DEVELOPMENT OF THE GRID CONNECTION AND ASSOCIATED INFRASTRUCTURE FOR THE HOUTHAALBOOMEN NORTH PV CLUSTER NEAR LICHTENBURG, NORTH WEST PROVINCE

Avifauna Baseline and Impact Assessment Report

July 2022

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EXECUTIVE SUMMARY

Pachnoda Consulting cc was requested by Euphorbia PV (Pty) Ltd to compile an avifauna impact assessment report for the proposed grid connection infrastructure for the Houthaalboomen North PV Cluster.

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 information was obtained during two independent sampling sessions (January 2022 and May 2022).

Five prominent avifaunal habitat types were identified on the site, and consisted of open mixed dolomite grassland with bush clump mosaics, open mixed woodland, artificial livestock watering points, wet/moist grazed grassland and transformed land. Approximately 186 bird species are expected to occur in the wider study area, of which 88 species were observed in the study area. The expected richness included eight threatened or near threatened species, 16 southern African endemics and 20 are near-endemic species. The critically endangered White-backed Vulture (*Gyps africanus*) and the endangered Cape Vulture (*G. coprotheres*) were confirmed during the surveys, mainly as roosting individuals and birds soaring overhead. Eleven southern African endemics and 14 near-endemic species were confirmed on the study site.

The main impacts associated with the proposed grid connection included avian collisions and potential electrocution with associated infrastructure (mainly the proposed overhead power line).

An evaluation of potential and likely impacts on the avifauna revealed that the impact significance due to potential avian collisions and electrocutions was moderate after mitigation. However, the endangered Cape Vulture (*Gyps coprotheres*) and critically endangered White-backed Vulture (*Gyps africanus*) (and to a lesser degree also Lappet-faced Vulture *Torgos tracheliotos*) were identified as regular foraging visitors to the study area (according to SABAP2 reporting rates and on-site observations). **These species are highly prone to power line collisions, whereby the proposed overhead power line corridor could pose a collision and electrocution risk to vultures**. **The risk of collision/electrocution was considered likely when vultures feed on a carcass in close proximity to power line servitude or when attempting to roost on the pylon structures**.

It is strongly recommended that the proposed mitigation measures and monitoring protocols be implemented during the construction and operational phase of the

project.

In addition, a total of 40 collision-prone bird species have been recorded from the wider study area (*sensu* atlas data), of which 19 species were birds of prey.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

DECLARATION OF INDEPENDENCE

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

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

Lukas Niemand (Pr.Sci.Nat)
14 July 2022

Lukas Niemand is registered with The South African Council for Natural Scientific Professionals (400095/06) with more than 15 years of experience in ecological-related assessments and more than 10 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 Euphorbia PV (Pty) Ltd to compile an avifauna impact assessment report for the proposed grid connection infrastructure for the Houthaalboomen North PV Cluster. The proposed grid connection infrastructure includes a collector substation/ switching station (Houthaalboomen North Collector Substation) and a single or double circuit 132 kV power line to the existing Watershed MTS. The grid connection infrastructure is situated within the Ditsobotla Local Municipality within the Ngaka Modiri Molema District Municipality.

In order to enable the evacuation of the generated power from the onsite facility substations for the Houthaalboomen North PV Cluster (i.e. Euphorbia PV, Hillardia PV and Verbena PV facilities) to the collector substation, a grid connection solution (within a 200 m wide corridor) have been assessed of which the Houthaalboomen North collector substation/ switching station will be located on the south-eastern corner of Portion 4 of the Farm Houthaalboomen 31. The Houthaalboomen North collector substation/ switching station will facilitate the connection of the cluster facility substations to the Watershed Main Transmission Substation (MTS) via a single or double circuit 132 kV overhead powerline (Figure 1):

1.2 Objectives and Terms of Reference

The main objectives of the avifaunal study were to: (a) describe the avifauna associations in the project area and along the grid corridor 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 grid 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 Environmental Impact 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 grid infrastructure 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 project area and habitat units;

- conduct an assessment of all information on an EIA 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 study site;
    - 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 two 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 grid infrastructure.

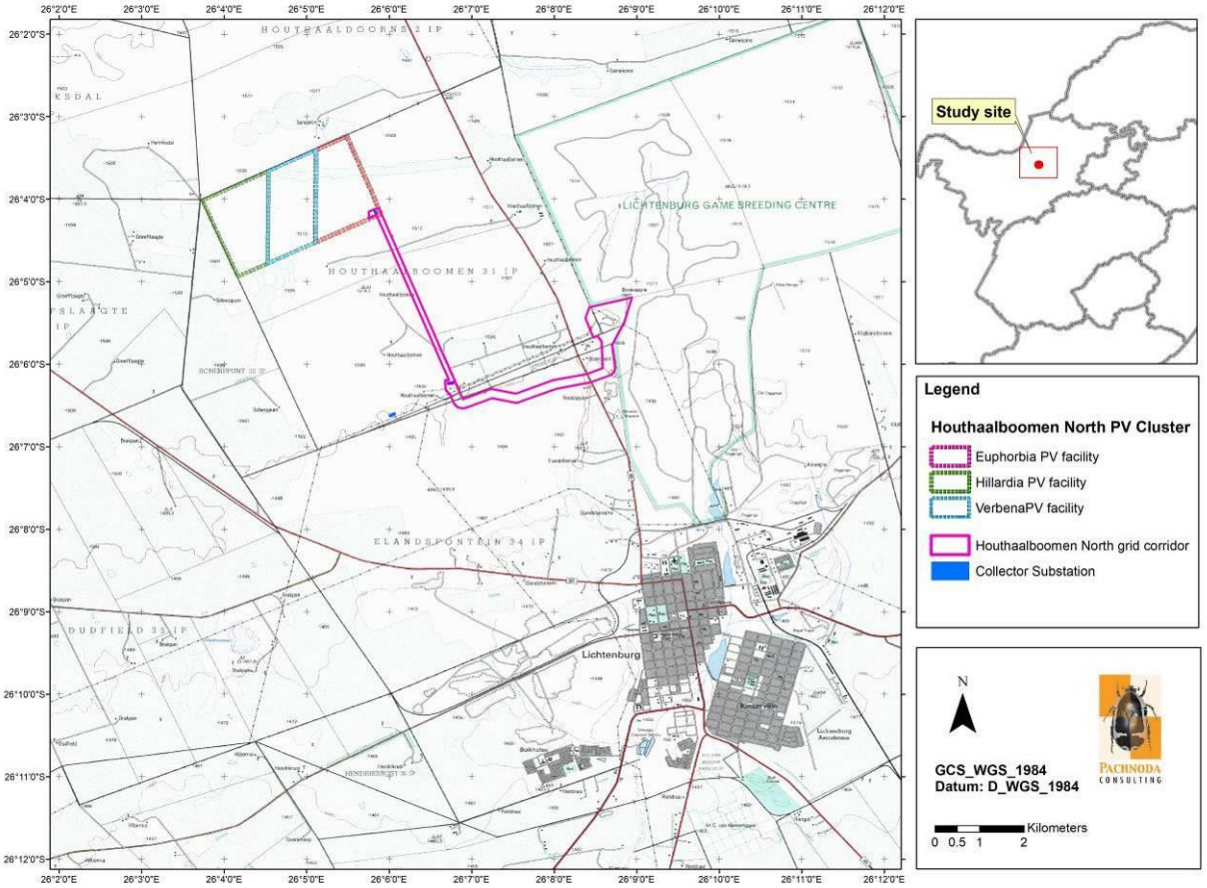


Figure 1: A topo-cadastral image illustrating the geographic position of the Houthaalboomen North grid corridor.

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 grid corridor.

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 corresponding to the austral wet and dry seasons (17-21 January 2022 and 16-20 May 2022); and
- personal observations from similar habitat types in proximity to the study area (Pachnoda Consulting 2018, 2021).

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 study site.
- The conservation status of bird species was categorised according to the global IUCN Red List of threatened species (IUCN, 2021) 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) 2626AA (Lichtenburg). The information was then modified according to the prevalent habitat types present on the development area. The SABAP1 data provides a “snapshot” of the abundance and composition of species recorded within a quarter degree grid cell (QDGC) which was the sampling unit chosen (corresponding to an area of approximately 15 min latitude x 15 min longitude). It should be noted that the atlas data makes use of reporting rates that were calculated from observer cards submitted by the public as well as citizen scientists. It

therefore provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991.

- Additional distributional data was also sourced from the SABAP2 database (http://www.sabap2.birdmap.africa). The information was then modified according to the prevalent habitat types present on the study area. Since bird distributions are dynamic (based on landscape changes such as fragmentation and climate change), SABAP2 was born (and launched in 2007) from SABAP1 with the main difference being that all sampling is done at a finer scale known as pentad grids (5 min latitude x 5 min longitude, equating to 9 pentads within a QDGC). Therefore, the data is more site-specific, recent and more comparable with observations made during the site visit (due to increased standardisation of data collection). The pentad grids relevant to the current project is 2600_2600 and 2600_2605 (although all eight pentad grids surrounding the central grid 2600_2600 were also scrutinised). (Figure 2).
- The choice of scientific nomenclature, taxonomy and common names were recommended by the International Ornithological Committee (the IOC World Bird List v. 12.1), unless otherwise specified (see www.worldbirdnames.org as specified by Gill et al, 2022). Colloquial (common) names were used according to Hockey *et. Al.* (2005) to avoid confusion.
- Incidental occurrence records for large birds of prey and vulture tracking data were included (up to 2018 only).
- Data on power line derived bird mortalities were requested from the electrical infrastructure mortality incident register (the dataset was provided by EWT).
- The best practice guidelines for solar facilities by BirdLife South Africa (Jenkins et al., 2017).
- Additional information regarding bird-power line interactions was provided by the author's own personal observations.

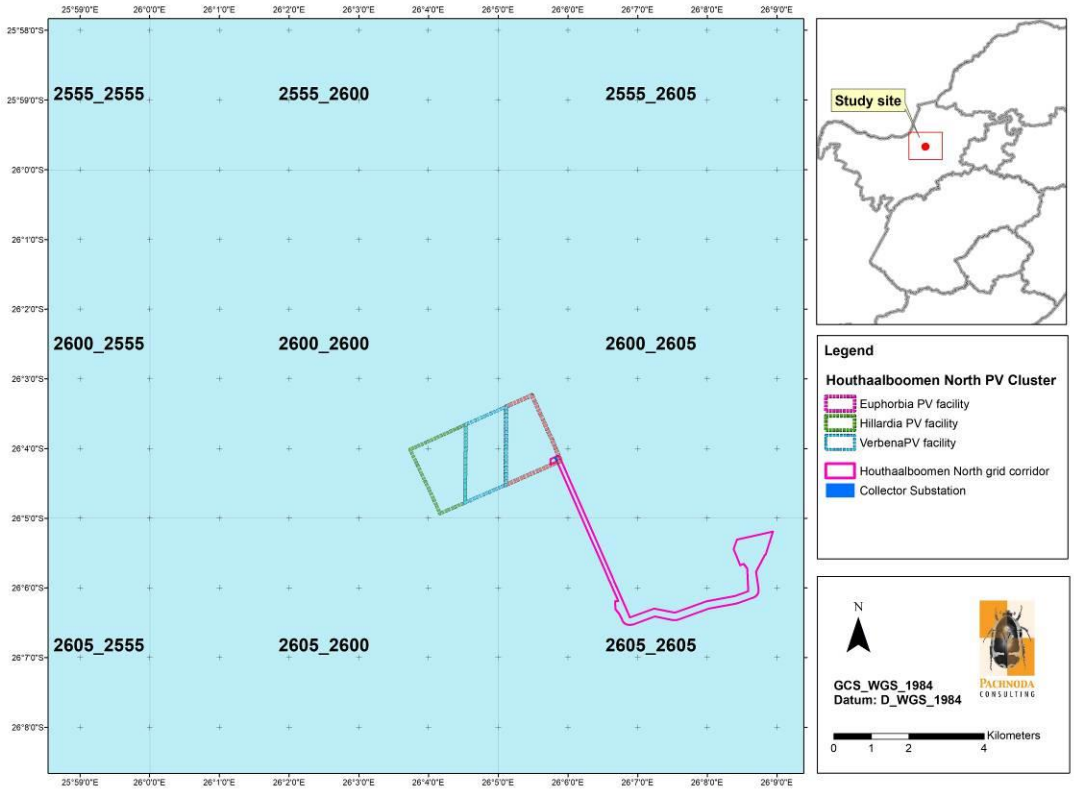


Figure 2: A map illustrating the pentad grids that were investigated for this project.

2.2 Field Methods

The avifauna of the study area was surveyed during two independent site visits representing a wet season (January 2022) and an early dry season survey (May 2022).

To obtain an inventory of bird species present, all bird species observed/detected while moving between point counts (as assessed on the Houthaalboomen North PV Cluster) 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.

2.3 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.
- The study area was previously poorly surveyed prior to the baseline survey. Therefore, bird richness information for the area is incomplete.
- 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 Houthaalboomen North collector substation/ switching station is located approximately 10 km north west of the town of Lichtenburg. while the Watershed Main Transmission Substation (MTS) is located approximately 5 km north of the town of Lichtenburg in the North West Province (Figure 1).

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 an ecological type known as Carletonville Dolomite Grassland (Mucina & Rutherford, 2006) (Figure 3).

From an avifaunal perspective it is evident that bird diversity is positively correlated with vegetation structure, and floristic richness is not often regarded to be a

significant contributor of patterns in bird abundance and their spatial distributions. Although 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.

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 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.

Currently, only 2% of the remaining 76% of untransformed Carletonville Dolomite Grassland is formally protected within the Cradle of Humankind World Heritage Site and various nature reserves such as Abe Baily and Krugersdorp Nature Reserves.

