DRAFT

BIRD IMPACT ASSESSMENT

SPECIALIST ASSESSMENT REPORT

BOTSWANA-SOUTH AFRICA (BOSA)

TRANSMISSION INTERCONNECTION PROJECT

November 2017

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PROFESSIONAL EXPERIENCE

Chris van Rooyen

Chris has 20 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in more than 100 power line and 25 wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently (2015) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Megan Diamond

Megan completed a Bachelor of Science degree in Environmental Management from the University of South Africa and has been involved in conservation for 18 years. She has ten years' experience in the field of bird interactions with electrical infrastructure (both linear and footprint) and during this time has completed impact assessments for at least 80 projects. In various roles (including Programme Manager) with the Endangered Wildlife Trust's Wildlife & Energy Programme and the Programme's primary project (Eskom-EWT Partnership) from 2006 to 2013, Megan was responsible for assisting the energy industry and the national utility in minimising the negative impacts (associated with electrical infrastructure) on wildlife through the provision of strategic guidance, risk and impact assessments, training and research. Megan currently owns and manages *Feathers Environmental Services* and is tasked with providing strategic guidance to industry through the development of best practice procedures and guidelines, reviewing and commenting on methodologies, specialist studies and EIA reports for Renewable Energy projects as well as providing specialist avifaunal input into renewable energy and power line developments within South Africa, elsewhere in Africa and across the globe. In addition, Megan has attended and presented at several conferences and facilitated workshops, as a subject expert, since 2007. Megan is a co-author of the *BirdLife South Africa / Endangered Wildlife Trust best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* and the *Avian Wind Farm Sensitivity Map for South Africa* (2015) and played an instrumental role in facilitating the endorsement of these two products by the South African Wind Energy Association (SAWEA), IAIAsa (International Association for Impact Assessment South Africa) and Eskom. In 2011/2012, she chaired the Birds and Wind Energy Specialist Group in South Africa. From 2013 to 2015, Megan chaired the IUCN/SSC Crane Specialist Group's Crane and Powerline Network, a working group comprised of subject matter experts from across the world, working in partnership to share lessons, develop capacity, pool resources, and accelerate collective learning towards finding innovative solutions to mitigate this impact on threatened crane populations.

DECLARATION OF INDEPENDENCE

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of the Environmental Impact Assessment for the proposed Botswana-South Africa (BOSA) Transmission Interconnection Project, other than fair remuneration for the specialist investigations completed in a professional capacity as specified by the Environmental Impact Assessment Regulations, 2014.

Full Name: Chris van Rooyen
Title / Position: Director

EXECUTIVE SUMMARY

South Africa

In general, the habitat in which the proposed Watershed B substation and the BOSA 400kV power line corridor are located is moderately sensitive from a potential bird impact perspective. The natural habitats are likely to support a diversity of Red Listed power line sensitive species. However, there is evidence of anthropogenic impacts in the broader area, particularly in the form of urbanisation, mining, cultivation and pastoral activities which is evident in the disturbed state of the natural habitat. The levels of disturbance associated with these land use practices are significant and have therefore had a negative impact on avifaunal diversity and abundance reflected in the low reporting rates for the majority of the power line sensitive Red Listed species.

Potential impacts affecting Red Listed avifauna requiring mitigation, relating to the construction and operation of the proposed power line include:

- Mortality due to collision of large terrestrial birds, vultures and waterbirds with the overhead power line during the operational phase; and
- Displacement as a result of habitat transformation and disturbance during the construction of the powerline.

The impact of the mortality of Red Listed avifauna due to collisions with the powerline is rated as Moderate negative pre-mitigation, but it can be reduced to Low negative after the application of mitigation measures. Mitigation measures include the following:

- High risk sections of power line must be identified by a qualified avifaunal specialist during the construction phase via a walk-through, once the tower positions have been finalized.
- If power line marking is required, bird flight diverters must be installed on the full span length on each of the conductors according to the Eskom Guidelines (see Appendix 4).
- Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.
- The powerline should be inspected once a year for a minimum of two years by an avifaunal specialist to establish if there is any significant collision mortality, which may require the marking of additional sections. Thereafter the frequency of inspections will be informed by the results of the first two years.

