particular habitat.

This association is confined to the tall bush clumps and woodland which contains aspect dominants such as *Vachellia erioloba, V. karroo* and *Celtis africana*. It includes the artificial livestock watering points, since these often contain large canopy constituents.

Dominant species: Chestnut-vented Warbler (*Curruca subcoerulea*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Fiscal Flycatcher (*Melaenornis silens*), Sabota Lark (*Calendulauda sabota*), Black-chested Prinia (*Prinia flavicans*), Kalahari Scrub-robin (*Cercotrichas paena*), Acacia Pied Barbet (*Tricholaema leucotis*) and Southern Masked Weaver (*Ploceus velatus*).

Indicator species: White-throated Robin-chat (*Cossypha humeralis*), Cape Robin-chat (*C. caffra*), Brown-crowned Tchagra (*Tchagra australis*), Long-billed Crombec (*Crombec rufescens*), White-backed Mousebird (*Colius colius*), Cape Starling (*Lamprotornis nitens*) and Crimson-breasted Shrike (*Laniarius atrococcineus*).

3. Association on tall untransformed monotonous grassland

This association is confined to the tall untransformed rocky grassland, mainly on upper-lying areas and crests.

Dominant species: Desert Cisticola (*Cisticola aridulus*) and Cloud Cisticola (*C. textrix*).

Indicator species: Cloud Cisticola (*C. textrix*)

4. Association on short grazed grassland with secondary elements

This association is confined to the open shortly grazed grassland with secondary graminoid species.

Dominant species: Capped Wheatear (*Oenanthe pileata*), Rufous-naped Lark (*Mirafra africana*), Spike-heeled Lark (*Chersomanes albofasciata*) and African Pipit (*Anthus cinnamomeus*).

Indicator species: African Pipit (*Anthus cinnamomeus*), Buffy Pipit (*A. vaalensis*) and Crowned Lapwing (*Vanellus coronatus*).

5. Association on open mixed grassland with woody elements (short bush clumps)

This association is confined to the open mixed grazed grassland interspersed with small bush clump mosaics. The bird composition contains both "grassland" and "bushveld" bird species.

Dominant species: Chestnut-vented Warbler (*Curruca subcoerulea*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Black-chested Prinia (*Prinia flavicans*), Kalahari Scrub-robin (*Cercotrichas paena*), White-bellied Sunbird (*Cinnyris talatala*) and Laughing Dove (*Spilopelia senegalensis*).

Indicator species: African Pipit (*Anthus cinnamomeus*), Capped Wheatear (*Oenanthe pileata*) and Eastern Clapper Lark (*Mirafra fasciolata*).

The highest number of bird species on the development area was observed from bush clumps with a tall canopy structure, followed by the bird association on the floodplain habitat (Table 7). The lowest number of bird species was recorded from shortly grazed grassland. High numbers of birds were observed from the floodplain habitat.

Table 7: A summary of the observed species richness and number of bird individuals confined to the bird associations on the development area.

Bird Association	Number of species	Number of Individuals	Shannon Wiener Index H'(log_e)
Floodplain habitat	27	55.25	2.00
Tall monotonous grassland	21	5.58	2.54
Short grazed grassland	17	6.40	2.59
Tall bush clumps (tall canopy trees)	63	33.73	3.48
Open grassland with bush clump elements	24	9.56	2.74

4.5. Passerine bird densities

Fifty-five passerine bird species were recorded from 33 point counts on the study area and immediate surroundings. The study area and immediate surroundings comprise of approximately 15.35 species.ha^{-1} (Appendix 2). The average density per hectare is 24.59 birds.ha^{-1} and ranges between 1.28 birds.ha^{-1} to 114.10 birds.ha^{-1}.

4.6. Movements/dispersal of Collision-prone birds

The only **regular** movements observed for waterbird species were the South African Shelduck (*Tadorna cana*) which could potentially collide with the PV infrastructure when visiting nearby water features in the area (Figure 20). These species were observed (especially in the early mornings) flying across the study area with individuals also observed perching on termite mounds. Most of these individuals tend to take advantage of the inundated conditions along the Kromdraaispruit. In addition, other waterbird species such as the Reed Cormorant (*Microcarbo africanus*), Yellow-billed Duck (*Anas undulata*), African Black Duck (*A. sparsa*), Red-billed Teal (*A. erythrorhyncha*) and Egyptian Goose (*Alopochen aegyptiaca*) were also observed flying along the Kromdraaispruit, which is considered to be an important flyway in the area. Several large to small birds of prey were also observed perching on either pylons and/or on tall *Vachellia erioloba* trees during roosting (e.g. Pale Chanting Goshawk *Melierax canorus*, Lanner Falcon *Falco biarmicus* and Greater Kestrel

Falco rupicoloides) (Figure 20). The flight routes for crows and vultures were random and haphazard and no predicted/deterministic pattern could be established, since these birds were mainly opportunistic and searching for food (Figure 20).

The home ranges of approximately four to five pairs of Northern Black Korhaan (*Afrotis afraoides*) correspond to the development area, with approximately two pairs corresponding to the development footprint (Figure 21). The latter has a high probability to become displaced from the footprint area due to the loss of habitat to accommodate the PV arrays.

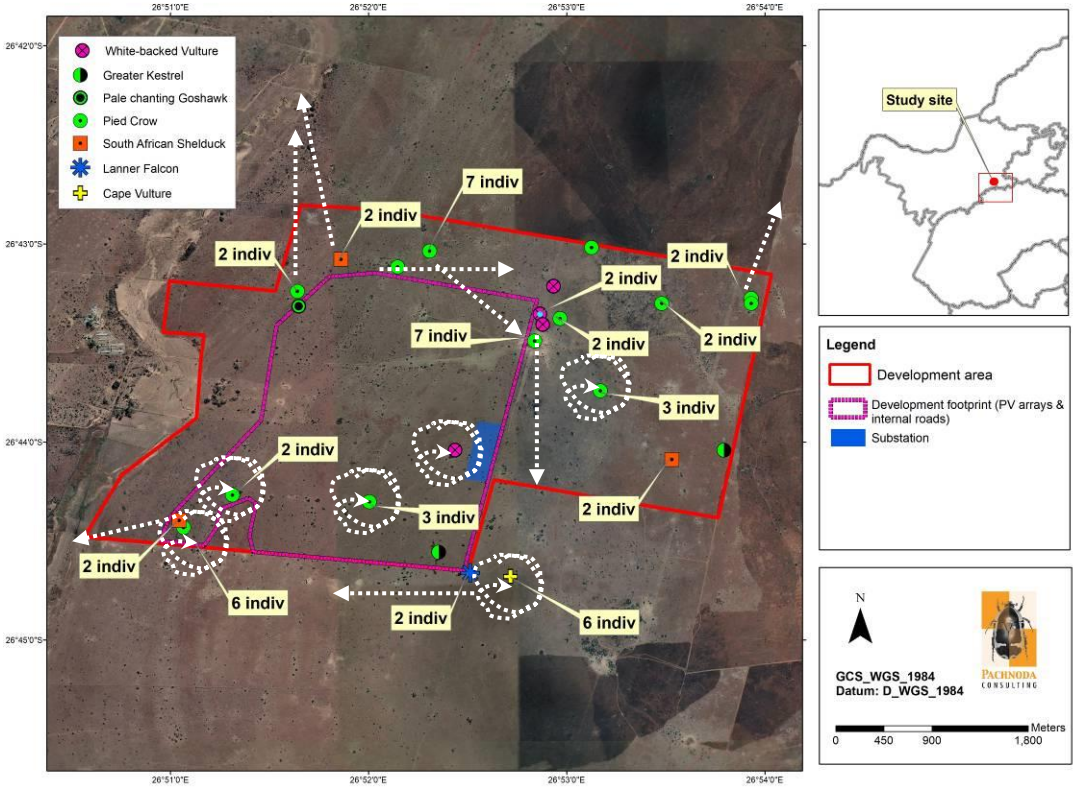

Figure 20: A map of the study area illustrating the occurrence and movements of collision prone birds. Birds without annotations refer to single individuals, and birds without flight directions (arrows) were perched.

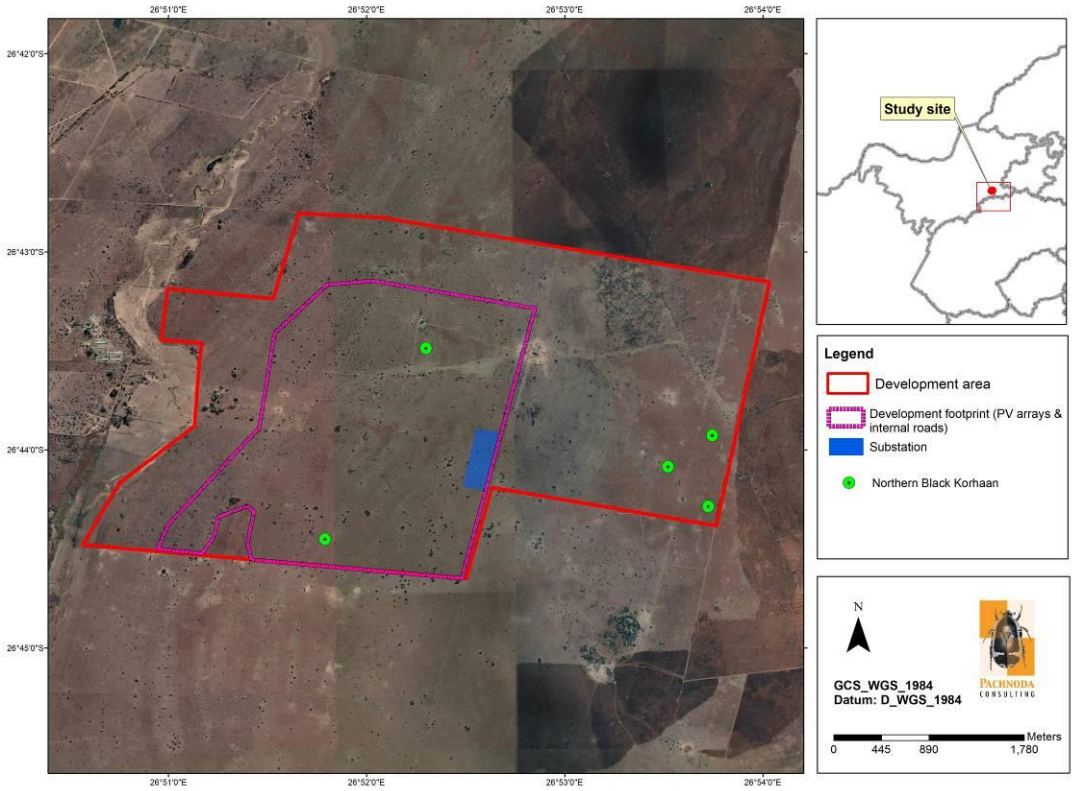

Figure 21: A map of the study area illustrating the occurrence of large terrestrial collision-prone birds.