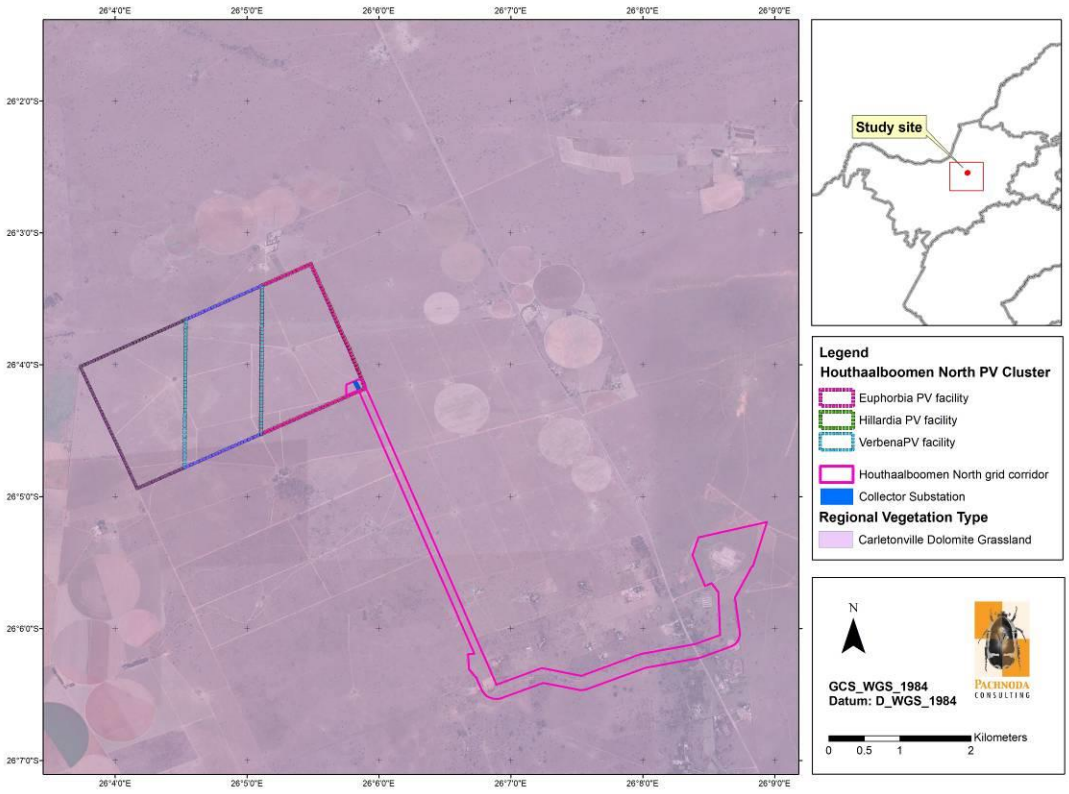


Figure 3: A topographic image illustrating the regional vegetation type corresponding to the study site. Vegetation type categories were identified according to Mucina & Rutherford (2006).

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 4):

Natural areas:

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

Transformed areas:

- Mines and quarries; and
- Bare none vegetated areas (MTS).

From the land cover dataset it is evident that most of the study area is covered by natural grassland and low shrubland. The study area is primarily used for livestock production and livestock grazing. Existing infrastructure includes a number of homesteads and the existing MTS. However, it is evident that a wetland class is present on the eastern side of the R505, which is represented by grazed moist grassland.

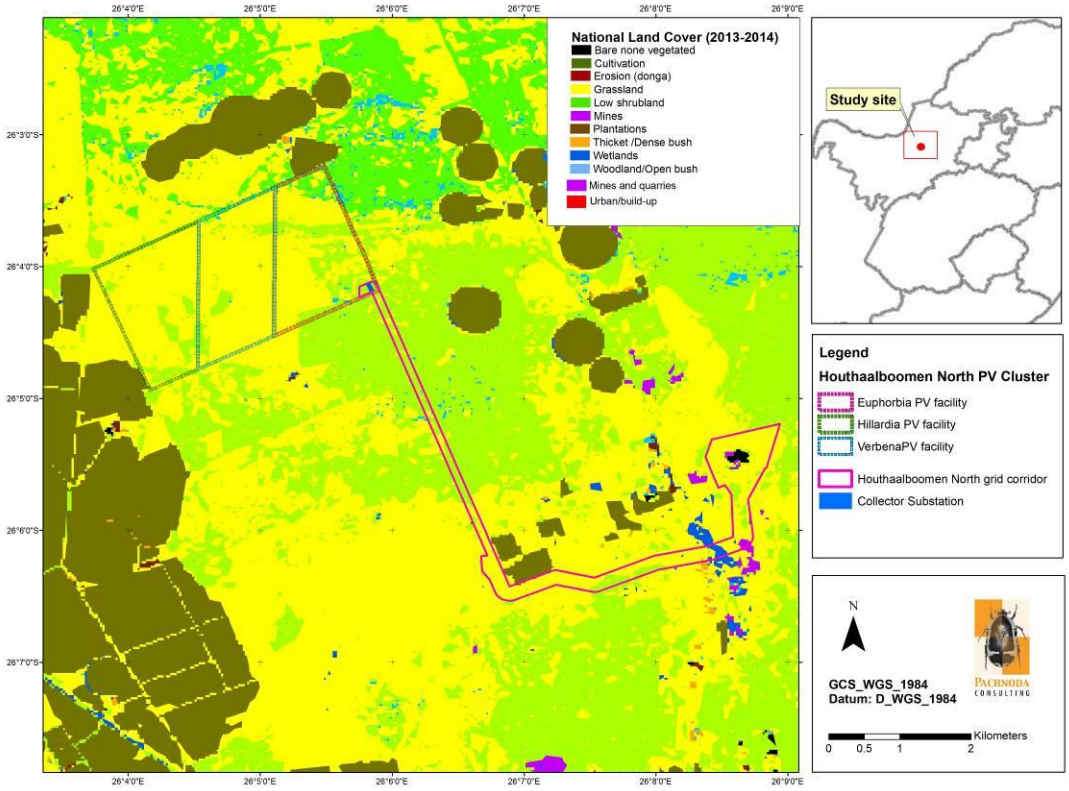


Figure 4: A map illustrating the land cover classes (Geoterrainimage, 2015) corresponding to the proposed study area.

3.4 Conservation Areas, Protected Areas and Important Bird Areas

The eastern part of the grid corridor is located adjacent to the Lichtenburg Game Breeding Centre (Figure 5). This conservation area contains a variety of game species, and the facility used to operate a vulture restaurant which attracts foraging vultures (c. three species) to the region. This area is currently under new management (by lease agreement with the municipality).

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

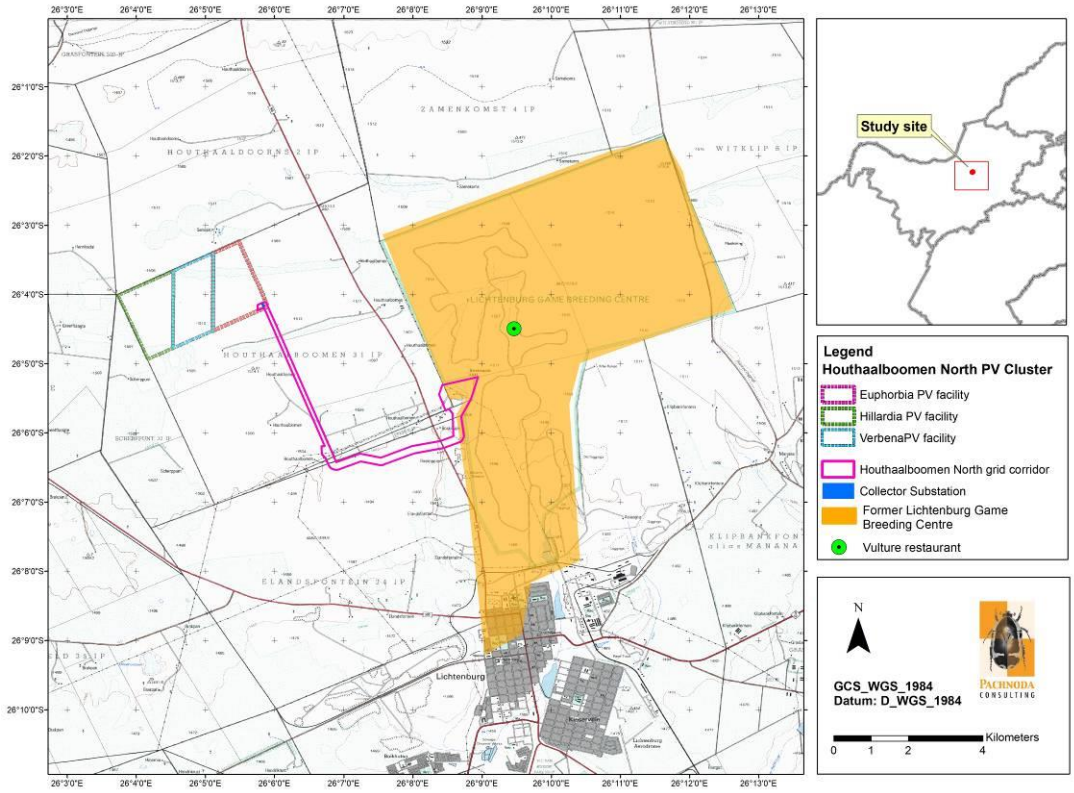


Figure 5: A map illustrating the locality of a game facility and a vulture restaurant adjacent to the proposed grid corridor. Note the locality of an active vulture restaurant in the study region.

4. RESULTS AND DISCUSSION

4.1 Avifaunal habitat types

Apart from the regional vegetation type, the local composition and distribution of the vegetation associations on the study site are a consequence of a combination of factors simulated by soil type, geology and grazing intensity (presence of livestock) which have culminated in a number of habitat types that deserve further discussion (Figure 6, Figure 7 and Figure 8):

1. *Open mixed dolomite grassland with bush clump mosaics:* This unit is dominant on the study site and covers nearly the entire surface area of the proposed grid corridor. It is represented by two discrete floristic variations which also provide habitat for two discrete avifaunal associations. The first floristic variation consists of open untransformed to semi-transformed mixed dolomite grassland and bush clumps with an eminent woody layer. The grassland variation is represented by untransformed and grazed Carletonville Dolomite Grassland, depending on grazing intensity, and dominated by "late-successional" graminoids such a *Themeda triandra, Cymbopogon caesius, C. pospischilii, Trachypogon spicatus, Elionurus muticus* and *Andropogon schirensis*. It is occupied by a typical grassland bird composition dominated by insectivorous and granivore passerine bird species such as Desert Cisticola, (*Cisticola aridulus*), Eastern Clapper Lark (*Mirafra fasciolata*) (Melodious Lark (*Mirafra cheniana*), Spike-heeled Lark (*Chersomanes albofasciata*), Cape Longclaw (*Macronyx capense*), Ant-eating Chat (*Myrmecocichla formicivora*) and African Pipit (*Anthus cinnamomeus*). 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 Black-winged Kite (*Elanus caeruleus*).

   The bush clumps form a prominent mosaic characterised by the dominance of a woody layer of *Searsia lancea, S. pyroides, Ziziphus mucronata, Gymnosporia buxifolia* and *Asparagus laricinus*. *Celtis africana* and *Olea europaea subsp. africana* forms canopy constituents in some areas. The eminent increase in vertical heterogeneity provided by the woody layer is colonised by a "Bushveld" bird association consisting of insectivorous passerines such as Black-chested Prinia (*Prinia flavicans*), Chestnut-vented Warbler (*Sylvia subcoerulea*), Kalahari Scrub Robin (*Cercotrichas paena*), Fiscal Flycatcher (*Melaenornis silens*), Dark-capped Bulbul (*Pycnonotus tricolor*) as well as granivores such as Yellow Canary (*Crithagra flaviventris*) and Southern Masked Weaver (*Ploceus velatus*). Non-passerine bird taxa are represented by Laughing Dove (*Spilopelia senegalensis*), Ring-necked Dove (*Streptopelia capicola*), Acacia Pied Barbet (*Tricholaema leucomelas*) and White-backed Mousebird (*Colius colius*).

2. *Mixed open woodland:* This unit is scattered along the grid corridor and is represented by tall microphyllous woodland as well as other plant species that are similar in floristic composition to the bush clump mosaics. The tall vertical heterogeneity assists with the colonisation of a "Bushveld" bird association consisting of mainly insectivorous passerines. The latter composition is similar to the bird composition predicted for the bush clump mosaic habitat unit. Other noteworthy species include Crested Barbet (*Trachyphonus vaillantii*), Crimson-breasted Shrike (*Laniarius atrococcineus*) and Common Scimitarbill (*Rhinopomastus cyanomelas*). This habitat often provides roosting opportunities for large birds of prey such as Vultures.

3. *Artificial livestock watering points*: These are represented by artificial water troughs and reservoirs with the purpose to provide drinking water to livestock. However, they act as focal congregation areas for many granivore passerine and non-passerine species, including Cape Sparrow (*Passer melanurus*), Laughing Dove (*Spilopelia senegalensis*), Namaqua dove (*Oena capensis*), Scaly-feathered Weaver (*Sporopipes squamifrons*) and Wattled Starling (*Creatophora cinerea*). Due to cattle congregating at these features, they also invariably attract scavenger species such as vultures

4. *Wet/moist grazed grassland*: This habitat is located on eastern part of the grid corridor in close proximity to the R505. It is often colonised by dense, coarse grass and monocotyledon plant species pertaining to the genera *Hyparrhenia* which provide breeding and roosting habitat for Southern Red Bishop (*E. orix*) and Levaillant's Cisticola (*Cisticola tinniens*). It is also often visited by terrestrial species such as Blacksmith Lapwing (*Vanellus armatus*) and Black-headed Heron (*Ardea melanocephala*).

5. *Transformed areas*: This area is represented by a waster rock dumps, excavations/quarries and the MTS infrastructure. These areas are unimportant habitat for bird species.

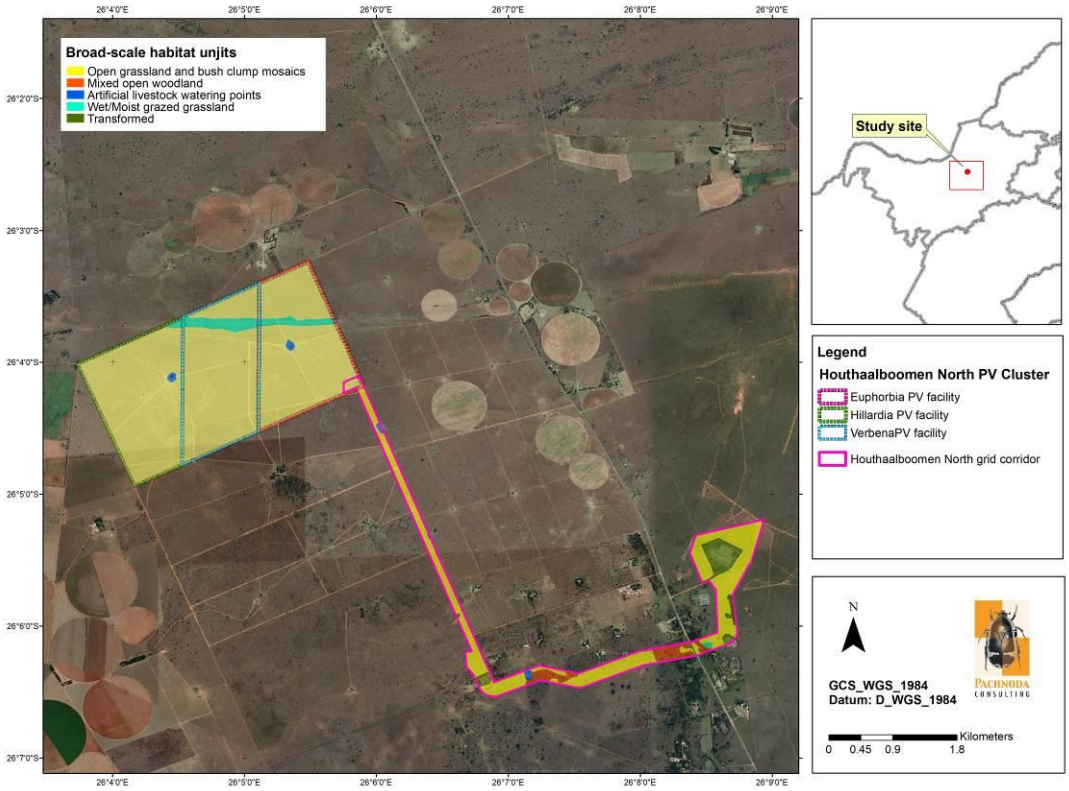


Figure 6: A habitat map illustrating the important avifaunal habitat types on the study site.