The impact of displacement due to disturbance and habitat destruction is rated as Low negative, and it can be further reduced to Very Low – negative through the application of mitigation measures. Mitigation measures include the following:

- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.
- Prior to construction commencing, a walk-through should be performed by an avifaunal specialist to record any large raptor nests that could be impacted by the construction of the proposed powerline. Should any nests be recorded, it would require management of the potential impacts on the breeding birds once

construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where breeding priority raptors could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active

The construction and operation of the proposed 400kV powerline should result in manageable impacts on Red Listed avifauna, provided the recommended mitigation measures are diligently implemented, including the monitoring requirements as detailed in the EMP.

Botswana

In general, the habitat in which the proposed BOSA 400kV power line corridor are located is moderately sensitive from a potential bird impact perspective. The natural habitats are likely to support a diversity of Red Listed power line sensitive species. However, there is evidence of anthropogenic impacts in the broader area, particularly in the form of urbanisation, cultivation and pastoral activities which is evident in the disturbed state of the natural habitat in places. The levels of disturbance associated with these land use practices are significant and have therefore had a negative impact on avifaunal diversity and abundance reflected in the low reporting rates for the majority of the power line sensitive Red Listed species.

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The impact of the mortality of Red Listed avifauna due to collisions with the powerline is rated as Moderate negative pre-mitigation, but it can be reduced to Low negative after the application of mitigation measures. Mitigation measures include the following:

- High risk sections of power line must be identified by a qualified avifaunal specialist during the construction phase via a walk-through, once the tower positions have been finalized. BirdLife Botswana should be consulted prior to the walk-through with a view to inviting them to participate in the walk-through exercise.
- If power line marking is required, bird flight diverters must be installed on the full span length on each of the conductors according to the Botswana Power Corporation guidelines, (or Eskom Guidelines, if the former have not yet been developed (see Appendix 4).
- Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.
- The powerline should be inspected once a year for a minimum of two years by an avifaunal specialist establish if there is any significant collision mortality, which may require the marking of additional sections. Thereafter the frequency of inspections will be informed by the results of the first two years. BirdLife Botswana should be consulted with a view to inviting them to participate in the monitoring exercise.

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1 INTRODUCTION

1.1 Background

Over the last decade, excess electricity generation across the Southern African Development Community (SADC) region has diminished quite substantially and many regional transmission lines are now congested. In order to provide a high-quality supply of electricity to meet the ever-increasing needs of its end users and stimulate regional development and economic growth, the Southern African Power Pool (SAPP) is tasked with coordinating the activities of power utilities in the SADC region and facilitating the development of new generation and transmission facilities.

One of the identified and planned initiatives is the Botswana-South Africa (BOSA) Transmission Interconnection Project, which requires the construction of approximately 220 km of 400kV transmission power line between the existing Isang substation, located approximately 40km north of Gaborone in Botswana and the proposed Watershed B substation in South Africa's North-West Province. The construction of the proposed power line will support the restructuring and strengthening of a high voltage transmission system to improve and intensify power transfers, stability and regional trade within the SAPP network.

The SAPP Coordination Centre (on behalf of Eskom of South Africa and Botswana Power Corporation of Botswana), as the designated project coordinator and contracting authority, has appointed Aurecon South Africa (Pty) Ltd (hereinafter referred to as Aurecon) as the lead consultant to provide advisory services that will encompass the project development cycle, including the necessary Environmental and Social Impact Assessments for the proposed BOSA Transmission Interconnection Project. Aurecon has appointed Chris van Rooyen Consulting to compile this specialist avifaunal assessment report that details the sensitive bird habitats within the study area and the potential bird related impacts associated with the proposed power line project.

1.2 Selection of a Preferred Power Line Alternative

Identifying suitable power line route alternatives from one point to another is an essential component of any power line development project. Ideally, the routing for an overhead electricity transmission line should follow a straight line, traverse over flat terrain with no obstacles and avoid sensitive areas or other constraints. Since meeting all these criteria is seldom possible, selecting the best route must aim to minimise the impacts on the environment and people, while accommodating the technical and financial challenges.