4.7. Avifaunal sensitivity

A sensitivity map was compiled, illustrating habitat units comprising potential sensitive elements based on the following arguments (Figure 22):

Areas of high sensitivity

- Large patches of tall untransformed grassland on undulating slopes provided optimal foraging habitat for the endangered Secretarybird (*Sagittarius serpentarius*). This species is known to occur in the region based on various observations adjacent to the study area (sensu SABAP2) and could potentially utilise the study area on occasion.
- The Kromdraaispruit and floodplain were regarded as an important flyway for waterbirds, thereby also facilitating the dispersal of birds towards the Vaal River - PV infrastructure located in close proximity to avian flyways may result in increased bird collisions (with the PV panels). This flyway was consistently utilised by anatid (duck) members, especially African Black Duck (*Anas sparsa*), Yellow-billed Duck (*A. undulata*), Red-billed Teal (*A. erythrorhyncha*), Egyptian Goose (*Alopochen aegyptiaca*) and South African Shelduck (*Tadorna cana*). The Kromdraaispruit floodplain also provided potential

habitat for the occurrence of the endangered African Marsh-harrier (*Circus ranivorus*). According to SABAP2 data, it is known to occur along the Kromdraaispruit system. A 500m buffer was assigned to the Kromdraaispruit (based on Ruddock and Whitfield (2007) and references therein for breeding *Circus* sp.).

- A pair of regionally vulnerable Lanner Falcons (*Falco biarmicus*) was confirmed from the south-eastern part of the study area, and could potentially breed on the site (buffered by 400m).
- Part of the proposed study area, especially the east was regularly visited by foraging vultures, especially the globally endangered Cape Vulture (*Gyps coprotheres*) and the globally critically endangered White-backed Vulture (*G. africanus*). These birds often roost on the pylon structures on the eastern part of the study area.
- The artificial livestock watering points (represented by artificial water troughs and reservoirs) with the purpose to provide drinking water to livestock act as focal congregation areas for many of granivore passerine and non-passerine species, which could increase the risk of birds colliding with the PV infrastructure. Due to the congregation of passerine species at these features, they could invariably attract small to medium sized bird of prey species (members of the genera *Falco*, *Micronisus* and *Accipiter*). However, these could be removed or relocated.

Areas of medium sensitivity

- These include natural open dolomite grassland and bush clump mosaics which provide potential suitable foraging habitat for some collision-prone bird species, including the Northern Black Korhaan (*Afrotis afraoides*) with the potential to interact (e.g. collide) with the proposed electrical infrastructure.

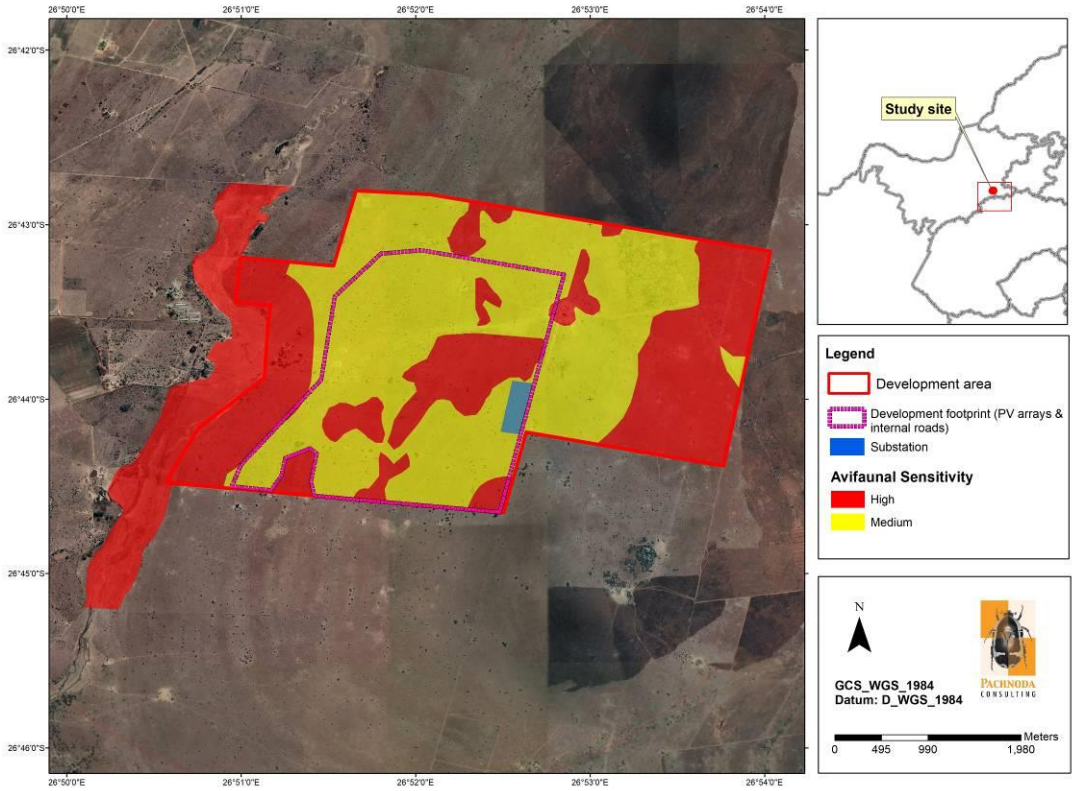

Figure 22: A map illustrating the avifaunal sensitivity of the study site based on the ecological condition of habitat types and the occurrence of collision prone bird species.

4.8. Overview of Avian Impacts at Solar Facilities

4.8.1. 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. mammals). 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 (due to solar flux-based mortalities associated with CSP sites).
- 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.

4.8.2. 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 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 power lines and reticulation); and
- 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.

4.9. Impacts associated with the Highveld Solar PV Facility

Table 8 provides a summary of the impacts anticipated and quantification thereof (see Appendix 3 for methods used during the assessment of impacts).

4.9.1. Loss of habitat and displacement of birds

Approximately 433 ha (consisting of the PV arrays, internal roads and substation) of the available development footprint (c. 553 ha) will be cleared of vegetation and habitat to accommodate the panel arrays and associated infrastructure. **This 433 ha take the sensitivity map into consideration by avoiding areas that were initially classified with high sensitivity**. In addition, clearing of additional vegetation during the widening of the proposed access road will also take place, even though this is an existing road. Clearing of vegetation will inevitably result in the loss of habitat and

displacement of bird species. From the results, approximately 15.35 species.ha^{-1} and 1.28 birds.ha^{-1} will become displaced should the activity occur across all the habitat types on the study area (as per Jenkins et al., 2017). Displacement will mainly affect passerine and smaller non-passerine species inhabiting the open savannoid grasslands with bush clump mosaics (mainly habitat identified with medium avifaunal sensitivity. However, it is possible that roadwork's (during the upgrade of the access road) will temporary displace passerine and smaller non-passerine species from the road reserve. Since the proposed access road crosses the Kromdraaispruit and due to the location of a small impoundment near the Rietspruit Road turnoff, it is also anticipated that waterbirds may become temporarily displaced from habitat where inundation (surface water) is prevalent. However, the latter impact is unlikely to result in the mortality of birds.

The following bird species are most likely to be impacted by the loss of habitat due to their habitat requirements, endemism and conservation status (although not limited to) due to the proposed PV development:

- Northern Black Korhaan (*Afrotis afraoides*);
- White-throated Scrub-robin (*Cossypha humeralis*);
- Ashy Tit (*Melaniparus cinerascens*);
- Kalahari Scrub Robin (*Cercotrichas paena*);
- Orange River Francolin (*Scleroptila gutturalis*) and potentially also small to medium birds of prey such as:
- Black-winged Kite (*Elanus caeruleus*);
- Lesser Kestrel (*Falco naumanni*);
- Lanner Falcon (*Falco biarmicus*);
- Greater Kestrel (*Falco rupicoloides*);
- Pale Chanting Goshawk (*Melierax canorus*) and
- Gabar Goshawk (*Micronisus gabar*).

When considering the number of displaced bird species and their widespread occurrence in the region, the predicted impact due to the overall displacement and habitat loss is moderate without mitigation measures. However, the possibility exists that the endangered Secretarybird (*Sagittarius serpentarius*) could become displaced should construction activities overspill onto suitable foraging habitat.