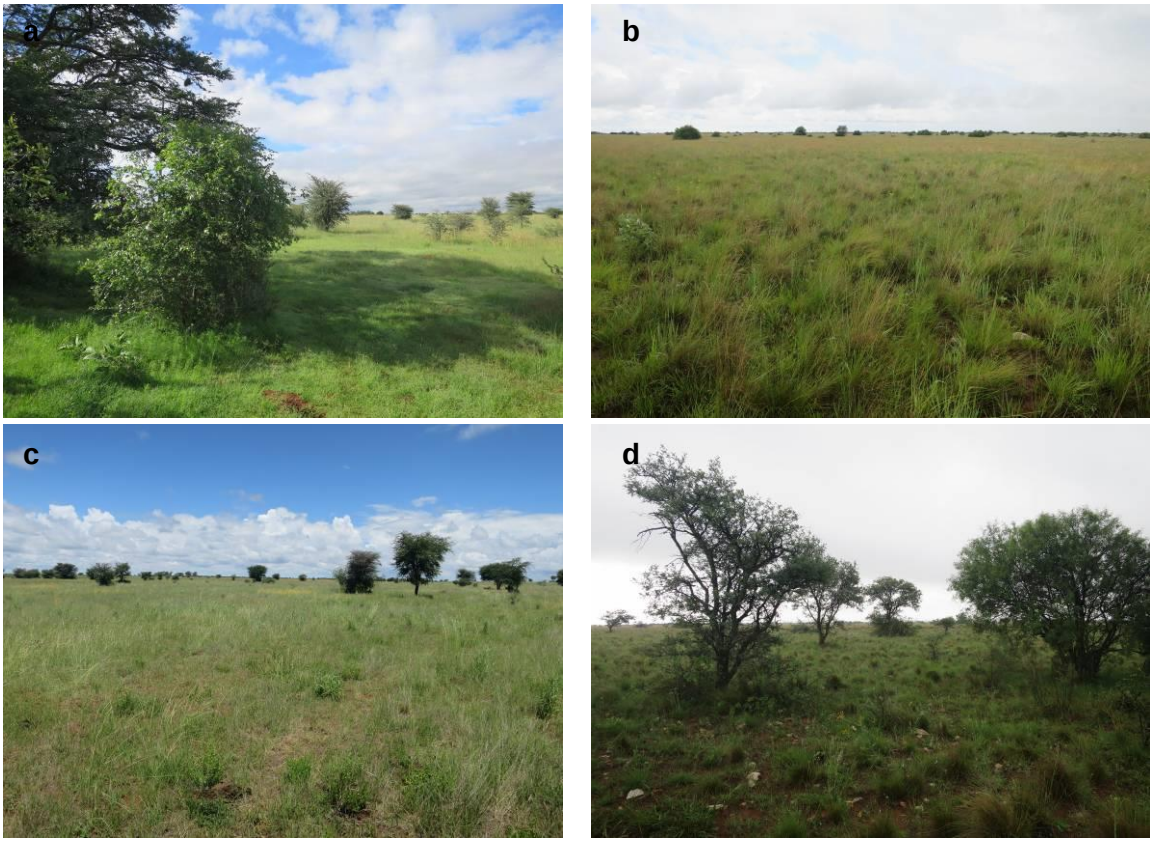
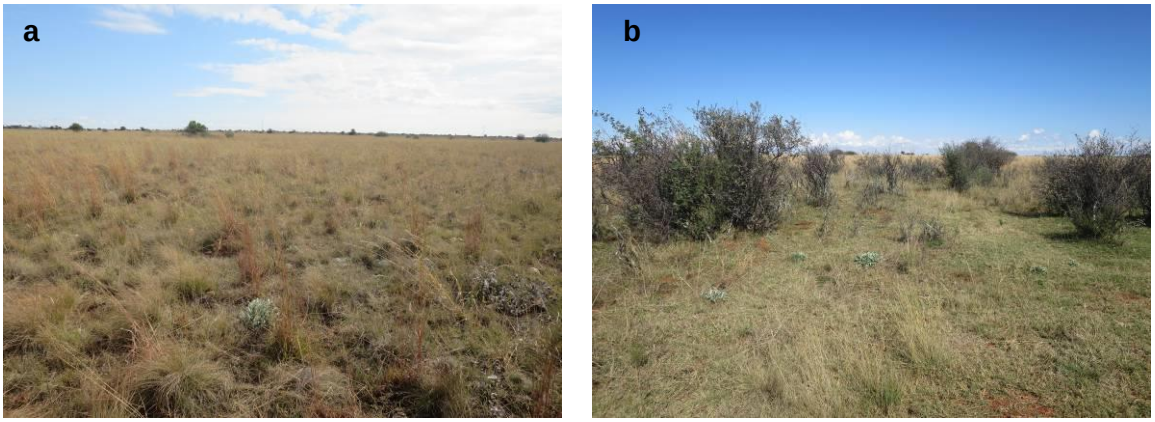


Figure 7: A collage of images illustrating examples of avifaunal habitat types on the assessment area observed during the austral summer season (January 2022): (a - d) open mixed dolomite grassland and bush clump mosaics, (e - f) moist grassland located on low-lying areas and (g - h) and artificial livestock watering points.



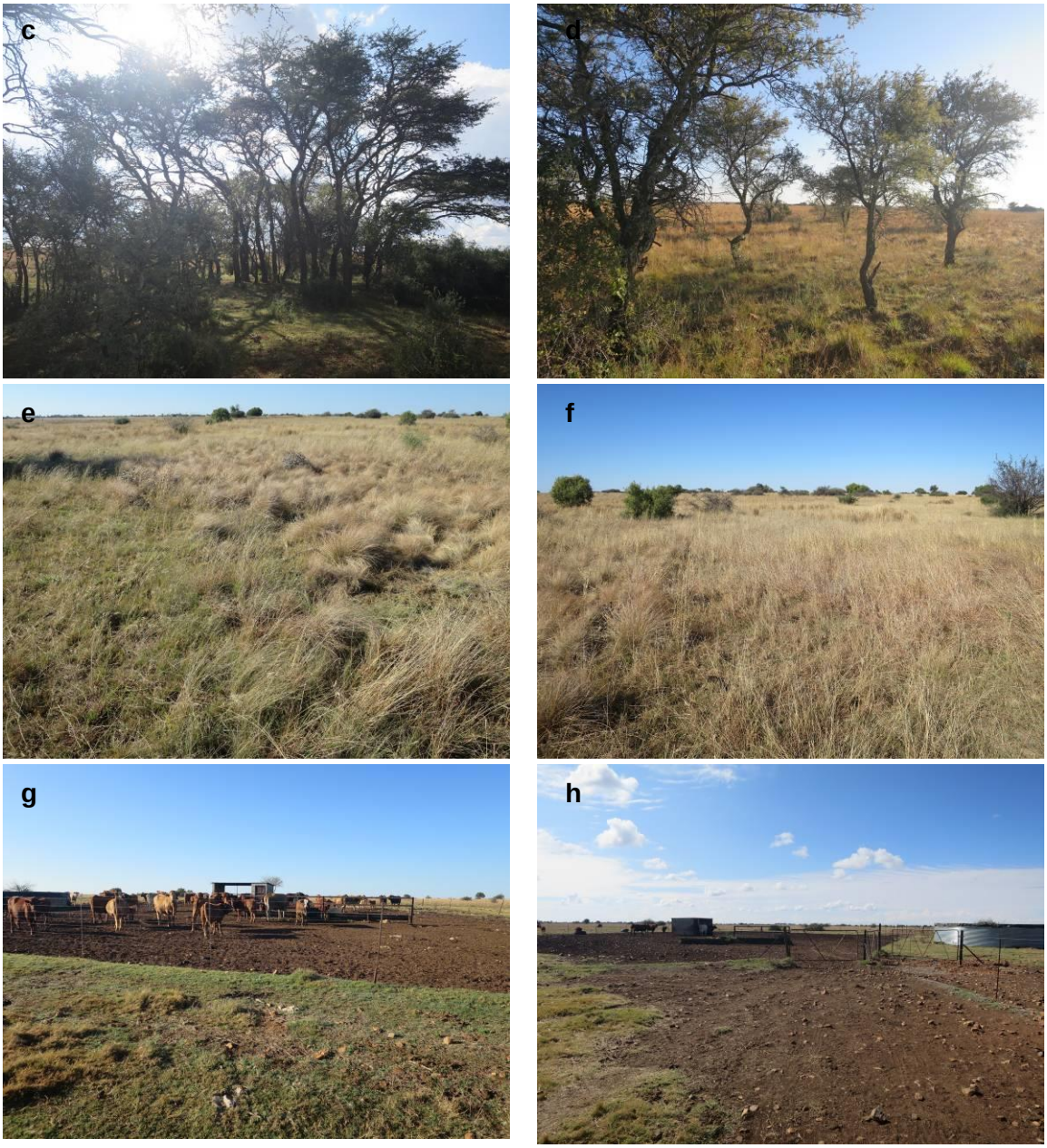


Figure 8: A collage of images illustrating examples of avifaunal habitat types on the assessment area observed during the austral dry season (May 2022): (a - d) open mixed dolomite grassland and bush clump mosaics, (e - f) moist grassland located on low-lying areas and (g - h) and artificial livestock watering points.

4.2 Species Richness and Summary statistics

Approximately ~186 bird species are expected to occur in the study area (refer to Appendix 1 and Table 1). The expected richness was inferred from the South African Bird Atlas Project (SABAP1 & SABAP2)[1] (Harrison et al., 1997; www.sabap2.birdmap.africa) and the presence of suitable habitat in the study area.

[1] The expected richness statistic was derived from the pentad grid 2600_2600 (including adjacent 8 grids) totalling 219 bird species (based on 75 submitted cards, 55 being full protocol cards and 20 being ad hoc cards).

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 19 % of the approximate 987[2] species listed for the southern African subregion[3] (and approximately 21 % of the 871 species recorded within South Africa[4]). However, the species richness obtained from the pentad grids 2600_2600 and 2600_2605 corresponding to the study area[5] is lower than the expected number of species with an average of 111.5 species recorded (range: 89-134 species). The average number of species for each full protocol card submitted (for observation of two hours or more) is 45.49 species (range = 15 - 99 species).

According to field observations, the total number of species observed on the study area is *ca*. 88 species (see Appendix 1). On a national scale, the species richness per pentad on the study area is considered to be high (refer to Figure 9).

According to Table 1, the study site is expected to be poorly represented by biome-restricted (see Table 2) and local endemic bird species with only a single biome-restricted and a single local endemic species present (observed). It is expected to support ca. 33 % of the near-endemic species present in the subregion. Of the 186 bird species expected to occur in the project area, eight are threatened or near threatened species, 16 are southern African endemics and 20 are near-endemic species (Table 3). In addition, two threatened species (White-backed Vulture *Gyps africanus* and Cape Vulture *G. coprotheres*) were observed on the study site (Table 3). Waterbird species were highly irregular and predominantly absent from the study area owing to the absence of any wetland features on the study area.

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 (study area and surroundings)***	Observed Richness Value (study area)****
Total number of species*	186 (21 %)	88 (47.3 %)
Number of Red Listed species*	8 (5.7 %)	2 (25 %)
Number of biome-restricted species – Zambezian and Kalahari-Highveld Biomes*	4 (29 %)	1 (25 %)
Number of local endemics (BirdLife SA, 2022)*	2 (5.1 %)	1 (50 %)
Number of local near-endemics (BirdLife SA, 2022)*	6 (20 %)	5 (83 %)
Number of regional endemics (Hockey *et al.,* 2005)**	16 (15 %)	11 (69 %)

2 *sensu* www.zestforbirds.co.za (Hardaker, 2020) including four recently confirmed bird species (vagrants).

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

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

5 Including observations made during the January and May 2022 surveys.

Number of regional near-endemics (Hockey *et al.,* 2005)**	20 (33 %)	14 (70 %)

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

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

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

**** Percentage values in brackets refer to totals compared against the expected number of species in the project area.

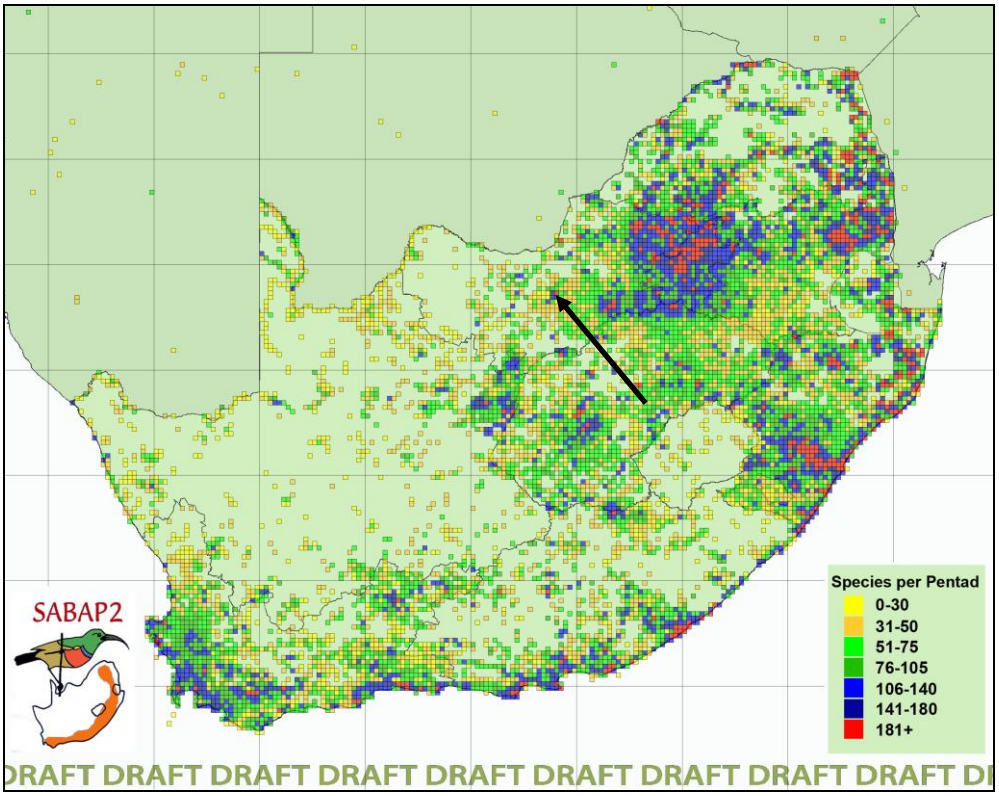


Figure 9: The bird species richness per pentad grid in comparison to the broader study area (see arrow) (map courtesy of SABAP2 and the Animal Demography Unit). According to the SABAP2 database, the study area hosts between 141 and 180 bird species.