During the inception phase, the project team followed a structured, systematic and comprehensive process that would enable the identification of a range of potential route corridors. Several factors that typically influence the selection of potential transmission line routes (i.e. the presence of towns, settlements, other infrastructure, protected areas, waterbodies, land cover, places of interest, contours and environmental and heritage constraints) were considered and used to inform potential route corridors. Nineteen potential sites were identified. Further analysis resulted in five corridors (Figure 1) being selected as the most viable corridors, that were evaluated during a Multi Criteria Decision Making (MCDM) workshop, held on 25 May 2016. The MCDM process prioritised the five corridor options against a set of criteria, considered to have most relevance to the selection of the route corridors based on specialist input. The criteria were grouped into four main categories (i.e. Technical, Environmental, Social and Strategic) and weighted accordingly to ensure that

those criteria considered to be more important in terms of site selection were given more significance in the site selection process.

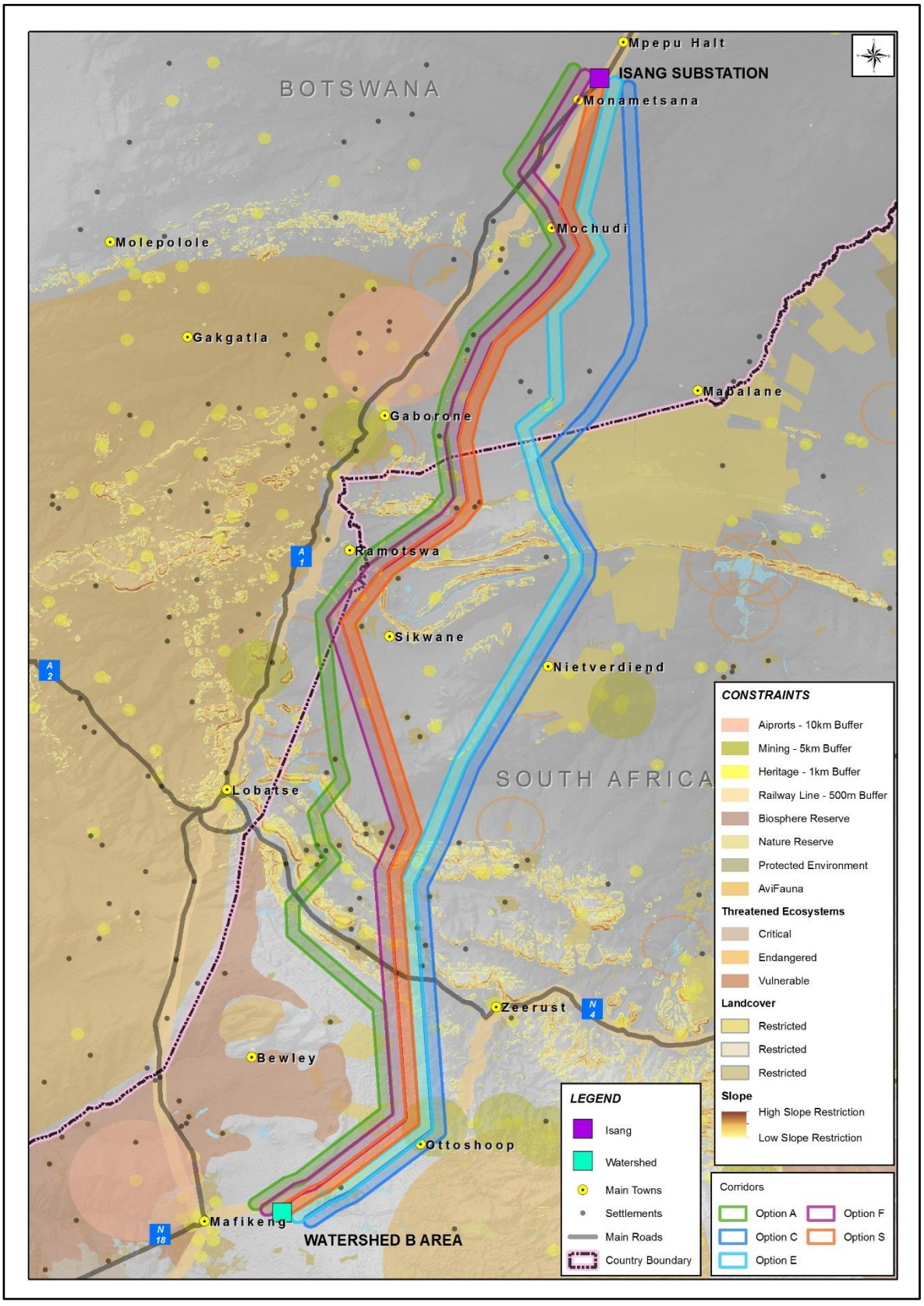

Figure 1. Regional map detailing the location of the five corridor options evaluated in the MCDM process (Aurecon, 2016)

One of the main considerations for high voltage lines is possible bird collision impact with the overhead conductors and earth wires. Breeding, roosting and feeding areas and migration routes all influence where high avifaunal activity is likely to occur and which areas will be most sensitive in terms of avifauna. An avian sensitivity map was compiled prior to the MCDM workshop detailing 1) no-go areas which should be avoided i.e. vulture colonies, nest locations, Important Bird Areas, vulture restaurants and water bodies and 2) areas of high sensitivity which should