4.9.2. Creation of "new" avian habitat and bird pollution

It is possible that the infrastructure (during operation) could attract bird species which may occupy the site or interact with the local bird assemblages in the wider region. These include alien and cosmopolitan species, as well as aggressive omnivorous passerines which could displace other bird species from the area:

- House Sparrow (*Passer domesticus*);
- Common Myna (*Acridotheres tristis*);

- Pied Crow (*Corvus albus*); and
- Speckled Pigeon (*Columba guinea*).

The infrastructure may attract large numbers of roosting columbid taxa, especially Speckled Pigeons (*Columba guinea*), which may result in avian "pollution" through excreta, thereby fouling the panel surfaces. The impact is manageable and will result in a low significance.

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

The presence of wetland-associated habitat units (e.g. Kromdraaispruit system) nearby to the development footprint could increase the risk of waterbirds and shorebird taxa interacting with the proposed PV panels. Placement of the proposed PV panels will be critical and should preferably avoid areas of high sensitivity as illustrated by Figure 22. Appropriate bird deterrent devices should be installed at strategic localities (especially facing the Kromdraaispruit - facing west, northwest and southwest), and these should include a combination of rotating flashers/reflectors to increase the visibility of the infrastructure. In addition, post construction monitoring to quantify mortalities will be important during to early operational phase in order to determine "hotspot" areas (areas where high mortalities are prevalent) which may require additional mitigation measures. Waterbirds with a high frequency of occurrence which could interact with the PV panels are the Egyptian Goose (*Alopochen aegyptiaca*), South African Shelduck (*Tadorna cana*), Yellow-billed Duck (*Anas undulata*), Red-billed Teal (*Anas erythrorhynchus*), African Black Duck *(A. sparsa*) and potentially also Reed Cormorant (*Microcarbo africanus*) and Glossy Ibis (*Plegadis falcinellus*).

However, desktop results and site observations show that the following species could interact with the panel infrastructure (based on species with high reporting rates):

- Yellow-billed Duck (*Anas undulata*);
- Red-billed Teal (*Anas erythrorhynchus*);
- African Black Duck (*Anas sparsa*);
- South African Shelduck (*Tadorna cana*);
- Spur-winged Goose (*Plectropterus gambiensis*);
- Egyptian Goose (*Alopochen aegyptiaca*);
- Little Grebe (*Tachybaptus ruficollis*);
- Reed Cormorant (*Microcarbo africanus*);
- Black-headed Heron (*Ardea melanocephala*);
- Little Egret (*Egretta garzetta*);
- Red-knobbed Coot (*Fulica cristata*) and probably also
- Grey Heron (*Ardea cinerea*);
- African Sacred Ibis (*Threskiornis aethiopicus*);
- Glossy Ibis (*Plegadis falcinellus*);
- Wood Sandpiper (*Tringa glareola*) and
- White-faced Duck (*Dendrocygna viduata*).

4.9.4. Interaction with overhead power lines and reticulation

Overhead powerlines are not part of the facility infrastructure and all internal cabling and MV corridors will be placed underground. However, a 132 kV switching substation and a 132k overhead powerline within a 300m wide and 20km long corridor is proposed to be constructed between the between the switching substation located on the Highveld Solar PV Facility and a point of connection on the Hermes DS - Potchefstroom DS 1 and Buffels East 1 - Potchefstroom 132kV Feeder lines located east of Khuma and the R502. This proposed powerline could result in bird collisions and electrocutions, and these impacts will be assessed as part of a separate Environmental Application (separate EIA report).

However, it is highly recommended that all existing overhead powerlines (irrespective of size) that span the proposed Highveld Solar PV facility be retrofitted with bird guards and appropriate bird flight diverters to reduce any potential collision trauma in birds due to birds attracted to the facility by the PV panels, especially due to the presence of vultures.

Table 8: The quantification of impacts associated with the proposed PV facility and its infrastructure.

1. Nature: Losses of natural habitat and displacement of birds through physical transformation, modifications, removals and land clearance. This impact is mainly restricted to the construction phase and is permanent.		
PV Layout (and associated infrastructure)	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Moderate (6)
Probability	Definite (5)	Highly Probable (4)
Significance	**High (65)**	**Medium (48)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent
Site access road	**Without mitigation**	**With mitigation**
Extent	Site (1)	Site (1)
Duration	Permanent (5)	Long-term (4)
Magnitude	Low (4)	Minor (2)
Probability	Definite (5)	Probable (3)
Significance	**Medium (50)**	**Low (21)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent

Mitigation:
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. Both the PV facility and associated infrastructure occur predominantly on habitat types of medium sensitivity. The best practicable mitigation will be to consolidate infrastructure to areas where existing impacts occur and to avoid any proposed buffer areas. However, the proposed access road corresponds to an existing road, and the potential impact of bird displacement is considered to be temporary (during the implementation of best practicable mitigation measures).
Residual:
It is anticipated that during rehabilitation (after removal of the panels), the vegetation will revert to secondary grassland and shrubland resulting in a potential decrease in bird species richness with low evenness values at a local scale. The residual impact of the PV facility will be medium.

2. Nature:		
The creation of novel or new avian habitat for commensal bird species or superior competitive species. This is expected to occur during the operation phase of the facility.		
PV Layout (and associated infrastructure)	**Without mitigation**	**With mitigation**
Extent	Footprint (1)	Footprint (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Low (18)**	**Low (12)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, with experimentation	Yes
Mitigation:		
Apply bird deterrent devices and remove nest structures constructed on infrastructure associated with the PV facility under the guidance of the ECO.		
Residual:		
Secondary displacement by completive bird species such as crows and increased fecundity rate for commensal bird species that are adapted to anthropogenic activities. The impact is regarded as low.		

3. Nature:		
Avian collision impacts related to the PV facility during the operation phase (collision with the PV panels).		
PV Layout (and associated infrastructure)	**Without mitigation**	**With mitigation**
Extent	Site and immediate surroundings (4)	Site and immediate surroundings (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	High (8)	Moderate (6)
Probability	Highly Probable (4)	Probable (3)
Significance	**High (64)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, potential loss of waterfowl and certain shorebird taxa species.	Yes, potential loss of waterfowl and certain shorebird taxa species.
Can impacts be mitigated?	Yes, with experimentation	Yes, with experimentation

Mitigation: 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 wetland features. 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 wetland features (e.g. the Kromdraaispruit) by at least 500m. If post-construction monitoring predicts and/or confirms 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.
Residual: Direct mortality is possible and may still occur irrespective of applied mitigation measures. Regular and systematic monitoring is proposed to assess the efficacy of applied mitigation and further research and testing is suggested to improve mitigation measures (e.g. bird deterrent devices). The residual impact is regarded as low.

4.10. Cumulative Impacts

Cumulative impacts are defined as impacts that result from additional or incremental activities caused by past or present actions together with the current project. Therefore, cumulative impacts are those that will affect the general avifaunal community on the study area due to other planned solar farm projects and electrical infrastructure in the region.

According to the National Screening Report (generated 23/09/2022), there is currently nine solar PV facilities with an approved environmental authorisation under consideration within 30km of the proposed Highveld Solar PV facility (Table 10). Three of these are within 16 km of the study area.

Table 9: Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed study area (sensu the results of the National Screening Tool).

No	EIA Reference No	Classification	Status of application	Distance from proposed area (km)
1	12/12/20/2122	Solar PV	Approved	15.9
2	12/12/20/2513/3	Solar PV	Approved	21.4
3	12/12/20/2629	Solar PV	Approved	15.9
4	14/12/16/3/3/2/778	Solar PV	Approved	14.2
5	12/12/20/2513/1	Solar PV	Approved	21.4
6	12/12/20/2513/2	Solar PV	Approved	27.3
7	12/12/20/2513/1/AM3	Solar PV	Approved	21.4
8	14/12/16/3/3/2/777	Solar PV	Approved	15.7
9	12/12/20/2513/4	Solar PV	Approved	21.4

The cumulative impacts are likely to increase the displacement and loss of habitat. In addition while the grid connection (via overhead powerlines) of these facilities could potentially contribute towards bird strikes with powerlines and PV structures in the region.

A summary of the cumulative impacts is provided in Table 10.

1. Nature: Regional losses of natural habitat and subsequent displacement of birds.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (2)	Local and immediate surroundings (3)
Duration	Permanent (5)	Long-term (4)
Magnitude	Moderate (6)	Moderate (6)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Medium (48)**	**Medium (52)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	To some extent	To some extent
Confidence in findings: High.		
Mitigation: It is difficult to mitigate against the loss of habitat without considering alternative sites. The best practicable mitigation will be to consolidate infrastructure (e.g. proposed powerline) to areas where existing impacts occur (e.g. placing the proposed infrastructure alongside existing infrastructure) and to concentrate infrastructure on land with a low biodiversity conservation value.		
2. Nature: Avian collision impacts related to the PV facility during the operational phase (collision with the PV panels).		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Site and immediate surroundings (3)	Local and immediate surroundings (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	High (8)
Probability	Probable (3)	Highly Probable (4)
Significance	**Medium (39)**	**Medium (60)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, potential loss of waterfowl and certain shorebird taxa species.	Yes, potential loss of waterfowl and certain shorebird taxa species.
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent
Confidence in findings: Low.		
Mitigation: Apply bird deterrent devices to the panels for birds that may mistake the panels for open water and to prevent them from landing on the panels. To aid post-construction monitoring and/or monitoring of bird mortality rates, it is advised to employ video cameras to document any bird mortalities and to conduct direct observations and carcass searches on a regular and systematic basis. Apply appropriate buffer zones to water features and wetlands.		