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

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

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 (Jan. & May 2022)	Collision with power lines	Collision with PV panels	Displacement (disturbance & loss of habitat)
White-backed Vulture	*Gyps africanus*	CR	CR	1	1		
Cape Vulture	*Gyps coprotheres*	EN, End	EN	1	1		
Lapped-faced Vulture	*Torgos tracheliotos*	EN	EN		1		
Martial Eagle	*Polemaetus bellicosus*	EN	EN		1		
Secretarybird	*Sagittarius serpentarius*	EN	EN		1		1
Cloud Cisticola	*Cisticola textrix*	N-end		1			1
Cape Longclaw	*Macronyx capensis*	End		1			1
Melodious Lark	*Mirafra cheniana*	End		1			1
South African Shelduck	*Tadorna cana*	End			1	1	
Northern Black Korhaan	*Afrotis afraoides*	End		1	1		1
White-backed Mousebird	*Colius colius*	End		1			1
Karoo Thrush	*Turdus smithi*	End		1			1
Ant-eating Chat	*Myrmecocichla formicivora*	End		1			1
Fairy Flycatcher	*Stenostira scita*	End		1			1
Fiscal Flycatcher	*Sigelus silens*	End					1
Pied Starling	*Lamprotornis bicolor*	End					1
Orange River White-eye	*Zosterops pallidus*	End					1
Cape White-eye	*Zosterops virens*	End		1			1
South African Cliff Swallow	*Petrochelidon spilodera*	End		1			1
Orange River Francolin	*Scleroptila gutturalis*	N-end		1	1		1
Acacia Pied Barbet	*Tricholaema leucomelas*	N-end		1			1
Eastern Clapper Lark	*Mirafra fasciolata*	N-end		1			1
Grey-backed Sparrow-lark	*Eremopterix verticalis*	N-end					1
Ashy Tit	*Parus cinerascens*	N-end		1			1
Cape Penduline-tit	*Anthoscopus minutus*	N-end					1
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
Crimson-breasted Shrike	*Laniarius atrococcineus*	N-end		1			1

Common Name	Scientific name	Regional Status	Global Status	Observed (Jan. & May 2022)	Collision with power lines	Collision with PV panels	Displacement (disturbance & loss of habitat)
Bokmakierie	*Telophorus zeylonus*	N-end		1			1
Great Sparrow	*Passer motitensis*	N-end					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			1
Shaft-tailed Whydah	*Vidua regia*	N-end					1
Mountain Wheatear	*Oenanthe monticola*	N-end					1
Yellow Canary	*Crithagra flaviventris*	N-end		1			1
Marabou Stork	*Leptoptilos crumenifer*	NT			1		
Abdim's Stork	*Ciconia abdimii*	NT			1		
Falcon, Lanner	*Falco biarmicus*	VU			1		
	Totals:	**41**	**5**	**25**	**11**	**1**	**33**

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

4.3 Bird species of conservation concern

Table 4 provides an overview of bird species of conservation concern that could occur on the study site based on their historical distribution ranges and the presence of suitable habitat. According to Table 4, a total of eight species could occur on the study site which includes five globally threatened species, one regionally threatened species and two regionally near-threatened species.

It is evident from Table 4 that the highest reporting rates (>15%) were observed for the globally endangered Cape Vulture (*Gyps coprotheres*) and the globally critically endangered White-backed Vulture (*Gyps africanus*). These species have a high likelihood of occurrence pending the presence of suitable food (livestock carcasses). Both species were also observed soaring overhead during the respective surveys conducted in 2022 and from similar habitat during 2021 (Figure 10). The Lappet-faced Vulture (*Torgos tracheliotos*) shows reporting rates higher than 7% and was previously recorded from similar habitat on the nearby Farm Zamenkomst No 04 located to the east of the study area (pers. obs., Pachnoda, 2018). The Lappet-faced Vulture is also regarded as a regular foraging visitor to the area.

The regionally vulnerable Lanner Falcon (*Falco biarmicus*) shows reporting rates higher than 7%. This species have a moderate probability of occurrence and is regarded as an occasional foraging visitor to the area.

The remaining species have low reporting rates (<2% full protocol) and are regarded as irregular foraging visitors with low probabilities of occurrence. However, during the surveys it was noticed that extensive areas of suitable foraging habitat persists for some of these species (e.g. Secretarybird *Sagittarius serpentarius*) 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 some of these species could occur in higher numbers due to being overlooked.

Table 4: Bird species of conservation concern that could utilise the study area 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	10.00 (according to two ad hoc cards)	Open stunted grassland, fallow land and agricultural fields.	An uncommon summer foraging visitor to areas consisting of open short grassland or arable land.
Falco biarmicus (Lanner Falcon)	-	Vulnerable	7.27	Varied, but prefers to breed in mountainous areas.	An occasional foraging visitor to the study area. It was last recorded during 2016 in the study area.
Gyps coprotheres (Cape Vulture)	Endangered	Endangered	16.36	Mainly confined to mountain ranges, especially near breeding site. Ventures far afield in search of food.	A regular foraging/scavenging visitor to the study site pending the presence of food (e.g. livestock carcasses).
Gyps africanus (White-backed Vulture)	Critically Endangered	Critically Endangered	18.18	Breed on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	A regular foraging/scavenging visitor to the study site pending the presence of food (e.g. livestock carcasses).
Leptoptilos crumeniferus (Marabou Stork	-	Near threatened	1.82	Varied, from savanna to wetlands, pans and	An irregular scavenging visitor to the area. It was last recorded

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
				floodplains – dependant of game farming areas	during 2010 from the study area.
Polemaetus bellicosus (Martial Eagle)	Endangered	Endangered	1.82	Varied, from open karroid shrub to lowland savanna.	An irregular foraging visitor. It was last recorded from pentad 2605_2605 south-east of the study site on 28 Jan 2012.
Sagittarius serpentarius (Secretarybird)	Endangered	Endangered	1.82	Prefers open grassland or lightly wooded habitat.	Regarded as an irregular foraging visitor to the study site despite the widespread presence of suitable foraging habitat.
Torgos tracheliotos (Lapped-faced Vulture)	Endangered	Endangered	7.27	Lowveld and Kalahari savanna; mainly on game farms and reserves.	A regular foraging/scavenging visitor to the study site pending the presence of food (e.g. livestock carcasses). It was confirmed from similar habitat adjacent to the study site (soaring over Portion 02 of the Farm Zamenkomst No 04 during the July 2018, and from at least another three observations corresponding to pentad grid 2600_2605). It is regarded as a regular passage visitor (soaring overhead) to the nearby vulture

Species	Global Conservation Status*	National Conservation Status**	Mean Reporting rate: SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
					restaurant.

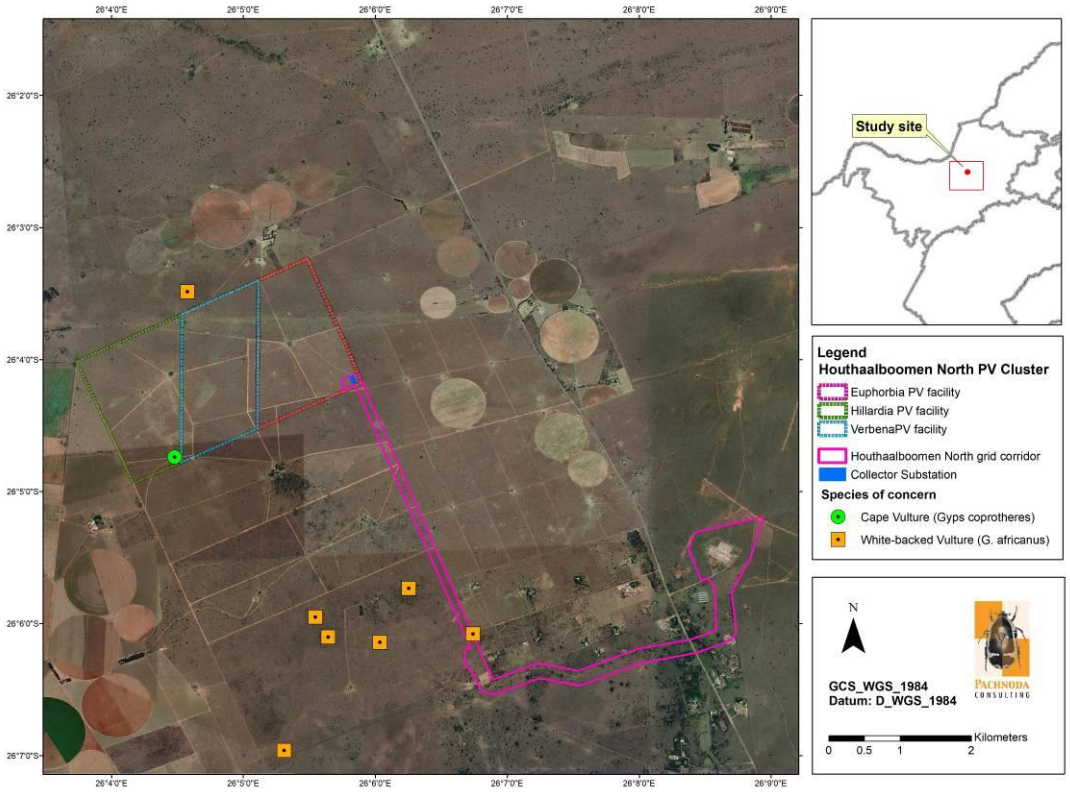


Figure 10: A map illustrating the occurrence of threatened and near threatened bird species observed on the study site and immediate surrounding during surveys conducted in August 2021, November 2021, January 2022 and May 2022.

4.3.2 Notes on the occurrence of Cape Vulture (Gyps coprotheres)

The globally endangered Cape Vulture (*G. coprotheres*) occurs on the study area and its presence is related to the occurrence of a nearby vulture restaurant (see section 3.4). It is of international significance and any mortality of adult individuals could have a negative effect on its species' population recruitment. Most of these suffer from a shortage of food supplies which is responsible for low reproductive rates (Taylor *et al*., 2015). In addition, Cape Vultures also typically search for food in groups. It is such congregations which increase the risk of mortalities whenever these individuals forage or roost in close proximity to overhead power lines. The proposed study area is also in close proximity to the foraging rangeland of Cape Vultures as evidenced by dispersal data obtained from vulture individuals fitted with satellite tracking devices (Figure 11).

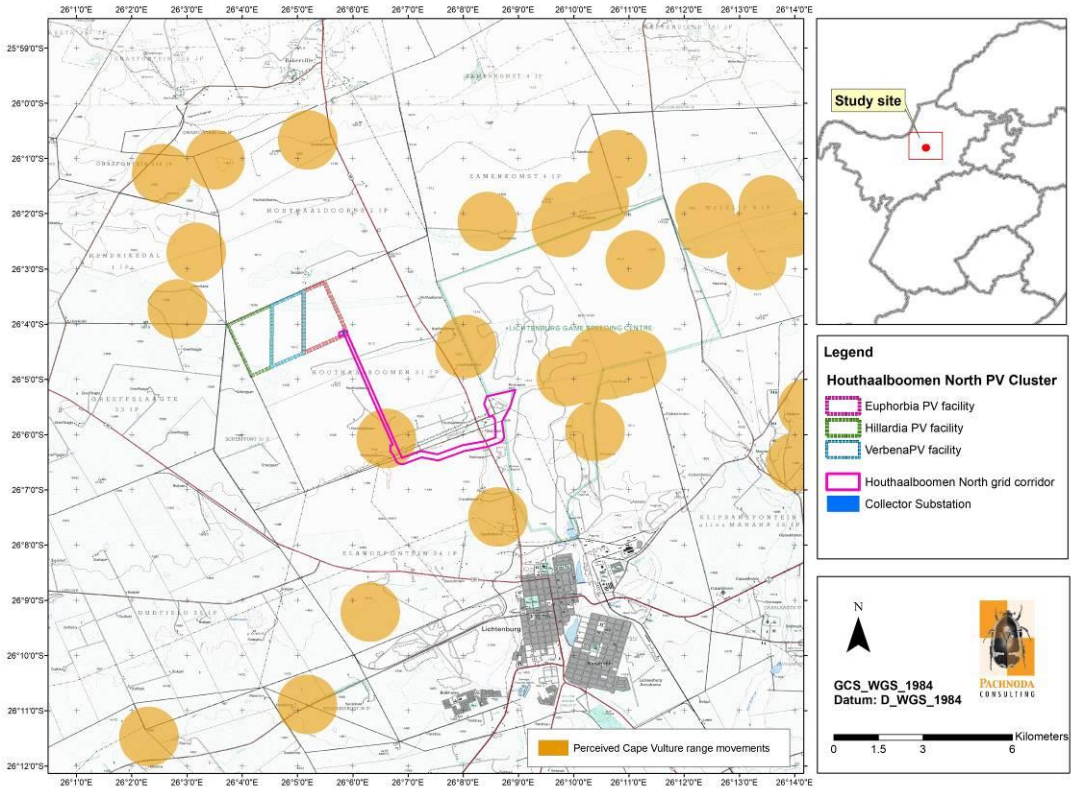


Figure 11: The occurrence of Cape Vultures (*Gyps coprotheres*) within the study region fitted with satellite trackers.