be avoided if possible i.e. protected areas and high vulture flight activity. These areas are delineated in Figure 1, in addition to other environmental, technical and social constraints. During the MCDM workshop, the following areas of high avifaunal activity were considered when ranking the corridor options in their order of preference (Table 1):

- Proximity to vulture breeding areas
- Proximity to Important Bird Areas (IBAs)
- Proximity to dams (avifaunal focal points)
- Proximity to vulture restaurants (avifaunal focal points)
- Proximity to protected areas

Table 1: Preference ratings per category and criterion 1=most favoured and 5=least favoured (Aurecon, 2016)

Category	Criteria	A	C	E	F	S
Technical (Inc. Financial)	Te1. Slope	3	1	1	2	2
	Te2. Access	3	1	1	2	2
	Te3. Length	5	1	2	4	3
	Te4. Width	1	2	2	3	3
Environmental	En1. Biodiversity	4	2	1	3	3
	En3. Avifauna	3	1	1	2	2
Social	So1. Heritage	5	4	1	3	2
	So2. Compensation	5	1	2	4	3
	So3. Social	5	1	2	4	3
	So4. Visual	5	1	2	4	3
Strategic	St1. Proximity	2	1	1	2	2

Based on the evaluation of each of the abovementioned criteria, the resultant combined relative priority score and the preference ranking assigned to each of the five corridor options, corridor Option C emerged as the preferred alternative for more detailed assessment.

2 BRIEF

The terms of reference for this assessment report are as follows:

- Describe the affected environment and avifauna in the broader area, with a particular focus on regionally and globally Red Listed species.

- Identify and discuss potential impacts of the proposed project on regionally and globally Red Listed avifauna during construction and operation.
- Identify information gaps and limitations.
- Discuss and assess the potential impacts of the proposed powerline on birds.
- Suggest mitigation measures to reduce the potential impacts, and
- Identify actions to be included in the construction and operational Environmental Management Plans.