4.11. Recommended avifaunal mitigation

4.11.1 Loss of habitat and displacement bird taxa (including threatened and near threatened birds)

It is difficult to mitigate against the loss of habitat when fixed infrastructure is applied. However, proper site selection of the facility is key to reducing the predicted impacts.

The following mitigation measures are proposed:

- Concentrate all surface infrastructure on habitat of medium avifaunal sensitivity. The development footprint of the various individual facilities must be kept as small as possible and sensitive habitats must be avoided.
- Where possible, existing access roads should be used and the construction of new roads should be kept to a minimum.
- Prevent an overspill of construction activities into areas that are not part of the proposed construction site - development should not interfere with any of the proposed buffer areas;
- Use indigenous plant species native to the study area during landscaping and rehabilitation.
- All internal electrical reticulation should be placed underground, while the alignment of the power line and substation should be placed parallel to existing lines.
- Where possible, all White-browed Sparrow-weaver colonies (*Plocepasser mahali*) should be retained.

4.11.2 Creation of "new" avian habitat and bird pollution

The following mitigation measures are proposed:

- Apply bird deterrent devices at selective areas (for example at the corners and middle part of the facility) to the PV panels to discourage birds from colonising the infrastructure or to discourage birds from constructing nests. These could include visual or bio-acoustic deterrents such as highly reflective rotating devices, anti-perching devices such as bird guards, scaring or chasing activities involving the use of trained dogs or raptors and/or netting. Nests should be removed when nest-building attempts are noticed under the guidance of the ECO.
- Reduce or minimise the use of outdoor lighting to avoid attracting birds to the lights or to reduce potential disorientation to migrating birds.
- Use indigenous plant species native to the study area during landscaping and rehabilitation.
- Where possible, large canopy trees (e.g. tall *Vachellia erioloba* trees) should be retained to be used as roosting habitat (hunting perches) for medium-sized

bird of prey species. These species could assists in keeping pigeon/dove and other "problem" species at bay.

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

The following mitigation measures are proposed:

- Implement an additional bird survey (pre-construction surveys - see section dealing with monitoring and EMP) during the peak wet season to obtain quantified data on the occurrence or flyways of waterbird taxa. The data will enable informed decisions regarding the use of deterrent devices.
- Apply bird deterrent devices to the panels at selective areas (for example at the corners and middle part of the facility) to discourage birds from colonising/colliding with the infrastructure. Bird deterrent devices should especially be placed at panels nearest to ("facing") wetland features. These could include visual or bio-acoustic deterrents such as highly reflective rotating devices, flashers, anti-perching devices such as bird guards, scaring or chasing activities involving the use of trained dogs or raptors and/or netting. An option is to employ video cameras at selected areas to document bird mortalities.
- Buffer all wetland-associated habitat (e.g. the Kromdraaispruit) by at least 500m.
- Apply systematic reflective/dynamic markers to the boundary fence to increase the visibility of the fence for approaching birds (e.g. korhaan taxa) and to avoid potential bird collisions with the fence structure.
- Reduce or minimise the use of outdoor lighting to avoid attracting birds to the lights or to reduce potential disorientation to migrating birds.

4.11.4 Existing powerlines (spanning the facility)

The following mitigation measures are proposed:

- All internal electrical infrastructure and cabling should be placed underground.
- Install bird guards/spikes above conductors at pylons.
- Fit powerline spans with bird flight diverters (see Figure 23).

Figure 23: Examples of bird flight diverters to be used on existing power lines: Double loop bird flight diverter (left) and Viper live bird flapper (right).

4.11.5 General mitigation measures

- All construction sites/areas must be demarcated on site layout plans (preferably), and no construction personnel or vehicles may leave the demarcated area except those authorised to do so. Those areas surrounding the construction sites that are not part of the demarcated development area should be considered as “no-go” areas for employees, machinery or even visitors.
- 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.
- Open fires is strictly prohibited and only allowed at designated areas.
- Killing or poaching of any bird species should be avoided by means of awareness programs presented to the labour force. The labour force should be made aware of the conservation issues pertaining to the bird taxa occurring on the study site. Any person found deliberately harassing any bird species in any way should face disciplinary measures, following the possible dismissal from the site.
- Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of eroded areas should be undertaken.

4.11.6 Mitigation relevant to the access road upgrade

- Minimize use of earthmoving equipment, generators and any other equipment that results in noise, dust or oil pollution. Use best practice noise reduction guidelines.
- Limit construction activities to daytime hours (after sunrise and before sunset).
- Apply access control during construction (i.e. construction personnel only) and prohibit driving after dark where feasible. Access during operation of the

road should be controlled, and only authorised personnel should be allowed to enter the site (as well as the landowner/farmer).

- The laydown areas for equipments should be placed/located on level surface and on habitat with low sensitivities. Avoid wetland and floodplain habitat.
- Where possible, retain large trees or canopy constituents (e.g. within the road reserve) since these will facilitate the dispersal of fruit/seed and allow for a canopy "continuum" whereby small bird species will disperse.
- All rehabilitation (where possible) should make use of indigenous plant species, and preferably of floristic species native to the project area. The species selected should strive to represent habitat types typical of the ecological landscape prior to construction.
- All personnel/staff must be informed that poaching will not be tolerated, and alerted to the conservation significance of the region. Awareness meetings must be held to inform staff. Any person found deliberately harassing any bird species in any way should face disciplinary measures, following the possible dismissal from the site.
- Limit erosion potential through anti-erosive measures wherever it may prove necessary. Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of the eroded areas.
- Install appropriate storm water control measures to limit excessive runoff into natural vegetation and the Kromdraaispruit that could change the surrounding habitat structure, sedimentation and bird composition.
- Install bridge culvers (at the Kromdraaispruit) of an appropriate size to allow for the natural flow (at base flow rates) of the Kromdraaispruit (when inundated) and to allow for the upstream/downstream dispersal of animals.
- The speed limit should be reduced by means of signage and speed reduction methods (e.g. speed humps and rumble strips) when approaching to Kromdraaispruit (from both sites) to avoid vehicle-animals conflicts. Regular monitoring of the road is recommended to determine "hotspot" areas where wildlife (bird)-vehicle collisions, which will allow for the installation of speed reduction devices.

4.12. Suggested monitoring and Environmental Management Plan

Information on collision trauma (bird mortalities) and the displacement of birds caused by PV solar facilities is insufficient. Therefore, as per the guidelines of Jenkins *et al.* (2017) it is highly recommended that additional pre- and post construction monitoring be implemented to augment existing data:

- At least one additional pre-construction survey is recommended, consisting of a minimum of 3-4 days which is necessary to inform the final EMPr during operation. The survey should coincide with the peak wet season when most of the drainage lines and wetland features in the wider study region are inundated. This will enable the observer to obtain quantified data on waterbird

richness and potential flyways, which will contribute towards the understanding of impacts related to collision trauma with the panels.

- A post-construction survey during operation with a minimum of 3 x 3-4 day surveys over a six month period (including the peak wet season). The surveys aim to obtain mortality data from birds colliding with the panels to advise on appropriate mitigation measures to be implemented to reduce potential bird mortalities. The surveys should be conducted in a regular and systematic manner by means of direct observations (and the use of installed video cameras) and carcass searches. A management programme must be compiled to assess the efficacy of applied mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include species of conservation concern.
- It is possible that bird mortalities due to collision will occur at **existing** power lines even after mitigation. The post-construction monitoring (during operation) should also quantify mortalities (especially vulture mortalities) caused by the existing power line network. The information could then be used to inform the electrical infrastructure mortality incident register. It is suggested that monitoring should be implemented once a month for at least one year when in operation. All searches should be done on foot. A management programme must be compiled to assess the efficacy of applied mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include birds of prey and species of conservation concern..

OBJECTIVE 1:	Minimise potential collision trauma with infrastructure and augmenting existing information on bird interactions with solar infrastructure

Project Component/s	» PV panel arrays
Potential Impact	» Collision trauma caused by photovoltaic panels (the "lake-effect")
Activity/Risk Source	» Operation of PV infrastructure
Mitigation: Target/Objective	» Zero bird mortalities due to collision trauma caused by PV panels

Mitigation: Action/Control	Responsibility	Timeframe
1. Apply bird deterrent devices to the PV panels to discourage birds from colonising the infrastructure or to discourage birds from constructing nests. These could include visual or bio-acoustic deterrents such as highly reflective rotating devices, anti-perching devices such as bird guards, scaring or chasing activities involving the use of trained dogs or raptors and/or netting. Nests should	ECO & OM	Operation (on-going)

be removed when nest-building attempts are noticed.		
2. Reduce or minimise the use of outdoor lighting to avoid attracting birds to the lights or to reduce potential disorientation to migrating birds.	ECO & OM	Operation (on-going)
3. Use indigenous plant species native to the study area during landscaping and rehabilitation and retain White-browed Sparrow-weaver colonies.	CER & ECO	Construction phase
4. Implement pre-construction monitoring protocols (as per Jenkins et al., 2017).	ECO & EM	Prior to construction - At least 1 survey of 3-4 days (during wet season)
5. Implement post-construction monitoring and carcass surveys (as per Jenkins et al., 2017)	OM & CER	Post- construction - At least 3 surveys, each 3-4 days during a 6 month period
6. Compile management programme to assess efficacy of mitigation and on-going research/trials	EM & OM	Operation (on-going)

Performance Indicator	Reduced statistical detection/observation of bird mortalities
Monitoring	1. Implement at least one pre-construction survey consisting of a minimum of 3-4 days. 2. Surveys should coincide with the peak wet season when most of the drainage lines and wetland features in the wider study region are inundated. 3. Obtain quantified data on waterbird richness and potential flyways, which will contribute towards the understanding of impacts related to collision trauma with the panels. 4. Monitor terrestrial birds at the fixed point counts by using the exact protocol applied during this report. 5. Implement post-construction survey during operation with a minimum of 3 x 3-4 day surveys during a six month period (including the peak wet season). 6. Obtain mortality data from birds colliding with the panels and advise on appropriate mitigation measures to be implemented to reduce potential bird mortalities. 7. Conduct post-construction monitoring in a systematic manner by means of direct observations (an option is the use of installed video cameras at selected areas) and carcass searches. 8. Implement management programme to assess the efficacy of applied mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include birds of prey and species of conservation concern.