4.3.3 Notes on the occurrence of Secretarybird (Sagittarius serpentarius)

The conservation status of this species was upgraded from Vulnerable to Endangered since recent evidence suggested that it has experienced rapid declines across its entire range due to habitat loss, anthropogenic disturbances, and intensive grazing (Birdlife International, 2020). Secretarybirds are widespread in Africa south of the Sahara, but have declined over most of their geographic distribution range due to the loss of suitable habitat caused by inappropriate grazing regimes (resulting in the expansion of woody vegetation), cultivation and urbanization. The expansion of woody vegetation often results in a reduction of suitable foraging habitat and foraging efficacy (Birdlife International, 2020). In addition, it is also highly susceptible to collision with electrical cables of powerlines, with over 94 powerline fatalities recorded over the past 20 years in South Africa. Based on reporting rates, this species appear to be largely absent from the study area, with high reporting rates further to the east (mainly the North West-Gauteng border) and south (grids 2605_2605, 2610_2610 and 2615_2615 - an area between Lichtenburg and Coligny) of the study region (Figure 12). The low reporting rates (or absence) of Secretarybirds on the study site remains unclear and is probably correlated with disturbances (displacement) associated with widespread cattle ranching in the area.

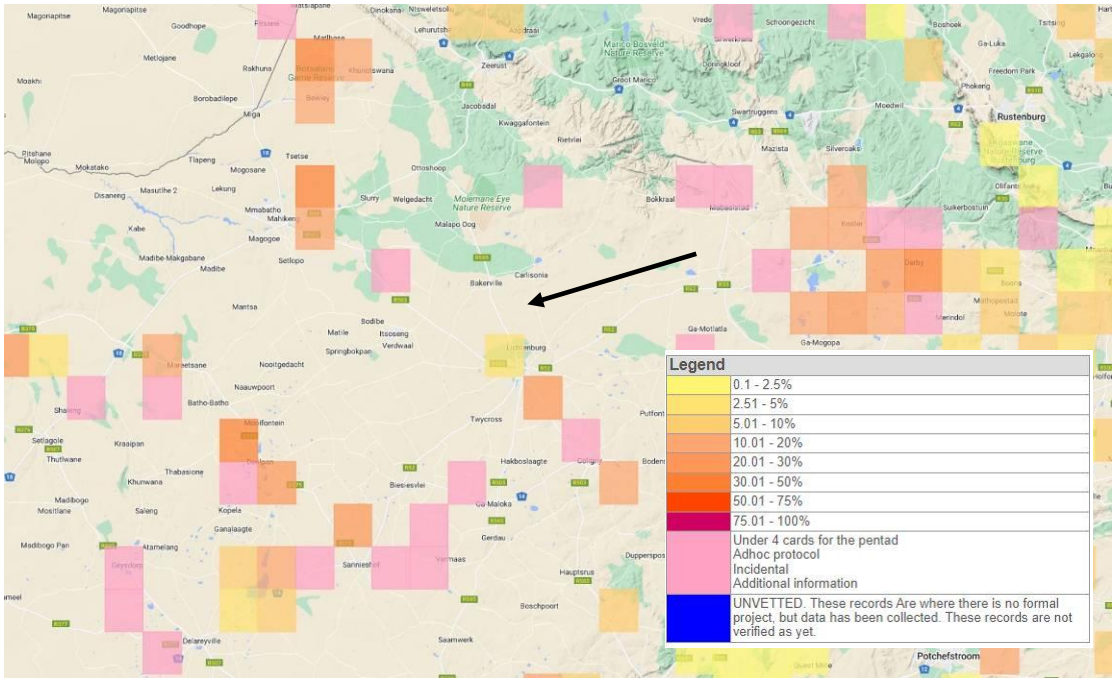


Figure 12: The occurrence of Secretarybirds (*Sagittarius serpentarius*) on the study area according to SABAP2 reporting rates (the arrow indicates the position of the study area). Note the presence of Secretarybirds to the south and east of the study region (map courtesy and copyright of SABAP2 and Animal Demography Unit).

4.4 Bird Assemblage Structure and Composition

4.4.1 Dominance and typical bird species

The dominant (typical) species on the study area are presented in Table 5. 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 Desert Cisticola (*Cisticola aridulus*), Cloud Cisticola (*C. textrix*) and Black-chested Prinia (*Prinia flavicans*). 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 predominantly represented by insectivores (insect-eating taxa) and by granivores (seed-eating taxa).

Table 5: Typical bird species on the study area.

Species	Av.Abundance	Consistency (Sim/SD)	Contribution (%)	Primary Trophic Guild
Desert Cisticola (Cisticola aridulus)	1.26	2.84	28.58	Insectivore: upper canopy foliage gleaner
Cloud Cisticola (*C. textrix*)	0.45	0.77	9.80	Insectivore: upper canopy foliage gleaner
Black-chested Prinia (*Prinia flavicans*)	0.95	0.73	9.75	Insectivore: upper canopy foliage gleaner

Eastern Clapper Lark (*Mirafra fasciolata*)	0.50	0.65	8.16	Granivore/Insectivore: ground gleaner
African Pipit (*Anthus cinnamomeus*)	0.47	0.66	7.55	Insectivore: ground gleaner
Rufous-naped Lark (*Mirafra africana*)	0.33	0.56	5.92	Granivore/Insectivore: ground gleaner
African Red-eyed Bulbul (*Pycnonotus nigricans)*	0.34	0.47	4.06	Frugivore: upper canopy forager
Southern Fiscal (*Lanius collaris*)	0.26	0.37	3.01	Insectivore and carnivore: upper canopy foliage gleaner

4.4.2 Composition and diversity

Multidimensional scaling and hierarchical agglomerative clustering ordination of bird abundance values on the study area could not statistically differentiate between any discrete bird association (Global R= 0.21, p=0.65 Figure 13), which means that most of the composition on the study area is similar to each other irrespective of the prevalent habitat types. However, three associations (although statistically insignificant) were detected due to the presence of surface water and tree canopy height. These include (1) an association on open dolomite grassland and bush clump mosaics (2) an association pertaining to tall *Vachellia erioloba* bush clumps and (3) an association confined to the presence of surface water (artificial watering points).

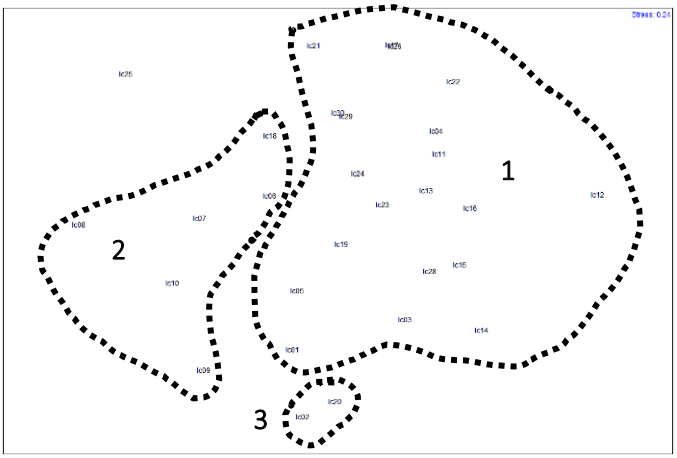


Figure 13: A two-dimensional non-metric multidimensional scaling ordination (stress=0.24) of the relative abundances of bird species based on Bray-Curtis similarities. It differentiates between three bird associations: (1) an association on open dolomite grassland with scattered bush clumps, an (2) association pertaining to tall *Vachellia erioloba* bush clumps and (3) an association confined to the presence of surface water (artificial watering holes).

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

1. Association on open dolomite grassland and bush clump mosaics

Dominant species: The Desert Cisticola (*Cisticola aridulus*), Black-chested Prinia (*Prinia flavicans*), Cloud Cisticola (*C. textrix*), Eastern Clapper Lark (Mirafra *fasciolata*), African Pipit (*Anthus cinnamomeus*), Rufous-naped Lark (*M. africana*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Ant-eating Chat (*Myrmecocichla formicivora*) and Laughing Dove (*Spilopelia senegalensis*).

Indicator species[6]: Mainly African Red-eyed Bulbul (*P. nigricans*). Spike-heeled Lark (*Chersomanes albofasciata*), Zitting Cisticola (*C. juncidis*), Orange River Francolin (*Scleroptila gutturalis*) and Cape Longclaw (*Macronyx capensis*), which occur in high numbers.

2. Association on tall Vachellia erioloba bush clumps

Dominant species: Desert Cisticola (*Cisticola aridulus*), White-browed sparrow-weaver (*Plocepasser mahali*), Ring-necked Dove (*Streptopelia capicola*), Southern Fiscal (*Lanius collaris*) and Laughing Dove (*Spilopelia senegalensis*).

Indicator species: Ashy Tit (*Melaniparus cinerascens*), Cape Starling (*Lamprotornis nitens*) and White-browed sparrow-weaver (*Plocepasser mahali*).

3. Association at surface water (artificial watering holes)

Dominant species: The Black-chested Prinia (*Prinia flavicans*), Speckled Pigeon (*Columba guinea*), White-backed Mousebird (*Colius colius*), Chestnut-vented Warbler (*Curruca subcoerulea*), Crowned Lapwing (*Vanellus coronatus*), Blacksmith Lapwing (*V. armatus*) and Ring-necked Dove (*Streptopelia capicola*).

Indicator species: Blacksmith Lapwing (*V. armatus),* Wattled Starling (*Creatophora cinerea*), Southern Grey-headed Sparrow (*Passer diffusus*), Capped Wheatear (*Oenanthe pileata*) and Chestnut-backed Sparrow-Lark (*Eremopterix leucotis*).

The highest number of bird species on the study area was observed from the open dolomite grassland with scattered bush clumps, followed by the bird association at artificial watering holes (Table 6). The lowest number of bird species was recorded from the tall *V. erioloba* bush clumps, although the number of individuals was similar to that of the surrounding open dolomite grassland.

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

Table 6: A summary of the observed species richness and number of bird individuals confined to the bird associations on the study area.

Bird Association	Number of species	Number of Individuals	Shannon Wiener Index $H'(\log_e)$
Open dolomite grassland & bush clump mosaics	45	11.43	3.35
Tall *Vachellia erioloba* bush clumps	27	11.08	2.86
Artificial watering points	30	32.25	3.05

4.5 Avifaunal sensitivity

A sensitivity map was compiled, illustrating habitat units comprising potential sensitive elements based on the following arguments (Figure 14):

Areas of high sensitivity

The artificial livestock watering points attract large numbers of granivore passerine and non-passerine bird species, of which many need to drink water on a daily basis. It is also often visited by birds of prey which come to drink or to hunt the congregating passerines and non-passerines (mainly doves). The placement of electrical infrastructure in close proximity to these areas could increase potential avian collisions with the infrastructure. In addition, the close proximity of cattle herd at the watering points along with the high potential for livestock carcasses to occur could provide opportunistic foraging habitat for threatened scavenging birds (e.g. vultures) which are prone to interact with the electrical infrastructure. These areas are therefore considered to be of high sensitivity, even though this habitat is of artificial origin. Nevertheless, these features could be removed or re-located away from overhead power lines.

The wet/moist grazed grassland patched along the proposed corridor (i the south) provides ephemeral foraging habitat for certain large terrestrial birds such as the Black-headed Heron (*Ardea melanocephala*) and gamebird species (e.g. Helmeted Guineafowl *Numida meleagris*). It is recommended that the earth wires of power lines spanning this particular be fitted with bird flight diverters (see below).

Areas of medium sensitivity

It includes open mixed woodland and extensive open grassland and bush clump mosaics. The mixed woodland (in the south) was often used as roosting platforms for vultures (observed during survey in August 2021; Pachnoda, 2021) and supported areas where a higher number of bird species are anticipated to occur.

The extensive open grassland and bush clump mosaics 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. However, reporting rates for threatened and near

threatened bird species are relatively low, thereby suggesting a medium sensitivity rating instead of a high sensitivity even though the majority of the habitat is natural. In addition, the open grassland and bush clump mosaics are widespread in the region.

Areas of low sensitivity

These habitat units are represented by transformed types.

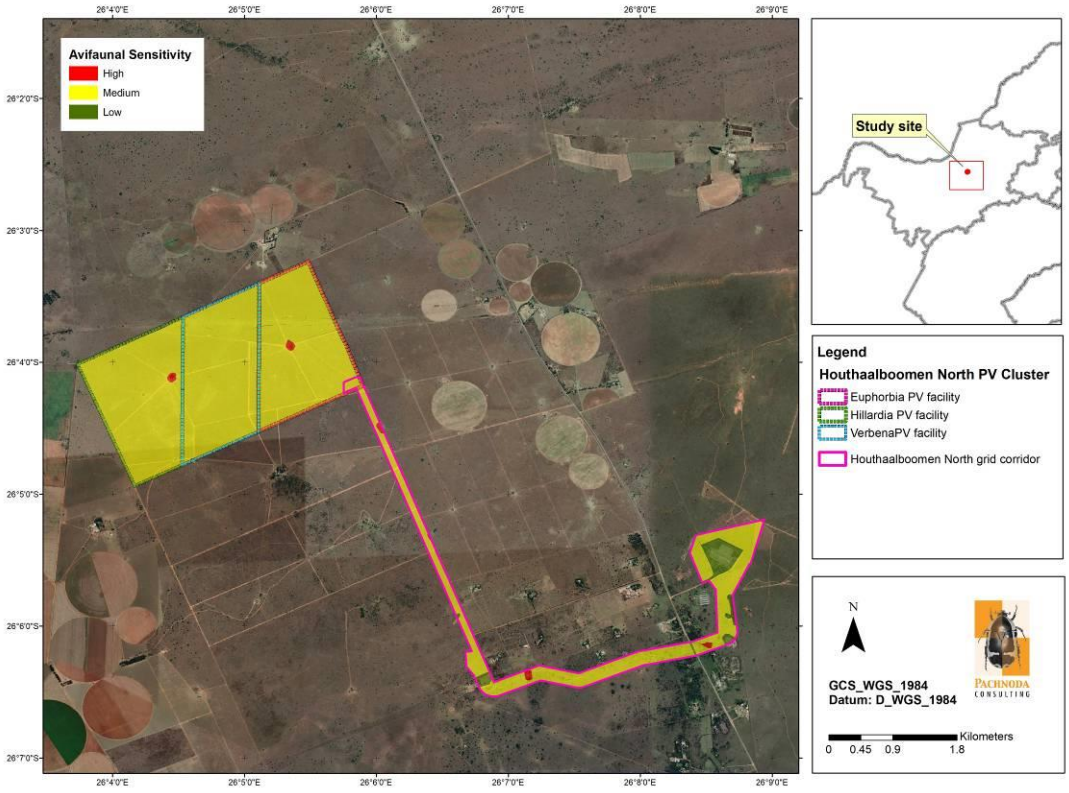


Figure 14: A map illustrating the avifaunal sensitivity of the study site based on the ecological condition of habitat types and the occurrence of collision prone species.

4.6 Overview of Avian Impacts

Birds are mobile, and are therefore also more readily affected by overhead electrical infrastructure than other taxonomic groups (e.g. mammals). In fact, birds are also vulnerable to impacts caused by other types of energy facilities such as solar and wind farms. For example, 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 at a solar facility. From this study it was evident that approximately 81 % of all avian mortalities at the solar facility were caused by collisions, mainly with electrical distribution lines.