3 STUDY APPROACH

3.1 Sources of information

3.1.1 South Africa

- Bird distribution data of the South African Bird Atlas 2 (SABAP2) was obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occur within the broader area i.e. within a block consisting of 76 pentad grid cells within which the corridor is situated. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. Between 2007 and 2017, a total of 467 full protocol cards (i.e. 467 bird surveys lasting a minimum of two hours each) have been completed for this area;
- The Southern African Bird Atlas 1 (SABAP1) (Harrison *et al.* 1997) was used as a supplementary source of information in that it provided information on the historical occurrence of birds in the study area;
- The Important Bird Areas project data was consulted to get an overview of important bird areas (IBAs) and species diversity in the South African portion of the study area (Marnewick *et al*. 2015 and Barnes, 1998);
- The Co-ordinated Waterbird Count (CWAC) data was consulted determine if large concentrations of water birds, associated with South African waterbodies, occur within the study area (http://cwac.adu.org.za/).
- The conservation status of all species considered to occur in the area was determined as per the most recent iteration of the 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al*. 2015) and the IUCN Red List of Threatened Species V7.1 (http://www.iucnredlist.org/) and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Vulture movement data for the area was requested from VULPRO, dated 2013 to 2016;
- The power line bird mortality incident database of the Endangered Wildlife Trust (1996 to 2007) was consulted to determine which of the species are typically impacted upon by power lines in a southern African context (Jenkins *et al.* 2010);
- Data on vegetation types in the study area was obtained from the Vegetation Map of South Africa (Mucina & Rutherford 2006);
- Google Earth ©2016 satellite imagery was used to examine the micro habitats within the study area;
- Personal observations from working in the North-West Province on various powerline projects since 1996, have also been used in forming a professional opinion of likely bird/habitat associations;
- Maps and shapefiles detailing the location of the proposed power line corridor were obtained from Aurecon.
- Information on the bird habitats in the study area was collected during a field investigation on 26 and 27 July 2017.
- Detailed aerial imagery of a LiDAR aerial survey for a 2km corridor along the entire route was obtained from Aurecon.

3.1.2 Botswana

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occur within the broader area i.e. within a block consisting of 27 pentad grid cells within which the study area is situated. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. Between 2007 and 2015, a total of 306 full protocol cards (i.e. 306 bird surveys lasting a minimum of two hours each) have been completed for the study area and its immediate surrounds;
- The Southern African Bird Atlas 1 (SABAP1) (Harrison *et al.* 1997) was used as a supplementary source of information in that it provided information on the historical occurrence of birds in the study area;
- Bird Atlas of Botswana (Penry, 1994) and was consulted as a supplementary source of information in that it provided information on the historical occurrence of birds in the study area;
- Birds in the Gaborone Area (Tyler & Borello, 1998) was consulted on the avifaunal habitats and avifaunal habitat usage in the broader area.
- The BirdLife International (2017) Country profile: Botswana was consulted for information on Important Bird Areas in the Botswana portion of the study area.
- The draft Red Data List of Birds in Botswana, compiled by the Botswana Bird Club (Tyler & Borello 2000) was used to determine the regional conservation status of birds in Botswana;
- Vulture movement data for the area was requested from VULPRO, dated 2013 to 2016;
- The power line bird mortality incident database of the Endangered Wildlife Trust (1996 to 2007) was consulted to determine which of the species are typically impacted upon by power lines in a southern African context (Jenkins *et al*. 2010);
- Data on vegetation types in the study area was obtained from the Provisional Vegetation Map of Botswana (Weare & Yalala, 2009);
- Google Earth ©2016 imagery was used to examine the micro habitats within the study area;
- Personal observations from working in Botswana on various powerline projects since 1996, have also been used in forming a professional opinion of likely bird/habitat associations;
- Maps and shapefiles detailing the location of the proposed power line corridor option C were obtained from Aurecon.
- Information on the bird habitats along the proposed corridor was collected during a field investigation on 26 and 27 July 2017.
- Detailed aerial imagery of a LiDAR aerial survey for a 2km corridor along the entire route was obtained from Aurecon.

3.2 Methods

3.2.1 South Africa

- The study area was defined as a 2km buffer around the proposed corridor (Figure 2). The broader area refers to an area of approximately 25km on both sides of the proposed corridor.
- The various data sources listed above were examined at a desktop level to identify avifauna that may be vulnerable to the impacts associated with the proposed power line development, with particular focus on regionally and globally Red Listed species.
- Bird habitat classes were identified using various GIS (Geographic Information System) layers, LiDAR aerial imagery, Google Earth ©2016 imagery, and field observations.

- The impacts of the proposed development on birds were predicted on the basis of experience in gathering and analysing data on avian impacts with various forms of linear infrastructure and developments in southern Africa since 1996.

3.2.2 Botswana

- The study area was defined as a 2km buffer around the proposed corridor (Figure 2). The broader area refers to an area of approximately 25km on both sides of the proposed corridor.
- The various data sources listed above were collected and examined at a desktop level to identify avifauna that may be vulnerable to the impacts associated with the proposed power line development, with particular focus on regionally and globally Red Listed species.
- Bird habitat classes were identified using various GIS (Geographic Information System) layers, LiDAR aerial imagery, Google Earth ©2016 imagery, and field observations.
- The impacts of the proposed development on birds were predicted on the basis of experience in gathering and analysing data on avian impacts with various forms of linear infrastructure and developments in southern Africa since 1996.