OBJECTIVE 2: Minimise collisions and electrocution associated with existing power lines

Project Component/s	» Overhead power lines
Potential Impact	» Collision and electrocution caused by power lines
Activity/Risk Source	» Overhead power lines
Mitigation: Target/Objective	» Reduced bird mortalities due to collision/electrocution

Mitigation: Action/Control	Responsibility	Timeframe
1. Apply bird deterrent devices to all new and existing power line.	ECO & CER	Construction
2. Implement post-construction monitoring and carcass surveys (including existing lines) - to run parallel with PV post-construction monitoring.	OM	Operation - weekly
3. Report mortalities (number, locality and species) to Electrical Energy Mortality Register at EWT.	OM	Operation (on-going)

Performance Indicator	Reduced statistical detection/observation of bird mortalities
Monitoring	1. Implement post-construction monitoring to quantify bird mortalities caused by the power line network. All searches should be done on foot. 2. Compile a management programme to assess the efficacy of applied mitigation measures and consult or change measures to reduce on-going mortalities when detected. Additional mitigation measures should be tested or applied, especially if mortalities include birds of prey and species of conservation concern.

4.13. Analysis regarding the feasibility of the project

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of WKN Windcurrent SA (Pty) to compile an avifauna baseline and impact assessment report for the proposed Highveld Solar PV facility and associated infrastructure on the Remainder of Portion 10 and Portions 56 and 79 of Farm Rietfontein 388 as well as the Remainder of Farm Rietfontein 3, near Stilfontein, North West Province.

Three prominent avifaunal habitat types were identified on the development area, which consisted of open savannoid grassland with bush clump mosaics, artificial livestock watering points and the Kromdraaispruit floodplain. The highest number of bird species and bird individuals were observed from the artificial livestock watering points and from bush clump habitat consisting of a prominent (tall) canopy. Approximately 245 bird species were expected to occur in the wider study area, of which 106 species were observed on the development area during the respective surveys. The expected richness included nine threatened or near threatened species, 16 southern African endemics and 21 are near-endemic species. The critically endangered White-backed Vulture (*Gyps africanus*) and endangered Cape Vulture (*G. coprotheres*) were observed as foraging individuals soaring overhead. In addition, a pair of vulnerable Lanner Falcons (*Falco biarmicus*) occurred within the study area. The nearby Kromdraaispruit floodplain west of development area provided potential suitable foraging habitat for the regionally endangered African Marsh Harrier (*Circus ranivorus*), although this species was not observed during the respective surveys. Although the African Marsh Harrier was not recorded on the study area during the survey period, it was recommended that all potential habitat be conserved (as a precautionary principle) by applying a 500m buffer to the edge of the Kromdraaispruit floodplain. Thirteen southern African endemics and 15 near-endemic species were confirmed on the development area.

An evaluation of potential and likely impacts on the avifauna revealed that the impact significance was moderate to low after mitigation (depending on the type of impact). However, the risk for certain waterbirds (mainly large-bodied waterfowl such as the South African Shelduck *Tadorna cana*, Egyptian Goose *Alopochen aegyptiacus* and members of the genus *Anas*) colliding with the PV infrastructure remained eminent due to the presence of the nearby Kromdraaispruit. It was strongly recommended

that the proposed mitigation measures and monitoring protocols (e.g. post construction monitoring) be implemented during the construction and operational phase of the project.

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Appendix 1: A shortlist of bird species expected to be present on the study site and immediate surroundings. The list provides an indication of the species occurrence according to SABAP2 reporting rates. The list was derived (and modified) from species observed in pentad grid 2640_2650 and the eight surrounding grids. The reporting rates include submissions made during the April/May 2022 and September 2022 surveys.

#	Common Name	Scientific Name	Observed (April/May & September 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
78	Abdim's Stork	*Ciconia abdimii*		0.21	1	0.00	0
432	Acacia Pied Barbet	*Tricholaema leucomelas*	1	60.74	294	18.07	15
95	African Black Duck	*Anas sparsa*		4.34	21	1.20	1
127	African Cuckoo-Hawk	*Aviceda cuculoides*		0.83	4	0.00	0
52	African Darter	*Anhinga rufa*		22.93	111	8.43	7
149	African Fish Eagle	*Haliaeetus vocifer*		6.20	30	3.61	3
171	African Harrier-Hawk	*Polyboroides typus*		2.27	11	1.20	1
418	African Hoopoe	*Upupa africana*		52.89	256	9.64	8
167	African Marsh Harrier	*Circus ranivorus*		0.41	2	0.00	0
387	African Palm Swift	*Cypsiurus parvus*		58.06	281	19.28	16
682	African Paradise Flycatcher	*Terpsiphone viridis*		14.05	68	3.61	3
685	African Pied Wagtail	*Motacilla aguimp*		2.27	11	0.00	0
692	African Pipit	*Anthus cinnamomeus*	1	39.46	191	10.84	9
544	African Red-eyed Bulbul	*Pycnonotus nigricans*	1	93.60	453	25.30	21
606	Common (African) Reed Warbler	*Acrocephalus scirpaceus baeticatus*		15.91	77	2.41	2
81	African Sacred Ibis	*Threskiornis aethiopicus*		31.82	154	15.66	13
250	African Snipe	*Gallinago nigripennis*		9.09	44	0.00	0
85	African Spoonbill	*Platalea alba*		16.94	82	1.20	1
576	African Stonechat	*Saxicola torquatus*	1	64.05	310	13.25	11

#	Common Name	Scientific Name	Observed (April/May & September 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
247	African Wattled Lapwing	*Vanellus senegallus*		5.37	26	0.00	0
772	Amethyst Sunbird	*Chalcomitra amethystina*		23.76	115	10.84	9
119	Amur Falcon	*Falco amurensis*		4.34	21	2.41	2
575	Ant-eating Chat	*Myrmecocichla formicivora*	1	20.66	100	9.64	8
533	Arrow-marked Babbler	*Turdoides jardineii*	1	n/a	1	0.00	0
514	Ashy Tit	*Melaniparus cinerascens*	1	5.79	28	1.20	1
510	Banded Martin	*Riparia cincta*		4.75	23	2.41	2
493	Barn Swallow	*Hirundo rustica*		30.99	150	20.48	17
203	Black Crake	*Zapornia flavirostra*		29.34	142	2.41	2
159	Black Sparrowhawk	*Accipiter melanoleucus*		2.89	14	2.41	2
650	Black-chested Prinia	*Prinia flavicans*	1	88.84	430	26.51	22
146	Black-chested Snake Eagle	*Circaetus pectoralis*		0.62	3	0.00	0
431	Black-collared Barbet	*Lybius torquatus*	1	44.63	216	13.25	11
69	Black-crowned Night Heron	*Nycticorax nycticorax*		15.29	74	3.61	3
841	Black-faced Waxbill	*Brunhilda erythronotos*	1	6.61	32	1.20	1
55	Black-headed Heron	*Ardea melanocephala*		30.58	148	9.64	8
245	Blacksmith Lapwing	*Vanellus armatus*	1	87.81	425	26.51	22
860	Black-throated Canary	*Crithagra atrogularis*	1	72.93	353	28.92	24
130	Black-winged Kite	*Elanus caeruleus*	1	49.17	238	22.89	19
282	Black-winged Pratincole	*Glareola nordmanni*		0.41	2	0.00	0
839	Blue Waxbill	*Uraeginthus angolensis*	1	64.46	312	13.25	11
99	Blue-billed Teal	*Spatula hottentota*		1.45	7	0.00	0
405	Blue-cheeked Bee-eater	*Merops persicus*		0.41	2	0.00	0
722	Bokmakierie	*Telophorus zeylonus*	1	22.73	110	3.61	3

#	Common Name	Scientific Name	Observed (April/May & September 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
823	Bronze Mannikin	*Spermestes cucullata*		7.64	37	1.20	1
145	Brown Snake Eagle	*Circaetus cinereus*		0.00	0	1.20	1
443	Brown-backed Honeybird	*Prodotiscus regulus*		2.07	10	0.00	0
714	Brown-crowned Tchagra	*Tchagra australis*	1	21.07	102	4.82	4
402	Brown-hooded Kingfisher	*Halcyon albiventris*		24.38	118	3.61	3
509	Brown-throated Martin	*Riparia paludicola*	1	28.93	140	0.00	0
731	Brubru	*Nilaus afer*		8.06	39	1.20	1
695	Buffy Pipit	*Anthus vaalensis*	1	2.69	13	0.00	0
4131	Burchell's Coucal	*Centropus burchellii*		21.49	104	2.41	2
703	Cape Longclaw	*Macronyx capensis*	1	39.88	193	10.84	9
531	Cape Penduline Tit	*Anthoscopus minutus*	1	0.62	3	0.00	0
581	Cape Robin-Chat	*Cossypha caffra*	1	57.85	280	14.46	12
94	Cape Shoveler	*Spatula smithii*		8.47	41	1.20	1
786	Cape Sparrow	*Passer melanurus*	1	84.09	407	24.10	20
737	Cape Starling	*Lamprotornis nitens*	1	66.12	320	22.89	19
98	Cape Teal	*Anas capensis*		1.65	8	0.00	0
316	Ring-necked Dove	*Streptopelia capicola*	1	66.53	322	20.48	17
581	Cape Robin-chat	*Cossypha caffra*	1	n/a	1	0.00	0
106	Cape Vulture	*Gyps coprotheres*	1	0.41	2	0.00	0
686	Cape Wagtail	*Motacilla capensis*	1	50.62	245	6.02	5
1172	Cape White-eye	*Zosterops virens*	1	9.71	47	6.02	5
568	Capped Wheatear	*Oenanthe pileata*	1	10.12	49	1.20	1
450	Cardinal Woodpecker	*Dendropicos fuscescens*	1	8.88	43	4.82	4
484	Chestnut-backed Sparrow-Lark	*Eremopterix leucotis*		4.96	24	1.20	1