4.6.1 Interaction with overhead power lines and reticulation

A 9 km 132kV single or double-circuit power line with a 200m wide corridor is proposed. *This corridor is NOT aligned alongside any existing overhead powerlines*. Birds are impacted in three ways by means of overhead power lines. It is however a common rule that large and heavy-bodied terrestrial bird species are more at risk of being affected in a negative way when interacting with transmission lines. These include the following:

Table 7 provides a summary of the impacts anticipated and quantification thereof (see Appendix 2 for methods used during the assessment of impacts).

- *Electrocution*

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

Large transmission lines (from 220 kV to 765 kV) are seldom a risk of electrocution, although smaller distribution lines (88 – 132 kV) pose a higher risk. However, for this project, the design of the pylon is an important consideration in preventing bird electrocutions. *However, electrocution of bird, especially vultures is proportional to the spatial position of livestock carcasses, and will probably only occur when a carcass is located underneath or in close proximity to an overhead power line*.

- *Collision*

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

Areas where bird collisions are likely to be high could be ameliorated by marking the lines with appropriate bird deterrent devices such as "bird diverters" and "flappers" to increase the visibility of the lines.

This may be true for most other bird species that are prone towards power line collisions, although the risk of Cape Vultures, Lapped-faced Vultures and White-backed Vultures colliding with the power line will persist due to the foraging behaviour and ecological requirements of these species. Cape Vultures feed communally and congregate in large numbers at a carcass; therefore any power line in close proximity could result in this species colliding with the earth wires, often resulting in more than a single mortality.

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

It is anticipated that natural vegetation will be cleared during construction phase to accommodate the switching substation and part of the power line servitude (including access roads). In addition, construction activities go hand in hand with high ambient noise levels. Although the construction of the power line is considered temporary, many species will vacate the area during the construction phase and will become temporarily displaced.

Displacement due to vegetation clearing will mainly affect passerine and smaller non-passerine species inhabiting the untransformed dolomite grasslands and bush clump mosaics. 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 grid 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*);
- Gabar Goshawk (*Micronisus gabar*);
- Yellow-billed Kite (*Milvus aegyptius*);
- Amur Falcon (*Falco rupicolus*) and
- African Hawk-eagle (*Aquila spilogaster*).

Table 7: The quantification of impacts associated with the proposed grid corridor 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.		
Grid Corridor (132 kV power line)	**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	**Medium (55)**	**Medium (52)**
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
Switching Substation	**Without mitigation**	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Minor (2)
Probability	Definite (5)	Probable (3)
Significance	**Medium (50)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, to some extent	Yes
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 power line and collector substation/ switching station contain the same habitat types which is mainly of medium sensitivity. However, the footprint of the pylons can be positioned in such a way to avoid areas of high sensitivity (e.g. moist/wet grassland), although this may not be possible during the construction of access roads/tracks. The best practicable mitigation will be to consolidate to infrastructure to areas where existing impacts occur. The proposed switching substation covers a small surface area, which will result in a reduced impact significance rating.		
Residual: It is anticipated that during rehabilitation (after removal of the infrastructure) that the vegetation will revert to secondary grassland and shrubland resulting in a decreased bird species richness with low evenness values on a local scale. The residual impact will be medium along the power line servitude. The residual impact of the collector substation will be low due to the small surface area of habitat loss.		

2. Nature: Avian collision impacts related to new overhead power (distribution) lines during operation.		
Grid Corridor (132 kV power line)	**Without mitigation**	**With mitigation**
Extent	Regional (4)	Regional (4)
Duration	Long-term (4)	Long-term (4)
Magnitude	Very High (10)	High (8)
Probability	Highly Probable (4)	Probable (3)

Significance	**High (72)**	**Medium (48)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, owing to the potential loss of critically endangered or endangered bird species	Yes, impact could still occur irrespective of mitigation.
Can impacts be mitigated?	Yes, to some extent	
Mitigation: Apply bird deterrent devices to the power lines and make use of "bird-friendly" pylon structures. Avoid the placement of cattle feedlots, kraals and watering points in close proximity to any overhead electrical infrastructure. All cattle feedlots and watering points within close proximity of power lines should be relocated (at least 100m from the power line servitude). Grazing of cattle in close proximity to overhead power lines should be avoided (to minimize potential occurrences of livestock carcasses near power line servitudes). To aid post-construction monitoring and/or monitoring of bird mortality rates, it is advised to conduct direct observations and carcass searches on a regular and systematic basis. As a priority, the entire length of the powerline should be marked with bird diverters (especially where it is spanning areas of high sensitivity where at least two consecutive spans on both sides where the alignment spans a sensitive habitat should be marked). In addition, the impact significance (after mitigation) could be reduced if the proposed corridor is to be placed alongside existing power line servitudes.		
Residual: Direct mortality is possible and may still happen irrespective of applied mitigation measures. The residual impact will be medium.		

3. Nature: Avian electrocution related to the new distribution line during operation.		
Grid Corridor (132 kV power line)	**Without mitigation**	**With mitigation**
Extent	Regional (4)	Regional (4)
Duration	Long-term (4)	Long-term (4)
Magnitude	Very High (10)	High (8)
Probability	Highly Probable (4)	Probable (3)
Significance	**High (72)**	**Medium (48)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, owing to the potential loss of critically endangered or endangered bird species	Yes, impact could still occur irrespective of mitigation.
Can impacts be mitigated?	Yes, to some extent	
Mitigation: Electrocution will be proportional to the spatial position of livestock carcasses (with reference to scavenging birds of prey), and will probably only occur when a carcass is located underneath or in close proximity to an overhead distribution power line. Apply bird deterrent devices to the power line. Avoid the placement of cattle feedlots and watering points near electrical infrastructure. All cattle feedlots and watering points within close proximity of power lines should be relocated (at least 100m from the power line servitude). Grazing of cattle at or in close proximity to distribution lines should be monitored at all times and preferably be avoided (to minimise potential livestock carcasses near power line servitudes). Make use of bird-friendly pylons and bird guards as recommended by EWT. Position of electrical infrastructure in close proximity to existing infrastructure will minimize the risk of electrocutions.		
Residual: Direct mortality is possible and may still happen irrespective of applied mitigation measures. The residual impact will be medium.		

4.6.2 Collision-prone bird species

A total of 40 collision-prone bird species have been recorded in the wider study area, of which 19 species are birds of prey (Table 8). Three of these species are vulture taxa (Cape Vulture *Gyps coprotheres*, White-backed Vulture *Gyps africanus* and Lappet-faced Vulture *Torgos tracheliotos*). Those species with SABAP2 reporting rates higher than 10% are regarded to be regular in the area and include the highly collision-prone and threatened White-backed Vulture and Cape Vulture.

Table 8: Collision-prone bird species and Red listed species (in red) expected to be present on the study site inferred from the South African Atlas Project (SABAP2).

Common Name	Scientific Name	Conservation Status Taylor, 2015)	SABAP2 Reporting Rate Full Protocol (%)
Abdim's Stork	*Ciconia abdimii*	Near threatened	0.00
African Hawk-eagle	*Aquila spilogaster*		n/a
African Sacred Ibis	*Threskiornis aethiopicus*		9.09
Amur Falcon	*Falco amurensis*		20.00
Black Sparrowhawk	*Accipiter melanoleucus*		3.64
Black-chested Snake Eagle	*Circaetus pectoralis*		7.27
Black-headed Heron	*Ardea melanocephala*		20.00
Black-winged Kite	*Elanus caeruleus*		27.27
Brown Snake Eagle	*Circaetus cinereus*		1.82
Cape Vulture	*Gyps coprotheres*	Endangered	16.36
Common (Steppe) Buzzard	*Buteo buteo vulpinus*		7.27
Coqui Francolin	*Peliperdix coqui*		16.36
Crested Francolin	*Dendroperdix sephaena*		5.45
Egyptian Goose	*Alopochen aegyptiaca*		20.00
Gabar Goshawk	*Micronisus gabar*		n/a
Greater Kestrel	*Falco rupicoloides*		9.09
Grey Heron	*Ardea cinerea*		14.55
Hadada Ibis	*Bostrychia hagedash*		54.55
Hamerkop	*Scopus umbretta*		5.45
Helmeted Guineafowl	*Numida meleagris*		43.64
Lanner Falcon	*Falco biarmicus*	Vulnerable	7.27
Lappet-faced Vulture	*Torgos tracheliotos*	Endangered	7.27
Lesser Kestrel	*Falco naumanni*		14.55
Marabou Stork	*Leptoptilos crumenifer*	Near threatened	1.82
Marsh Owl	*Asio capensis*		n/a
Martial Eagle	*Polemaetus bellicosus*	Endangered	1.82
Northern Black Korhaan	*Afrotis afraoides*		56.36
Orange River Francolin	*Scleroptila gutturalis*		38.18
Pied Crow	*Corvus albus*		61.82
South African Shelduck	*Tadorna cana*		12.73
Speckled Pigeon	*Columba guinea*		69.09

Spotted Eagle-Owl	*Bubo africanus*		3.64
Spur-winged Goose	*Plectropterus gambensis*		10.91
Swainson's Spurfowl	*Pternistis swainsonii*		54.55
Western Barn Owl	*Tyto alba*		7.27
Western Cattle Egret	*Bubulcus ibis*		45.45
White-backed Vulture	*Gyps africanus*	Critically Endangered	18.18
White-faced Whistling Duck	*Dendrocygna viduata*		12.73
Yellow-billed Duck	*Anas undulata*		18.18
Yellow-billed Kite	*Milvus aegyptius*		14.55

4.6.3 Vultures

Three species of vulture occur in the project area, which are *prone towards electrocution and collision with power lines*. These include the globally critically endangered White-backed Vulture (*Gyps africanus*), the globally endangered Cape Vulture (*G. coprotheres*) and the globally endangered Lappet-faced Vulture (*Torgos tracheliotos*). These species are of international significance and any mortality of adult individuals could have a negative effect on its species' population recruitment. Most of these suffer from a shortage of food supplies which is responsible for low reproductive rates, especially for Cape Vultures (Taylor *et al*., 2015). In addition, most of these species also tend to congregate at mammalian carcasses, where they feed in large groups, especially Cape Vultures. *In addition, Cape Vultures also typically search for food in groups. It is such congregations which increase the risk of mortalities whenever these individuals forage or roost in close proximity to power lines.*

The highest number of mortalities due to electrocution and collision recorded in the study region pertains to Cape Vultures (*Gyps coprotheres*) and White-backed Vultures (*Gyps africanus*) (according to the electrical infrastructure mortality incident register) (Figure 15). Most of the mortalities were caused by electrocution from smaller distribution lines in the area, although a significant number of Cape Vulture mortalities (*c*. 30 %) were also the result of collisions with transmission lines (Figure 16). There is a definite correlation between the size (in terms of voltage) of the power line and the type of mortality, whereby electrocution incidents were prominent at distribution lines while collisions occur at transmission lines. Therefore, it is postulated that the proposed power line corridor could contribute towards the rate of collision and electrocution mortalities in vulture species in the area. Most of the power line interactions also occurred in the Ventersdorp and Lichtenburg area (Figure 17), with a single mass mortality involving 10 Cape Vultures and eight White-backed Vultures on 09 March 2009. **It clearly shows that when these species congregate (for example when feeding from a carcass in close proximity to a power line or when roosting on pylons or nearby structures in close proximity to power lines), the risk of mortality due to both electrocution and collision is greatly increased**. The data also show that mitigation measures such as the

application of bird diverters tend to be ineffective, although it was evident that most of the existing power lines were not fitted with bird flight diverters.

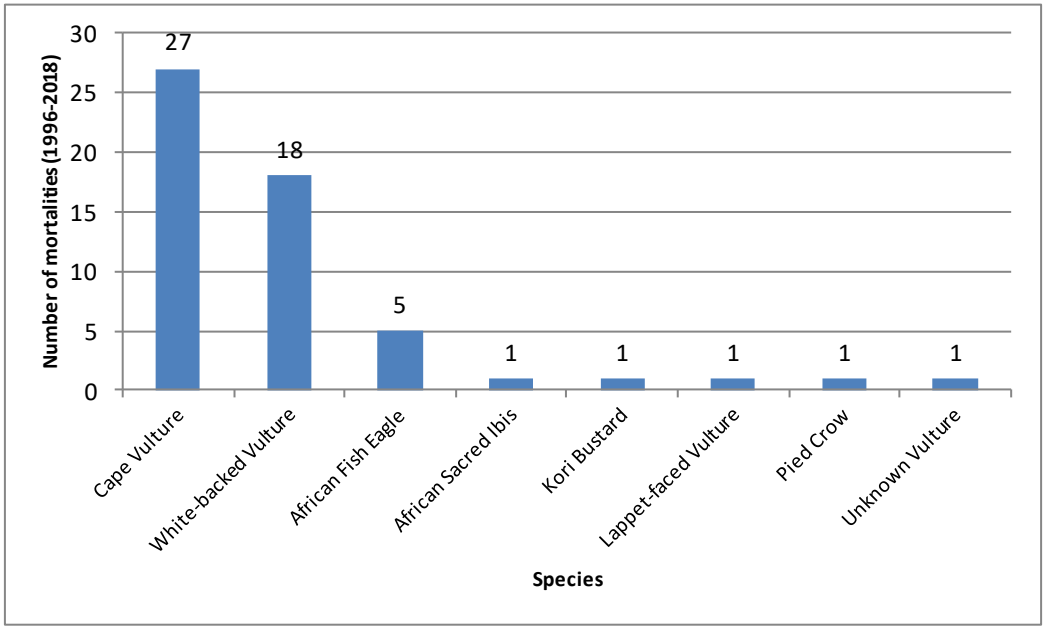


Figure 15: The number of mortalities (electrocutions and collisions) per bird species due to transmission and distribution lines in the study region (1996-2018).