3.3 Assumptions & limitations

3.3.1 South Africa

- The coverage by SABAP2 varies greatly, with grid cell coverage ranging from 0 to 134 cards, with an average of 6.14 cards per grid cell in the broader area. Strong reliance was therefore placed on expert opinion, supplemented by the other data sources listed above, to identify the avifauna which occur in the study area. The authors have drawn extensively on experience gained in avifaunal impact assessments in various parts of southern Africa since 1996, including the North-West Province.
- Predictions in this study are based on more than 20 years of experience gained in working in the field of birds and powerline interactions in southern Africa. However, bird behaviour can never be predicted with absolute accuracy. It should be noted though, that the impact of power lines on birds has been well researched with a robust body of published research stretching over thirty years.
- Potential future changes in habitat and land use were not considered in the assessment. However, it was assumed that it is not likely to change significantly in the foreseeable future.

3.3.2 Botswana

- The coverage by SABAP2 varies greatly, with grid cell coverage ranging from 0 to 134 cards, with an average of 11.33 cards per grid cell in the broader area. Strong reliance was therefore placed on expert opinion, supplemented by the other data sources listed above, to identify the avifauna which occur in the study area. The authors have drawn extensively on experience gained in avifaunal impact assessments in various parts of southern Africa since 1996, including Botswana.
- Predictions in this study are based on more than 20 years of experience gained in working in the field of birds and powerline interactions in southern Africa. However, bird behaviour can never be predicted with absolute accuracy. It should be noted though, that the impact of power lines on birds has been well researched with a robust body of published research stretching over thirty years.
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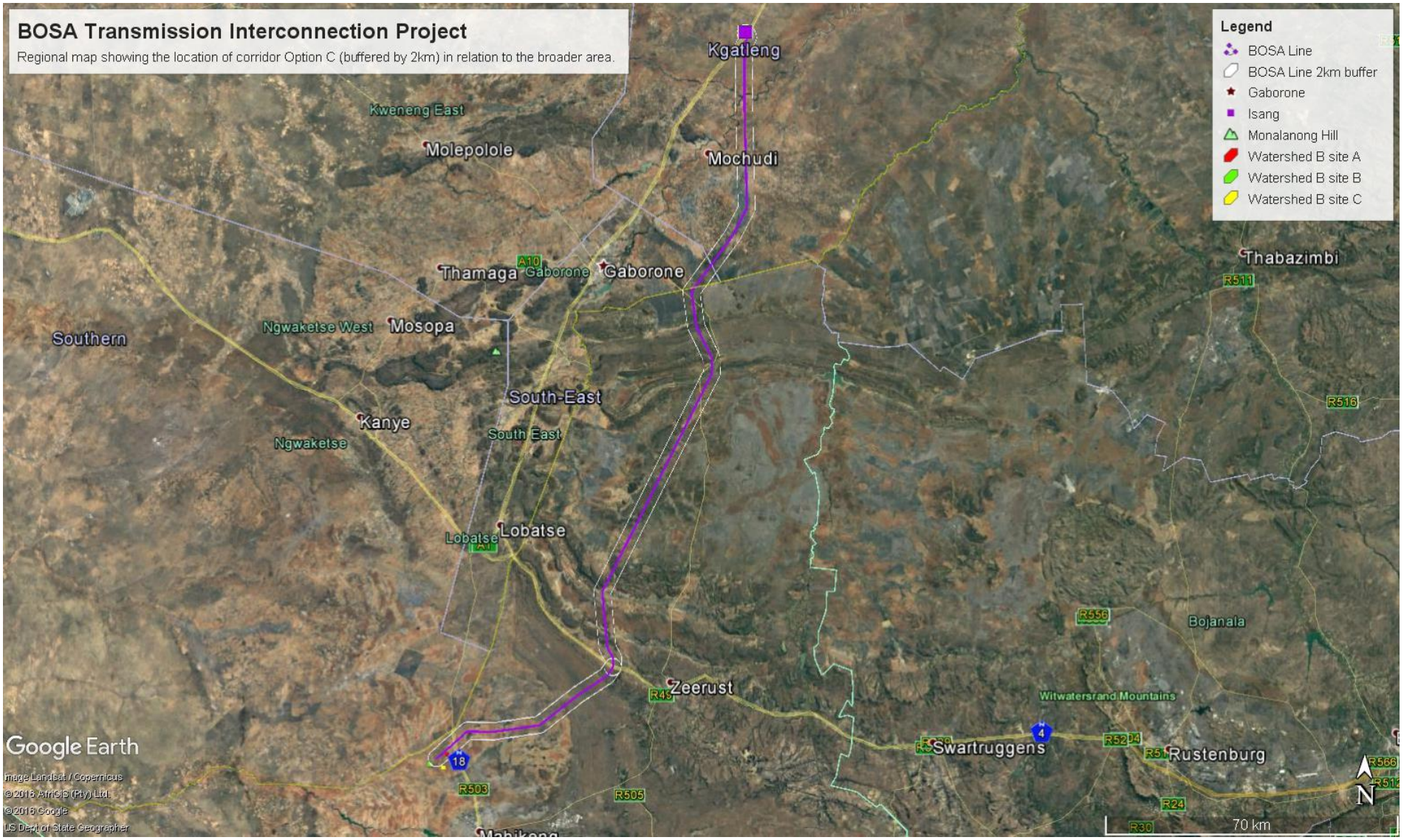