#	Common Name	Scientific Name	Observed (April/May & September 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
658	Chestnut-vented Warbler	*Curruca subcoerulea*	1	73.35	355	12.05	10
673	Chinspot Batis	*Batis molitor*	1	8.06	39	3.61	3
872	Cinnamon-breasted Bunting	*Emberiza tahapisi*		21.90	106	8.43	7
631	Cloud Cisticola	*Cisticola textrix*	1	16.53	80	4.82	4
154	Common (Steppe) Buzzard	*Buteo buteo vulpinus*		7.85	38	4.82	4
263	Common Greenshank	*Tringa nebularia*		3.72	18	0.00	0
507	Common House Martin	*Delichon urbicum*		0.41	2	0.00	0
210	Common Moorhen	*Gallinula chloropus*		48.76	236	4.82	4
734	Common Myna	*Acridotheres tristis*		78.51	380	21.69	18
189	Common Quail	*Coturnix coturnix*		0.41	2	0.00	0
258	Common Sandpiper	*Actitis hypoleucos*		4.55	22	0.00	0
421	Common Scimitarbill	*Rhinopomastus cyanomelas*	1	11.78	57	0.00	0
378	Common Swift	*Apus apus*		0.41	2	0.00	0
843	Common Waxbill	*Estrilda astrild*	1	15.91	77	2.41	2
594	Common Whitethroat	*Curruca communis*		0.83	4	1.20	1
439	Crested Barbet	*Trachyphonus vaillantii*	1	78.93	382	18.07	15
711	Crimson-breasted Shrike	*Laniarius atrococcineus*	1	10.74	52	1.20	1
242	Crowned Lapwing	*Vanellus coronatus*	1	81.41	394	27.71	23
854	Cuckoo Finch	*Anomalospiza imberbis*		0.21	1	0.00	0
821	Cut-throat Finch	*Amadina fasciata*		4.13	20	0.00	0
545	Dark-capped Bulbul	*Pycnonotus tricolor*	1	0.62	3	0.00	0
630	Desert Cisticola	*Cisticola aridulus*	1	30.99	150	8.43	7
352	Diederik Cuckoo	*Chrysococcyx caprius*	1	37.60	182	7.23	6
1183	Eastern Clapper Lark	*Mirafra fasciolata*	1	25.83	125	8.43	7

#	Common Name	Scientific Name	Observed (April/May & September 2022)	SABAP2 Reporting Rate			
				Full Protocol (%)	Number of cards	Ad Hoc Protocol (%)	Number of cards
89	Egyptian Goose	*Alopochen aegyptiaca*	1	67.77	328	18.07	15
404	European Bee-eater	*Merops apiaster*		32.85	159	7.23	6
132	European Honey-buzzard	*Pernis apivorus*		4.34	21	1.20	1
678	Fairy Flycatcher	*Stenostira scita*		2.89	14	0.00	0
570	Familiar Chat	*Oenanthe familiaris*		18.80	91	0.00	0
665	Fiscal Flycatcher	*Melaenornis silens*	1	44.01	213	4.82	4
517	Fork-tailed Drongo	*Dicrurus adsimilis*		0.41	2	0.00	0
101	Fulvous Whistling Duck	*Dendrocygna bicolor*		8.26	40	4.82	4
162	Gabar Goshawk	*Micronisus gabar*		19.42	94	9.64	8
595	Garden Warbler	*Sylvia borin*		0.41	2	1.20	1
83	Glossy Ibis	*Plegadis falcinellus*	1	21.07	102	1.20	1
874	Golden-breasted Bunting	*Emberiza flaviventris*		0.41	2	0.00	0
447	Golden-tailed Woodpecker	*Campethera abingoni*		0.62	3	2.41	2
603	Great Reed Warbler	*Acrocephalus arundinaceus*		5.79	28	0.00	0
346	Great Spotted Cuckoo	*Clamator glandarius*		0.21	1	1.20	1
440	Greater Honeyguide	*Indicator indicator*		3.51	17	1.20	1
122	Greater Kestrel	*Falco rupicoloides*	1	5.79	28	4.82	4
502	Greater Striped Swallow	*Cecropis cucullata*	1	45.66	221	10.84	9
419	Green Wood Hoopoe	*Phoeniculus purpureus*	1	24.17	117	13.25	11
830	Green-winged Pytilia	*Pytilia melba*	1	12.60	61	4.82	4
339	Grey Go-away-bird	*Crinifer concolor*		1.65	8	0.00	0
54	Grey Heron	*Ardea cinerea*	1	22.31	108	3.61	3
288	Grey-headed Gull	*Chroicocephalus cirrocephalus*		5.99	29	1.20	1
557	Groundscraper Thrush	*Turdus litsitsirupa*		10.54	51	3.61	3

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84	Hadada Ibis	*Bostrychia hagedash*	1	82.23	398	25.30	21
72	Hamerkop	*Scopus umbretta*	1	6.61	32	0.00	0
192	Helmeted Guineafowl	*Numida meleagris*	1	62.60	303	21.69	18
384	Horus Swift	*Apus horus*		0.41	2	0.00	0
784	House Sparrow	*Passer domesticus*	1	71.49	346	14.46	12
60	Intermediate Egret	*Ardea intermedia*		3.51	17	1.20	1
348	Jacobin Cuckoo	*Clamator jacobinus*		1.86	9	0.00	0
835	Jameson's Firefinch	*Lagonosticta rhodopareia*		10.33	50	0.00	0
586	Kalahari Scrub Robin	*Cercotrichas paena*	1	41.94	203	9.64	8
1104	Karoo Thrush	*Turdus smithi*		50.41	244	14.46	12
351	Klaas's Cuckoo	*Chrysococcyx klaas*		0.83	4	0.00	0
114	Lanner Falcon	*Falco biarmicus*	1	3.93	19	3.61	3
317	Laughing Dove	*Spilopelia senegalensis*	1	96.69	468	40.96	34
706	Lesser Grey Shrike	*Lanius minor*		4.34	21	4.82	4
442	Lesser Honeyguide	*Indicator minor*	1	8.26	40	2.41	2
125	Lesser Kestrel	*Falco naumanni*		5.58	27	2.41	2
604	Lesser Swamp Warbler	*Acrocephalus gracilirostris*		47.31	229	6.02	5
646	Levaillant's Cisticola	*Cisticola tinniens*	1	58.88	285	4.82	4
413	Lilac-breasted Roller	*Coracias caudatus*		0.41	2	2.41	2
410	Little Bee-eater	*Merops pusillus*	1	17.77	86	7.23	6
59	Little Egret	*Egretta garzetta*		14.26	69	4.82	4
6	Little Grebe	*Tachybaptus ruficollis*		40.70	197	7.23	6
609	Little Rush Warbler	*Bradypterus baboecala*		25.00	121	3.61	3
158	Little Sparrowhawk	*Accipiter minullus*		8.26	40	7.23	6

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253	Little Stint	*Calidris minuta*		9.71	47	0.00	0
385	Little Swift	*Apus affinis*		32.02	155	18.07	15
621	Long-billed Crombec	*Sylvietta rufescens*	1	3.93	19	2.41	2
852	Long-tailed Paradise Whydah	*Vidua paradisaea*		17.36	84	13.25	11
818	Long-tailed Widowbird	*Euplectes progne*	1	40.70	197	12.05	10
397	Malachite Kingfisher	*Corythornis cristatus*		14.88	72	4.82	4
661	Marico Flycatcher	*Melaenornis mariquensis*		1.45	7	0.00	0
361	Marsh Owl	*Asio capensis*		2.27	11	1.20	1
262	Marsh Sandpiper	*Tringa stagnatilis*		3.51	17	0.00	0
607	Marsh Warbler	*Acrocephalus palustris*		1.03	5	0.00	0
142	Martial Eagle	*Polemaetus bellicosus*		0.21	1	0.00	0
456	Melodious Lark	*Mirafra cheniana*	1	2.27	11	2.41	2
318	Namaqua Dove	*Oena capensis*		27.48	133	16.87	14
183	Natal Spurfowl	*Pternistis natalensis*		1.65	8	1.20	1
637	Neddicky	*Cisticola fulvicapilla*	1	61.57	298	10.84	9
1035	Northern Black Korhaan	*Afrotis afraoides*	1	45.25	219	21.69	18
179	Orange River Francolin	*Scleroptila gutturalis*	1	10.33	50	3.61	3
1171	Orange River White-eye	*Zosterops pallidus*	1	62.40	302	13.25	11
838	Orange-breasted Waxbill	*Amandava subflava*		4.34	21	0.00	0
157	Ovambo Sparrowhawk	*Accipiter ovampensis*		2.48	12	1.20	1
165	Pale Chanting Goshawk	*Melierax canorus*	1	4.34	21	2.41	2
365	Pearl-spotted Owlet	*Glaucidium perlatum*	1	n/a	1	0.00	0
113	Peregrine Falcon	*Falco peregrinus*		5.17	25	1.20	1
522	Pied Crow	*Corvus albus*	1	75.62	366	40.96	34