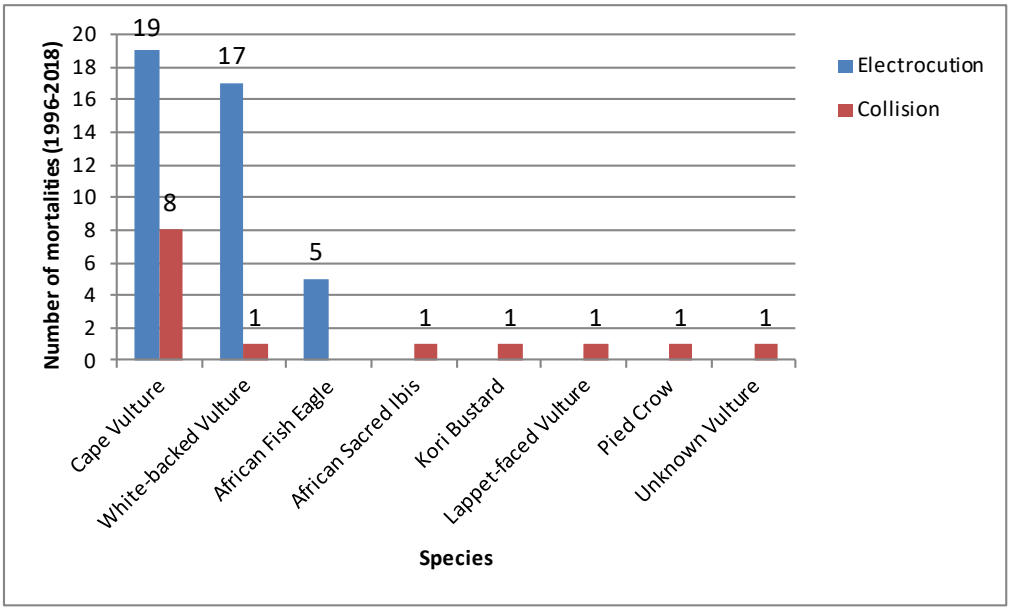


Figure 16: The number of mortalities per bird species caused by electrocutions (distribution lines) and collisions (transmission lines) in the study region (1996-2018).

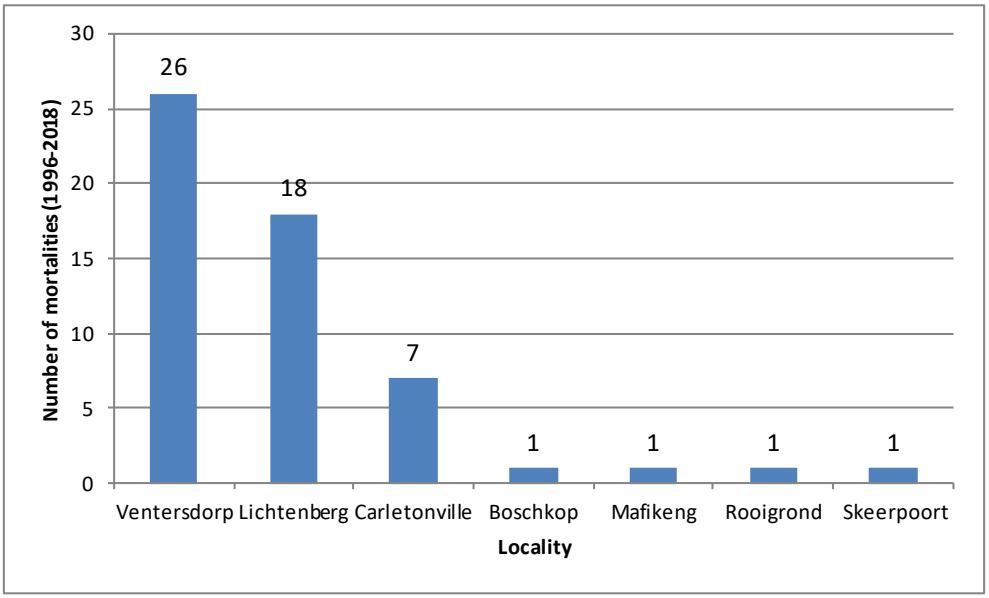


Figure 17: The number of bird mortalities caused by power lines per geographic locality (1996-2018), including the Lichtenburg area.

4.7 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 in the study area due to other planned solar farm projects and electrical infrastructure in the region.

The Houthaalboomen North PV Cluster and grid connection is one of many similar facilities located in the project area. Three other PV facilities (Lichtenburg 1 - 3 PV facilities) are planned on the Remaining Extent of Portion 02 of the Farm Zamenkomst No 04, Portion 06 of the Farm Zamenkomst No 04 and Portion 23 of Farm Houthaalboomen No 31 respectively. The Euphorbia PV facility is located adjacent to the Lichtenburg 2 PV facility. These three solar facilities will cumulatively occupy an area of approximately 784 ha which also contributes to the construction of grid corridors for connection with the MTS.

In addition, three other PV facilities (Dicoma, Setaria and Barleria PV facilities) are planned on Portions 1, 9 and 10 of the Farm Houthaalboomen 31. These three solar facilities will cumulatively occupy an area of approximately 542 ha and are located 2.4km to the south of the Houthaalboomen North PV Cluster.

Other solar projects (along with their own grid connections) are also proposed in the region which include the 75 MW Tlisitseng PV Facilities (covering a maximum of 600 ha in total on Portion 25 of the Farm Houthaalboomen No. 31), the Watershed Solar Energy Facility and the Lichtenburg Solar Park.

The grid connections (via overhead power lines) of these facilities with high voltage lines will increase the probability of bird strikes with power lines and avian mortalities due to collision and electrocution. *It is especially vulture species that are at risk of colliding or electrocution by the proposed additional electrical infrastructure*.

A summary of the cumulative impacts is provided in Table 9.

Table 9: A summary of the cumulative impacts.

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 (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Moderate (6)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Medium (52)**	**Medium (52)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, to some extent	
Confidence in findings: High.		
Mitigation: The best practicable mitigation will be to consolidate infrastructure (e.g. proposed power line) to areas where existing impacts occur (e.g. placing the proposed power lines alongside existing power lines).		

2. ***Nature:*** Avian collision impacts related to the overhead power lines during operation.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Regional (4)	Regional (4)
Duration	Long-term (4)	Long-term (4)
Magnitude	High (8)	High (8)
Probability	Probable (3)	Highly Probable (4)
Significance	**Medium (48)**	**High (64)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, owing to the potential loss of critically endangered or endangered bird species	Yes, owing to the potential loss of critically endangered or endangered bird species
Can impacts be mitigated?	Yes, to some extent	Yes, to some extent
Confidence in findings: High.		
Mitigation: Apply bird deterrent devices to the power line and make use of "bird-friendly" pylon structures. Prioritise the construction of new powerlines parallel to existing lines. To aid post-construction monitoring and/or monitoring of bird mortality rates, it is advised to conduct direct observations and carcass searches on a regular and systematic		

basis. **As a priority, all new power lines should be marked with bird diverters**.

*3. **Nature:*** Avian electrocution related to the distribution lines during operation*.*		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Regional (4)	Regional (4)
Duration	Long-term (4)	Long-term (4)
Magnitude	High (8)	High (8)
Probability	Probable (3)	Highly Probable (4)
Significance	**Medium (48)**	**High (64)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, owing to the potential loss of critically endangered or endangered bird species	Yes, owing to the potential loss of critically endangered or endangered bird species.
Can impacts be mitigated?	Yes, to some extent	
Confidence in findings: Moderate.		
Mitigation: Apply bird deterrent devices to the power line and make use of "bird-friendly" pylon structures. Move cattle feedlots and watering points away from electrical infrastructure. **As a priority, all new power lines should be marked with bird diverters and bird guards**. Make use of bird-friendly pylons and bird guards. Where possible, position electrical infrastructure in close proximity to existing infrastructure.		

4.8 Recommended avifaunal mitigation

4.8.1 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, including pylons footprints on habitat of medium to low avifaunal sensitivity.
- 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.

4.8.2 Power line interaction: collision and electrocution with power lines

The following mitigation measures are proposed:

- The impact significance of avian collisions and avian electrocutions will be reduced if the proposed power line servitude be placed alongside existing

powerlines. This is not always possible (e.g. the current project), although it may be argued that by placing the proposed power line alongside existing power line servitudes will greatly increase the visibility of the overhead cables to passing birds (during daylight), thereby reducing collision with the overhead cabling structures..

- Avoid the placement of cattle feedlots, kraals and watering within 100 m from the powerline servitude. **It is advised that grazing cattle at or in close proximity to distribution lines *(c.* 100 m) be monitored (to avoid the risk of livestock carcasses near distribution lines, which may attract vultures and the increased the risk of collision or electrocution by overhead lines**). In the event that a carcass is located, it should immediately be removed from the area. If livestock carcasses are considered safe for consumption by vultures, it may be donated to the nearby vulture restaurant.
- EWT should be consulted on an appropriate pylon design to be used for the project. In general, the proposed pylon design must incorporate the following design parameters:
    - The clearances between the live components should be as wide as possible within the design limitations/capabilities of the power line.
    - The height of the tower should allow for unrestricted movement of terrestrial birds between successive pylons.
    - The live components should be "bundled" to increase the visibility for approaching birds.
    - "Bird streamers" should be eliminated by discouraging birds from perching above the conductors. In addition, conductors should be strung below the pole to avoid bridging the air gap by perching birds of prey.

It is therefore recommended that the pylon design incorporates "features as illustrated in Figure 18[7].

From Figure 18 it is clear that perching by birds is discouraged by the addition of diagonal crossbars or by doing away with the crossbars that holds the conductors in place. Bird "streamers" are also eliminated by fitting the poles with bird guards/spikes above the conductors. However, safe perching is facilitated by the fitment of a horizontal bar on top of the pole structure without the risk of electrocution (due to the perpendicular orientation of the bar relative to the conductors).

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

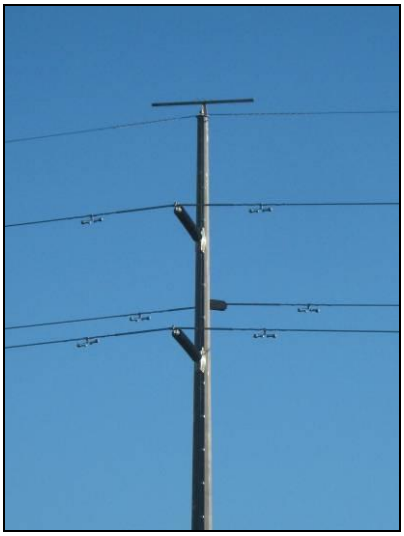



Figure 18: Two bird-friendly tower designs to be considered for the current project.

- As a priority, all new power lines should be marked with bird diverters (see Figure 19).

Figure 19: Examples of bird flight diverters to be used on the power lines: Double loop bird flight diverter (left) and Viper live bird flapper (right).

4.8.3 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.

4.9 Suggested monitoring and Environmental Management Plan

- It is possible that bird mortalities due to collision will occur at the power lines even after mitigation. Monthly post-construction monitoring (during operation) for at least three years after construction should be implemented to attempt to quantify mortalities (especially vulture mortalities) caused by the 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 collisions and electrocution associated with 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 new power lines	ECO & CER	Construction
2. Implement post-construction monitoring and bird carcass surveys	OM	Operation - daily
3. Compile management programme to assess efficacy of mitigation and on-going research/trials	OM & CER	Operation - monthly for at least three years

4. 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 surveys for livestock carcasses. 2. Implement post-construction monitoring to quantify bird mortalities caused by the power line network. All searches should be done on foot. 3. 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.

4.10 An opinion regarding the feasibility of the project

Pachnoda Consulting cc was requested by the Houthaalboomen North Grid (Pty) Ltd to compile an avifauna impact assessment report for the proposed grid connection infrastructure for the Houthaalboomen North PV Cluster.

Five prominent avifaunal habitat types were identified on the site, and consisted of open mixed dolomite grassland with bush clump mosaics, open mixed woodland, artificial livestock watering points, wet/moist grazed grassland and transformed land. Approximately 186 bird species are expected to occur in the wider study area, of which 88 species were observed in the study area. The expected richness included eight threatened or near threatened species, 16 southern African endemics and 20 are near-endemic species. The critically endangered White-backed Vulture (*Gyps africanus*) and the endangered Cape Vulture (*G. coprotheres*) were confirmed during the surveys, mainly as roosting individuals and birds soaring overhead. Eleven southern African endemics and 14 near-endemic species were confirmed on the study site.

An evaluation of potential and likely impacts on the avifauna revealed that the impact significance due to potential avian collisions and electrocutions was moderate after mitigation. However, the endangered Cape Vulture (*Gyps coprotheres*) and critically endangered White-backed Vulture (*Gyps africanus*) (and to a lesser degree also Lappet-faced Vulture *Torgos tracheliotos*) were identified as regular foraging visitors to the study area (according to SABAP2 reporting rates and on-site observations). **These species are highly prone to power line collisions, whereby the proposed overhead power line corridor could pose a collision and electrocution risk to vultures**. **The risk of collision/electrocution was considered likely when vultures feed on a carcass in close proximity to a power line servitude or when attempting to roost on the pylon structures**.

It is strongly recommended that the proposed mitigation measures and monitoring protocols 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 area. 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 2600_2600 and the eight surrounding grids. The reporting rates include submissions made during the January and May 2022 surveys.