Figure 2: Regional map showing the location of corridor Option C (buffered by 2km) in relation to the broader area.
Proposed BOSA 400kV power line corridor Option C = purple line
2km Buffer = white polygon

4 STUDY AREA

4.1 Important Bird Areas (IBAs)

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

4.1.1 South Africa

The proposed BOSA 400kV power line does not traverse an IBA. However, one IBA does occur within the broader area i.e. the Botsalano Nature Reserve (SA024).

Botsalano Nature Reserve is located approximately 40km north of central Mahikeng, near the border with Botswana and is the closest IBA to the proposed power line (approximately 15km). Habitat within the reserve consists of elements of both the Grassland and the Savanna biomes and consequently support both grassland and woodland dependent bird species. The area is of particular interest from an ornithological point of view as it is one of very few reserves in South Africa that holds the western population of the Short-clawed Lark *Certhilauda chuana*. It is also one of the few reserves in which Melodious Lark *Mirafra cheniana* can be found. The open grassland flats are also known to periodically support Yellow-throated Sandgrouse *Pterocles gutturalis*. The surrounding woodland–grassland mosaic is known to hold Secretarybird *Sagittarius serpentarius*, Kori Bustard *Ardeotis kori* and a diversity of small woodland passerines e.g. Monotonous Lark *Mirafra passerina*, Pied Babbler *Turdoides bicolor*, White-throated Robin-chat *Cossypha humeralis*, Kalahari Scrub Robin *Erythropygia paena*, Burnt-necked Eremomela *Eremomela usticollis*, Barred Wren-Warbler *Calamonastes fasciolatus*, Marico Flycatcher *Melaenornis mariquensis*, Crimson-breasted Shrike *Laniarius atrococcineus*, Southern White-crowned Shrike *Eurocephalus anguitimens*, Burchell's Starling *Lamprotornis australis*, Scaly-feathered Finch *Sporopipes squamifrons*, Violet-eared Waxbill *Uraeginthus granatinus*, Black-faced Waxbill *Estrilda erythronotos*, Shaft-tailed Whydah *Vidua regia*. Dusky Lark *Pinarocorys nigricans* and Tinkling Cisticola *Cisticola rufilatus*. The reserve's proximity to Botswana, with its extensive rural landscape management, means that a number of globally threatened species regularly occur within the reserve i.e. Lappet-faced Vulture *Torgos tracheliotus* (five active nests were spotted during the aerial count in mid-August 2014), breeding White-backed Vulture *Gyps africanus,* as well as Cape Vulture *Gyps coprotheres*. Raptors feature prominently, with Martial Eagle *Polemaetus bellicosus*, Bateleur *Terathopius ecaudatus*, Tawny Eagle *Aquila rapax*, Wahlberg's Eagle *Aquila wahlbergi*, African Hawk Eagle *Aquila spilogaster*, Brown Snake Eagle *Circaetus cinereus*, Black-chested Snake Eagle *Circaetus pectoralis* and Lanner Falcon *Falco biarmicus* all occurring in good numbers (Marnewick *et al.* 2015).