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394	Pied Kingfisher	*Ceryle rudis*		8.06	39	2.41	2
746	Pied Starling	*Lamprotornis bicolor*	1	28.93	140	12.05	10
490	Pink-billed Lark	*Spizocorys conirostris*		2.07	10	1.20	1
846	Pin-tailed Whydah	*Vidua macroura*		39.26	190	8.43	7
694	Plain-backed Pipit	*Anthus leucophrys*		1.86	9	1.20	1
674	Pririt Batis	*Batis pririt*		7.44	36	0.00	0
57	Purple Heron	*Ardea purpurea*		12.19	59	0.00	0
844	Quailfinch	*Ortygospiza atricollis*	1	26.03	126	8.43	7
642	Rattling Cisticola	*Cisticola chiniana*	1	18.80	91	7.23	6
708	Red-backed Shrike	*Lanius collurio*		19.63	95	21.69	18
837	Red-billed Firefinch	*Lagonosticta senegala*		32.85	159	7.23	6
805	Red-billed Quelea	*Quelea quelea*	1	64.26	311	16.87	14
97	Red-billed Teal	*Anas erythrorhyncha*	1	38.84	188	2.41	2
501	Red-breasted Swallow	*Cecropis semirufa*		4.34	21	2.41	2
488	Red-capped Lark	*Calandrella cinerea*	1	11.98	58	1.20	1
343	Red-chested Cuckoo	*Cuculus solitarius*		2.69	13	0.00	0
205	Red-chested Flufftail	*Sarothrura rufa*		3.93	19	1.20	1
813	Red-collared Widowbird	*Euplectes ardens*		9.50	46	2.41	2
314	Red-eyed Dove	*Streptopelia semitorquata*	1	85.54	414	25.30	21
392	Red-faced Mousebird	*Urocolius indicus*	1	70.25	340	20.48	17
820	Red-headed Finch	*Amadina erythrocephala*		39.88	193	20.48	17
212	Red-knobbed Coot	*Fulica cristata*		60.33	292	8.43	7
453	Red-throated Wryneck	*Jynx ruficollis*	1	0.83	4	1.20	1
50	Reed Cormorant	*Microcarbo africanus*	1	53.31	258	13.25	11

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940	Rock Dove	*Columba livia*		52.48	254	12.05	10
123	Rock Kestrel	*Falco rupicolus*		1.24	6	1.20	1
506	Rock Martin	*Ptyonoprogne fuligula*		1.03	5	0.00	0
256	Ruff	*Calidris pugnax*		7.44	36	1.20	1
458	Rufous-naped Lark	*Mirafra africana*	1	53.31	258	24.10	20
460	Sabota Lark	*Calendulauda sabota*		14.67	71	6.02	5
789	Scaly-feathered Weaver	*Sporopipes squamifrons*	1	35.54	172	19.28	16
105	Secretarybird	*Sagittarius serpentarius*		0.62	3	0.00	0
608	Sedge Warbler	*Acrocephalus schoenobaenus*		0.62	3	0.00	0
847	Shaft-tailed Whydah	*Vidua regia*		8.06	39	2.41	2
504	South African Cliff Swallow	*Petrochelidon spilodera*	1	27.89	135	16.87	14
90	South African Shelduck	*Tadorna cana*	1	29.96	145	7.23	6
707	Southern Fiscal	*Lanius collaris*	1	62.81	304	27.71	23
4142	Southern Grey-headed Sparrow	*Passer diffusus*	1	67.98	329	24.10	20
803	Southern Masked Weaver	*Ploceus velatus*	1	96.49	467	36.14	30
102	Southern Pochard	*Netta erythrophthalma*		3.93	19	0.00	0
808	Southern Red Bishop	*Euplectes orix*	1	82.64	400	27.71	23
390	Speckled Mousebird	*Colius striatus*		40.29	195	16.87	14
311	Speckled Pigeon	*Columba guinea*	1	79.13	383	22.89	19
474	Spike-heeled Lark	*Chersomanes albofasciata*	1	5.17	25	3.61	3
368	Spotted Eagle-Owl	*Bubo africanus*	1	2.48	12	0.00	0
654	Spotted Flycatcher	*Muscicapa striata*		12.81	62	2.41	2
275	Spotted Thick-knee	*Burhinus capensis*	1	10.95	53	3.61	3
88	Spur-winged Goose	*Plectropterus gambensis*		26.45	128	2.41	2

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62	Squacco Heron	*Ardeola ralloides*		8.88	43	1.20	1
63	Striated Heron	*Butorides striata*		9.50	46	3.61	3
185	Swainson's Spurfowl	*Pternistis swainsonii*	1	54.55	264	12.05	10
649	Tawny-flanked Prinia	*Prinia subflava*		4.55	22	2.41	2
277	Temminck's Courser	*Cursorius temminckii*		0.21	1	0.00	0
804	Thick-billed Weaver	*Amblyospiza albifrons*		24.59	119	6.02	5
238	Three-banded Plover	*Charadrius tricollaris*		34.92	169	1.20	1
851	Village Indigobird	*Vidua chalybeata*		15.08	73	1.20	1
840	Violet-eared Waxbill	*Granatina granatina*	1	6.41	31	3.61	3
735	Wattled Starling	*Creatophora cinerea*	1	40.50	196	18.07	15
359	Western Barn Owl	*Tyto alba*	1	3.51	17	1.20	1
61	Western Cattle Egret	*Bubulcus ibis*	1	73.76	357	40.96	34
689	Western Yellow Wagtail	*Motacilla flava*		0.21	1	0.00	0
80	White Stork	*Ciconia ciconia*		0.00	0	1.20	1
391	White-backed Mousebird	*Colius colius*	1	30.79	149	3.61	3
107	White-backed Vulture	*Gyps africanus*	1	0.83	4	1.20	1
763	White-bellied Sunbird	*Cinnyris talatala*	1	29.55	143	6.02	5
47	White-breasted Cormorant	*Phalacrocorax lucidus*		16.32	79	7.23	6
780	White-browed Sparrow-Weaver	*Plocepasser mahali*	1	87.60	424	30.12	25
100	White-faced Whistling Duck	*Dendrocygna viduata*		34.92	169	3.61	3
409	White-fronted Bee-eater	*Merops bullockoides*		20.25	98	6.02	5
383	White-rumped Swift	*Apus caffer*		27.27	132	8.43	7
582	White-throated Robin-Chat	*Cossypha humeralis*	1	2.48	12	0.00	0
495	White-throated Swallow	*Hirundo albigularis*		27.69	134	3.61	3

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814	White-winged Widowbird	*Euplectes albonotatus*	1	15.08	73	7.23	6
599	Willow Warbler	*Phylloscopus trochilus*		7.44	36	1.20	1
264	Wood Sandpiper	*Tringa glareola*		12.60	61	3.61	3
866	Yellow Canary	*Crithagra flaviventris*	1	39.46	191	8.43	7
96	Yellow-billed Duck	*Anas undulata*	1	58.26	282	14.46	12
129	Yellow-billed Kite	*Milvus aegyptius*		0.83	4	1.20	1
76	Yellow-billed Stork	*Mycteria ibis*		0.83	4	0.00	0
812	Yellow-crowned Bishop	*Euplectes afer*		20.04	97	7.23	6
859	Yellow-fronted Canary	*Crithagra mozambica*		1.45	7	0.00	0
629	Zitting Cisticola	*Cisticola juncidis*	1	22.93	111	20.48	17

Appendix 2: Preliminary density estimates of birds recorded from the study site and immediate surroundings during two independent surveys conducted during April/May 2022 and September 2022.

Species	f01	f02	f03	f04	f05	f06	f07	f08	f09	f10	f11	f12	f13	f14	f15
Ant-eating Chat	0	0	0	0	0	0	0	0	0	0	0	0	0	1.5	0
African Pipit	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1
African Red-eyed Bulbul	2	0	0	3	2.5	1	3	2.5	0	0.5	3	0	0.5	0	0
Ashy Tit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Stonechat	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
Black-chested Prinia	2	0	0	2	2	2	2	2	0	0	2	0	2	1	2
Black-faced Waxbill	0	0	0	0.5	0	1	0	0	0	0	0	0	0	0	0
Bokmakierie	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Brown-crowned Tchagra	0	0	0	2	1	1	1	1	0	0	1	0	1	0	0
Black-throated Canary	1	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0
Buffy Pipit	0	1.5	1	0	0	0	0	0	0	0	0	0	0	0	0
Blue Waxbill	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cloud Cisticola	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0
Capped Wheatear	0	0	1	0	0	0	0	0	0	0.5	1	1	0	0	1
Cape Longclaw	0	0	1	0.5	0	0	0	0	0	0	0	0	0	0	0
Common Scimmitarbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Waxbill	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape Penduline Tit	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0
Cape Robin-chat	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
Crimson-breasted Shrike	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinspot Batis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Cape Sparrow	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0