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
78	Abdim's Stork	*Ciconia abdimii*		0.00	0	10.00	2
432	Acacia Pied Barbet	*Tricholaema leucomelas*	X	52.73	29	5.00	1
141	African Hawk-eagle	*Aquila spilogaster*	X	n/a	1		
418	African Hoopoe	*Upupa africana*		29.09	16	5.00	1
387	African Palm Swift	*Cypsiurus parvus*		27.27	15	0.00	0
682	African Paradise Flycatcher	*Terpsiphone viridis*		5.45	3	0.00	0
692	African Pipit	*Anthus cinnamomeus*	X	43.64	24	5.00	1
544	African Red-eyed Bulbul	*Pycnonotus nigricans*	X	50.91	28	0.00	0
606	African Reed Warbler	*Acrocephalus baeticatus*		10.91	6	0.00	0
81	African Sacred Ibis	*Threskiornis aethiopicus*		9.09	5	5.00	1
576	African Stonechat	*Saxicola torquatus*		32.73	18	0.00	0
247	African Wattled Lapwing	*Vanellus senegallus*		1.82	1	0.00	0
772	Amethyst Sunbird	*Chalcomitra amethystina*		3.64	2	0.00	0
119	Amur Falcon	*Falco amurensis*	X	20.00	11	10.00	2
575	Ant-eating Chat	*Myrmecocichla formicivora*	X	63.64	35	20.00	4
533	Arrow-marked Babbler	*Turdoides jardineii*		5.45	3	0.00	0
514	Ashy Tit	*Melaniparus cinerascens*	X	7.27	4	5.00	1
510	Banded Martin	*Riparia cincta*	X	27.27	15	5.00	1
493	Barn Swallow	*Hirundo rustica*	X	30.91	17	10.00	2
513	Black Cuckooshrike	*Campephaga flava*		1.82	1	0.00	0

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
159	Black Sparrowhawk	*Accipiter melanoleucus*		3.64	2	0.00	0
650	Black-chested Prinia	*Prinia flavicans*	X	70.91	39	15.00	3
146	Black-chested Snake Eagle	*Circaetus pectoralis*		7.27	4	0.00	0
431	Black-collared Barbet	*Lybius torquatus*		27.27	15	10.00	2
715	Black-crowned Tchagra	*Tchagra senegalus*		5.45	3	0.00	0
55	Black-headed Heron	*Ardea melanocephala*		20.00	11	10.00	2
521	Black-headed Oriole	*Oriolus larvatus*		5.45	3	0.00	0
245	Blacksmith Lapwing	*Vanellus armatus*	X	49.09	27	5.00	1
860	Black-throated Canary	*Crithagra atrogularis*	X	40.00	22	5.00	1
130	Black-winged Kite	*Elanus caeruleus*	X	27.27	15	30.00	6
270	Black-winged Stilt	*Himantopus himantopus*		7.27	4	5.00	1
839	Blue Waxbill	*Uraeginthus angolensis*		21.82	12	10.00	2
405	Blue-cheeked Bee-eater	*Merops persicus*		12.73	7	0.00	0
722	Bokmakierie	*Telophorus zeylonus*	X	60.00	33	5.00	1
145	Brown Snake Eagle	*Circaetus cinereus*		1.82	1	0.00	0
714	Brown-crowned Tchagra	*Tchagra australis*	X	21.82	12	15.00	3
509	Brown-throated Martin	*Riparia paludicola*		1.82	1	0.00	0
731	Brubru	*Nilaus afer*		3.64	2	5.00	1
695	Buffy Pipit	*Anthus vaalensis*		3.64	2	5.00	1
4131	Burchell's Coucal	*Centropus burchellii*		10.91	6	0.00	0
703	Cape Longclaw	*Macronyx capensis*	X	34.55	19	5.00	1
531	Cape Penduline Tit	*Anthoscopus minutus*		3.64	2	0.00	0
581	Cape Robin-Chat	*Cossypha caffra*		16.36	9	0.00	0
786	Cape Sparrow	*Passer melanurus*	X	69.09	38	5.00	1

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
737	Cape Starling	*Lamprotornis nitens*	X	40.00	22	10.00	2
316	Ring-necked Dove	*Streptopelia capicola*	X	40.00	22	20.00	4
106	Cape Vulture	*Gyps coprotheres*	X	16.36	9	0.00	0
686	Cape Wagtail	*Motacilla capensis*		41.82	23	0.00	0
1172	Cape White-eye	*Zosterops virens*	X	34.55	19	0.00	0
568	Capped Wheatear	*Oenanthe pileata*	X	12.73	7	0.00	0
484	Chestnut-backed Sparrow-Lark	*Eremopterix leucotis*	X	12.73	7	10.00	2
658	Chestnut-vented Warbler	*Curruca subcoerulea*	X	60.00	33	10.00	2
673	Chinspot Batis	*Batis molitor*	X	12.73	7	5.00	1
872	Cinnamon-breasted Bunting	*Emberiza tahapisi*		14.55	8	10.00	2
631	Cloud Cisticola	*Cisticola textrix*	X	36.36	20	5.00	1
	Common Buttonquail	*Turnix sylvaticus*	X	n/a	1		
154	Common (Steppe) Buzzard	*Buteo buteo vulpinus*	X	7.27	4	10.00	2
734	Common Myna	*Acridotheres tristis*	X	49.09	27	5.00	1
421	Common Scimitarbill	*Rhinopomastus cyanomelas*		21.82	12	5.00	1
843	Common Waxbill	*Estrilda astrild*		10.91	6	0.00	0
594	Common Whitethroat	*Curruca communis*		3.64	2	0.00	0
173	Coqui Francolin	*Peliperdix coqui*	X	16.36	9	0.00	0
439	Crested Barbet	*Trachyphonus vaillantii*	X	60.00	33	5.00	1
174	Crested Francolin	*Dendroperdix sephaena*		5.45	3	0.00	0
711	Crimson-breasted Shrike	*Laniarius atrococcineus*	X	29.09	16	5.00	1
242	Crowned Lapwing	*Vanellus coronatus*	X	67.27	37	5.00	1
545	Dark-capped Bulbul	*Pycnonotus tricolor*		36.36	20	5.00	1
630	Desert Cisticola	*Cisticola aridulus*	X	41.82	23	10.00	2

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
352	Diederik Cuckoo	*Chrysococcyx caprius*	X	40.00	22	5.00	1
1183	Eastern Clapper Lark	*Mirafra fasciolata*	X	38.18	21	0.00	0
89	Egyptian Goose	*Alopochen aegyptiaca*	X	20.00	11	0.00	0
404	European Bee-eater	*Merops apiaster*		23.64	13	0.00	0
412	European Roller	*Coracias garrulus*		1.82	1	0.00	0
570	Familiar Chat	*Oenanthe familiaris*		1.82	1	0.00	0
665	Fiscal Flycatcher	*Melaenornis silens*		45.45	25	5.00	1
	Fairy Flycatcher	*Stenostira scita*	X	n/a	1		
517	Fork-tailed Drongo	*Dicrurus adsimilis*		1.82	1	0.00	0
	Gabar Goshawk	*Micronisus gabar*	X	n/a	1		
874	Golden-breasted Bunting	*Emberiza flaviventris*		1.82	1	5.00	1
603	Great Reed Warbler	*Acrocephalus arundinaceus*		1.82	1	0.00	0
785	Great Sparrow	*Passer motitensis*		3.64	2	0.00	0
440	Greater Honeyguide	*Indicator indicator*		7.27	4	0.00	0
122	Greater Kestrel	*Falco rupicoloides*		9.09	5	10.00	2
502	Greater Striped Swallow	*Cecropis cucullata*	X	36.36	20	5.00	1
419	Green Wood Hoopoe	*Phoeniculus purpureus*		10.91	6	0.00	0
830	Green-winged Pytilia	*Pytilia melba*	X	16.36	9	5.00	1
339	Grey Go-away-bird	*Crinifer concolor*		27.27	15	5.00	1
54	Grey Heron	*Ardea cinerea*		14.55	8	5.00	1
485	Grey-backed Sparrow-Lark	*Eremopterix verticalis*		5.45	3	0.00	0
557	Groundscraper Thrush	*Turdus litsitsirupa*		7.27	4	0.00	0
84	Hadada Ibis	*Bostrychia hagedash*	X	54.55	30	5.00	1
72	Hamerkop	*Scopus umbretta*		5.45	3	0.00	0

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
192	Helmeted Guineafowl	*Numida meleagris*	X	43.64	24	5.00	1
784	House Sparrow	*Passer domesticus*	X	40.00	22	5.00	1
586	Kalahari Scrub Robin	*Cercotrichas paena*	X	50.91	28	10.00	2
1104	Karoo Thrush	*Turdus smithi*	X	43.64	24	0.00	0
114	Lanner Falcon	*Falco biarmicus*		7.27	4	0.00	0
108	Lappet-faced Vulture	*Torgos tracheliotos*		7.27	4	5.00	1
317	Laughing Dove	*Spilopelia senegalensis*	X	85.45	47	25.00	5
706	Lesser Grey Shrike	*Lanius minor*	X	16.36	9	0.00	0
442	Lesser Honeyguide	*Indicator minor*		5.45	3	0.00	0
125	Lesser Kestrel	*Falco naumanni*	X	14.55	8	0.00	0
604	Lesser Swamp Warbler	*Acrocephalus gracilirostris*		12.73	7	0.00	0
646	Levaillant's Cisticola	*Cisticola tinniens*		27.27	15	0.00	0
410	Little Bee-eater	*Merops pusillus*		7.27	4	5.00	1
385	Little Swift	*Apus affinis*	X	29.09	16	0.00	0
621	Long-billed Crombec	*Sylvietta rufescens*		14.55	8	0.00	0
852	Long-tailed Paradise Whydah	*Vidua paradisaea*		3.64	2	0.00	0
818	Long-tailed Widowbird	*Euplectes progne*	X	41.82	23	5.00	1
73	Marabou Stork	*Leptoptilos crumenifer*		1.82	1	0.00	0
661	Marico Flycatcher	*Melaenornis mariquensis*		7.27	4	0.00	0
	Marsh Owl	*Asio capensis*	X	n/a	1		
607	Marsh Warbler	*Acrocephalus palustris*		5.45	3	10.00	2
142	Martial Eagle	*Polemaetus bellicosus*		1.82	1	0.00	0
	Melodious Lark	*Mirafra cheniana*	X	n/a	1		
564	Mountain Wheatear	*Myrmecocichla monticola*		3.64	2	0.00	0

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
318	Namaqua Dove	*Oena capensis*	X	27.27	15	15.00	3
637	Neddicky	*Cisticola fulvicapilla*	X	30.91	17	5.00	1
1035	Northern Black Korhaan	*Afrotis afraoides*	X	56.36	31	10.00	2
179	Orange River Francolin	*Scleroptila gutturalis*	X	38.18	21	5.00	1
1171	Orange River White-eye	*Zosterops pallidus*		18.18	10	5.00	1
522	Pied Crow	*Corvus albus*	X	61.82	34	10.00	2
746	Pied Starling	*Lamprotornis bicolor*		7.27	4	5.00	1
846	Pin-tailed Whydah	*Vidua macroura*	X	21.82	12	0.00	0
694	Plain-backed Pipit	*Anthus leucophrys*	X	9.09	5	0.00	0
844	Quailfinch	*Ortygospiza atricollis*	X	32.73	18	5.00	1
642	Rattling Cisticola	*Cisticola chiniana*		7.27	4	0.00	0
708	Red-backed Shrike	*Lanius collurio*		21.82	12	0.00	0
837	Red-billed Firefinch	*Lagonosticta senegala*		9.09	5	0.00	0
805	Red-billed Quelea	*Quelea quelea*	X	45.45	25	0.00	0
97	Red-billed Teal	*Anas erythrorhyncha*		16.36	9	0.00	0
501	Red-breasted Swallow	*Cecropis semirufa*		1.82	1	5.00	1
488	Red-capped Lark	*Calandrella cinerea*	X	16.36	9	0.00	0
813	Red-collared Widowbird	*Euplectes ardens*		1.82	1	0.00	0
314	Red-eyed Dove	*Streptopelia semitorquata*	X	67.27	37	15.00	3
392	Red-faced Mousebird	*Urocolius indicus*	X	50.91	28	15.00	3
820	Red-headed Finch	*Amadina erythrocephala*	X	18.18	10	0.00	0
940	Rock Dove	*Columba livia*		14.55	8	0.00	0
506	Rock Martin	*Ptyonoprogne fuligula*		5.45	3	5.00	1
458	Rufous-naped Lark	*Mirafra africana*	X	49.09	27	10.00	2

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
460	Sabota Lark	*Calendulauda sabota*		10.91	6	5.00	1
789	Scaly-feathered Weaver	*Sporopipes squamifrons*	X	40.00	22	0.00	0
105	Secretarybird	*Sagittarius serpentarius*		1.82	1	0.00	0
847	Shaft-tailed Whydah	*Vidua regia*		3.64	2	5.00	1
504	South African Cliff Swallow	*Petrochelidon spilodera*	X	14.55	8	0.00	0
90	South African Shelduck	*Tadorna cana*		12.73	7	0.00	0
707	Southern Fiscal	*Lanius collaris*	X	81.82	45	20.00	4
4142	Southern Grey-headed Sparrow	*Passer diffusus*	X	23.64	13	5.00	1
803	Southern Masked Weaver	*Ploceus velatus*	X	70.91	39	5.00	1
808	Southern Red Bishop	*Euplectes orix*		50.91	28	0.00	0
390	Speckled Mousebird	*Colius striatus*		14.55	8	0.00	0
311	Speckled Pigeon	*Columba guinea*	X	69.09	38	15.00	3
474	Spike-heeled Lark	*Chersomanes albofasciata*	X	40.00	22	0.00	0
368	Spotted Eagle-Owl	*Bubo africanus*		3.64	2	0.00	0
654	Spotted Flycatcher	*Muscicapa striata*		16.36	9	0.00	0
275	Spotted Thick-knee	*Burhinus capensis*	X	10.91	6	0.00	0
88	Spur-winged Goose	*Plectropterus gambensis*		10.91	6	0.00	0
867	Streaky-headed Seedeater	*Crithagra gularis*		7.27	4	0.00	0
185	Swainson's Spurfowl	*Pternistis swainsonii*	X	54.55	30	5.00	1
411	Swallow-tailed Bee-eater	*Merops hirundineus*		1.82	1	0.00	0
649	Tawny-flanked Prinia	*Prinia subflava*		3.64	2	0.00	0
238	Three-banded Plover	*Charadrius tricollaris*		18.18	10	0.00	0
840	Violet-eared Waxbill	*Granatina granatina*		5.45	3	0.00	0
735	Wattled Starling	*Creatophora cinerea*	X	38.18	21	5.00	1

#	Common Name	Scientific Name	Observed (January & May 2022)	SABAP2 Reprting Rate			
				Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
359	Western Barn Owl	*Tyto alba*	X	7.27	4	0.00	0
61	Western Cattle Egret	*Bubulcus ibis*	X	45.45	25	10.00	2
391	White-backed Mousebird	*Colius colius*	X	56.36	31	5.00	1
107	White-backed Vulture	*Gyps africanus*	X	18.18	10	0.00	0
763	White-bellied Sunbird	*Cinnyris talatala*		10.91	6	0.00	0
780	White-browed Sparrow-Weaver	*Plocepasser mahali*	X	72.73	40	15.00	3
588	White-browed Scrub Robin	*Cercotrichas leucophrys*		3.64	2	0.00	0
727	White-crested Helmetshrike	*Prionops plumatus*		1.82	1	0.00	0
100	White-faced Whistling Duck	*Dendrocygna viduata*		12.73	7	0.00	0
409	White-fronted Bee-eater	*Merops bullockoides*		12.73	7	0.00	0
582	White-throated Robin-chat	*Cossypha humeralis*		n/a	1		
383	White-rumped Swift	*Apus caffer*	X	23.64	13	0.00	0
495	White-throated Swallow	*Hirundo albigularis*		20.00	11	0.00	0
814	White-winged Widowbird	*Euplectes albonotatus*	X	12.73	7	0.00	0
599	Willow Warbler	*Phylloscopus trochilus*		9.09	5	5.00	1
866	Yellow Canary	*Crithagra flaviventris*	X	65.45	36	15.00	3
96	Yellow-billed Duck	*Anas undulata*		18.18	10	5.00	1
129	Yellow-billed Kite	*Milvus aegyptius*	X	14.55	8	5.00	1
812	Yellow-crowned Bishop	*Euplectes afer*	X	7.27	4	0.00	0
859	Yellow-fronted Canary	*Crithagra mozambica*		1.82	1	0.00	0
437	Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*		3.64	2	0.00	0
629	Zitting Cisticola	*Cisticola juncidis*	X	41.82	23	0.00	0

Appendix 2: 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).