Species	f01	f02	f03	f04	f05	f06	f07	f08	f09	f10	f11	f12	f13	f14	f15
Cape Starling	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0
Chestnut-vented Warbler	1	0	0	2	2.5	2	2.5	4.5	0	1	2	0	3	0	2
Cape Wagtail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape White-eye	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Dark-capped Bulbul	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert Cisticola	0	0.5	0	0	0	0	0.5	0	1	0	0	1	0	1	0
Eastern Clapper Lark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fiscal Flycatcher	0.5	0	0	3	1.5	1	1.5	2.5	0	0	1	0	2	0	0
Green-winged Pytilia	0	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0	0
Long-billed Crombec	0	0	0	0	0	0	0.5	1	0	0	0	0	1	0	0
Kalahari Scrub-robin	0	0	0	1	0.5	2	1.5	2	0	0	1	0	2	0	1
Levaillant's Cisticola	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melodious Lark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neddicky	0	0	0	1	0	0	0.5	0	0	0	0	0	0	0	0
Orange River White-eye	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Pied Starling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rattling Cisticola	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Red-billed Quelea	25	0	0	0	0	12.5	0	0.5	0	0	5	0	0	0	0
Rufous-naped Lark	0	0	1.5	0	0	0	0	0	0	0.5	0	0	0	0	0
Sabota Lark	0	0	0	0	1	1	0.5	2	0	0	0	0	0.5	0	0
Southern Fiscal	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Scaly-feathered Weaver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Southern Greyheaded Sparrow	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Spike-heeled Lark	0	0.5	3	0	0	0	0	0	0	1	0	0	0	0	0
Southern Masked Weaver	0	0	0	1.5	0	4	1.5	0	0	0	2	0	0	0	0

Species	f01	f02	f03	f04	f05	f06	f07	f08	f09	f10	f11	f12	f13	f14	f15
Southern Red Bishop	11.5	0	0	0	0	37.5	0	0	0	0	0	0	0	0	0
Red-capped Lark	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Violet-eared Waxbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White-bellied Sunbird	0	0	0	0.5	0.5	0	1	0.5	0	0	0.5	0	0.5	0	0
White-browed Sparrow-weaver	0	0	0	2	0	1.5	0	0	0	0	2.5	0	0	0	0
White-throated Robin-chat	0	0	0	1	0.5	0	1	0	0	0	0	0	0	0	0
Yellow Canary	0.5	0	0	1	0	3	0	2	0	0	2	0	0	0	0
Zitting Cisticola	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
Number of individuals	55	2.5	7.5	39.5	20.5	89	25.5	25	1	6.5	55.5	3	14.5	4	12.5
Number of species	18	3	5	29	16	23	19	17	1	7	23	4	11	4	8
Number of birds/ha	**70.51**	**3.21**	**9.62**	**50.64**	**26.28**	**114.10**	**32.69**	**32.05**	**1.28**	**8.33**	**71.15**	**3.85**	**18.59**	**5.13**	**16.03**
Number of species/ha	**23.08**	**3.85**	**6.41**	**37.18**	**20.51**	**29.49**	**24.36**	**21.79**	**1.28**	**8.97**	**29.49**	**5.13**	**14.10**	**5.13**	**10.26**
Average number of birds/ha	**24.59**														
Average number of species/ha	**15.35**														

Species	f16	f17	f19	f20	f22	f23	f24	f25	f26	f27	f28	f29	f30	f31	f32	f33	f34	f35	Mean birds/ha
Ant-eating Chat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.002**
African Pipit	0	0	0	1	0	0	0	0.5	0	0	0	0	0.5	0	0.5	0	0.5	0	**0.007**
African Red-eyed Bulbul	0	2	4	2	0.5	2	1	0	1.5	0	0.5	0	0	0	0	0	0.5	1.5	**0.039**
Ashy Tit	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	**0.001**
African Stonechat	0	0	0	0.5	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	**0.004**
Black-chested Prinia	0	0	2	1	1	2	1	2	2	0	2	2	2	1	0	1	1	2	**0.048**
Black-faced Waxbill	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.002**
Bokmakierie	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	**0.006**
Brown-crowned Tchagra	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	**0.013**

Species	f16	f17	f19	f20	f22	f23	f24	f25	f26	f27	f28	f29	f30	f31	f32	f33	f34	f35	Mean birds/ha
Black-throated Canary	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**0.005**
Buffy Pipit	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0.004**
Blue Waxbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.004**
Cloud Cisticola	0	0	0.5	0	0	0	0.5	0	0	1	0	0	0	0	0	0	0	0	**0.003**
Capped Wheatear	1	1	0	0	0.5	0	1	1	0	0	0	0	1	1	1	1	1	0	**0.016**
Cape Longclaw	0	0	0	1	0	1	0	0	2	0	0	0	0	0	0	0	0	0	**0.006**
Common Scimmitarbill	0	0	0.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0.002**
Common Waxbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Cape Penduline Tit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Cape Robin-chat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Crimson-breasted Shrike	0	0	0.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0.002**
Chinspot Batis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.002**
Cape Sparrow	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**0.006**
Cape Starling	0	0	0	0	0	0	0.5	0	0	0	0	0	0.5	0	0	0	0	0	**0.006**
Chestnut-vented Warbler	0	1	3	1	1	2	0	0	1	1	2	1.5	3	1.5	0	1	2	2	**0.054**
Cape Wagtail	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	**0.001**
Cape White-eye	0	0	2.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**0.005**
Dark-capped Bulbul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Desert Cisticola	0	0	0	0	0.5	0	1	1.5	1	0	0	0	0	0	1	1	0	1	**0.013**
Eastern Clapper Lark	0	0	0	0	0	0.5	1	0	0	0	0	0	0	0	0.5	0.5	0	0	**0.003**
Fiscal Flycatcher	0	0	2.5	0	0	1	0	0	0	0	0.5	0	0	0	0	0	0	0	**0.020**
Green-winged Pytilia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Long-billed Crombec	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0.005**
Kalahari Scrub-robin	0	1	1.5	0.5	0.5	1.5	0	0	0	0	2	0	0.5	0	0	0	0.5	1	**0.024**
Levaillant's Cisticola	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**0.005**
Melodious Lark	0	1	0	0	0	0.5	1	0	0	0	0	0	0	0	0	1	0	0	**0.004**

Species	f16	f17	f19	f20	f22	f23	f24	f25	f26	f27	f28	f29	f30	f31	f32	f33	f34	f35	Mean birds/ha
Neddicky	0	0	1	0	0	0.5	0	0	0	0	1	1.5	0	0	0	0	0	0	**0.006**
Orange River White-eye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Pied Starling	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0.002**
Rattling Cisticola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Red-billed Quelea	0	0	0	0	0	0	0	0	0	10	2	0	0	0	1.5	0	0	0	**0.067**
Rufous-naped Lark	0.5	0	0	0.5	0	0	0.5	0.5	0	0	0.5	0	0	0	0.5	0	0	0	**0.006**
Sabota Lark	0	0	0	0.5	0.5	1	0	0	0	0	0.5	0	0.5	0.5	0.5	0.5	0	0.5	**0.012**
Southern Fiscal	0	0	1	0.5	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0	0	**0.005**
Scaly-feathered Weaver	0	0	0	1.5	0	0	0	0	0	0	1.5	4	1	1.5	0	0	0	0	**0.016**
Southern Greyheaded Sparrow	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	**0.004**
Spike-heeled Lark	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0.008**
Southern Masked Weaver	0	0	1.5	1.5	0.5	0	0	0	1.5	0	1.5	0	0	0	0	1	0	1	**0.021**
Southern Red Bishop	0	0	0	0.5	0	0	0	0	38.5	0	0	0	5	0	0	0	0	0	**0.109**
Red-capped Lark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
Violet-eared Waxbill	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0.001**
White-bellied Sunbird	0	0.5	0.5	0	0	0	0	0	0	1	0	0	0	0.5	0	1	0.5	1	**0.010**
White-browed Sparrow-weaver	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0.008**
White-throated Robin-chat	0	0	0.5	0.5	0	0	0	0	0	0	1	0	0	0.5	0	0	0	0	**0.006**
Yellow Canary	0	0	1	2.5	0	0	0	0	0	0	1	1	0	0	0	0	0	0.5	**0.017**
Zitting Cisticola	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**0.002**
Number of individuals	1.5	7.5	32.5	20	5	24	10	7.5	55.5	13	25	11.5	15.5	7.5	9	9	6	11.5	
Number of species	2	8	26	20	8	20	13	7	15	4	21	7	10	8	11	10	7	10	
Number of birds/ha	**1.92**	**9.62**	**41.67**	**25.64**	**6.41**	**30.77**	**12.82**	**9.62**	**71.15**	**16.67**	**32.05**	**14.74**	**19.87**	**9.62**	**11.54**	**11.54**	**7.69**	**14.74**	
Number of species/ha	**2.56**	**10.26**	**33.33**	**25.64**	**10.26**	**25.64**	**16.67**	**8.97**	**19.23**	**5.13**	**26.92**	**8.97**	**12.82**	**10.26**	**14.10**	**12.82**	**8.97**	**12.82**	
Average number of birds/ha	**24.59**	**24.59**																	

Species	f16	f17	f19	f20	f22	f23	f24	f25	f26	f27	f28	f29	f30	f31	f32	f33	f34	f35	Mean birds/ha
Average number of species/ha	15.35	15.35																	

Appendix 3: Assessment of Impacts

Direct, indirect and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase must be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration**, wherein it will be indicated whether:
    - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
    - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
    - medium-term(5–15 years) – assigned a score of 3;
    - long term(> 15 years) - assigned a score of 4; or
    - permanent - assigned a score of 5;
- The **consequences (magnitude)**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the status, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the degree to which the impact can be mitigated.

The significance is calculated by combining the criteria in the following formula:
S=(E+D+M)P

S = Significance weighting
E = Extent

D = Duration
M =Magnitude
P = Probability

The significance weightings for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated), and
- 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).