4.1.2 Botswana

There are no IBAs located within the study area. However, four IBAs do occur within the broader area i.e. Mannyelanong Hill (BW007), southeast Botswana (BW011), Phakalane sewage lagoons, near Gaborone (BW010) and Bokaa Dam (BW009).

Mannyelanong Hill (BW007) is situated approximately 25km from the proposed corridor at its closest point, and lies south-east of the village of Otse in the hardveld of south-east Botswana, with its undulating plains and scattered rocky hill ranges. The cliff and its lower wooded slope is fenced off to serve as a sanctuary for the important nesting population of Cape Vulture, one of only two localities currently used by this species in Botswana. Despite significant declines (45%) in breeding population numbers between 1963 and 1982, the following decade saw this population stabilise at around 50 pairs breeding per season. The current population consists of about 70 breeding pairs, and is now one of Botswana's largest vulture colonies. One pair of Black Stork *Ciconia nigra* nests on the cliffs; the nest-site has been used in most seasons since 1941. Verreaux's Eagle *Aquila verreauxi* also breeds on the Mannyelanong cliffs, together with Lanner Falcon and Rock Kestrel *Falco rupicolus* (BirdLife International, 2017a).

The South-east Botswana (BW011) is situated about 25km from the proposed corridor at its closest point, and consist of an extensive 750 000ha area that is comprised of Pitsane grasslands as well as mixed savanna, low rolling hills and farmland. This IBA was established on the occurrence of an important population of the restricted-range Short-clawed Lark *Certhilauda chuana*, which is prevalent and locally abundant in the area (approximately 70% of the Botswanan population, comprising 8,000–10,000 birds). In addition, Blue Crane *Anthropoides paradisea* are regularly seen at or near Kgoro Pan and may breed nearby, whilst Lesser Kestrel *Falco naumanni* and Pallid Harrier *Circus macrourus* frequently hunt over the grasslands in the austral summer. Cape Vultures from the breeding colony at Mannyelanong Hill, Kori Bustard, Secretarybird and Black Stork all forage over this area. The site also supports a number of species which occur in Botswana only, or mainly, in this south-east corner; these include Orange River Francolin *Francolinus levaillantoides*, White-bellied Korhaan *Eupodotis cafra* (two records only), Cape Longclaw *Macronyx capensis* and Long-tailed Widowbird *Euplectes progne*. There are a few records of Burchell's Courser *Cursorius rufus*, now rare in Botswana. A wide range of species restricted to the Kalahari–Highveld biome occur, including Sociable Weaver *Philetairus socius* which breeds, other than in the Kalahari in south-west Botswana, only in an isolated population in the Pitsane grasslands. The Palearctic migrant Olivetree Warbler *Hippolais olivetorum* is not uncommon throughout much of the site (BirdLife International 2017b).

The aforementioned IBAs are located within close proximity to the study area, particularly for wide ranging species like vultures. Although the proposed BOSA 400kV power line will not have any direct impact on the IBAs and the species they support in terms displacement through habitat transformation and/or disturbance, species that may engage in nomadic movements (i.e. Kori Bustard and Secretarybird) and vultures that are likely to forage within the study area and in close proximity to the proposed power line, may be susceptible to the collision impact. In a recent publication, Cape Vulture movement patterns and core foraging ranges were found to be closely associated with the spatial distribution of transmission power lines (Figure 3) and that the construction of power lines may contribute to the range expansion of the species to areas that lack suitable perching substrates (Phipps *et al.* 2013). The vultures' ability to traverse vast distances and the high proportion of time they spend foraging outside protected areas and particularly in the vicinity of power lines makes them especially vulnerable to negative interactions with the expanding power line network across the region. VULPRO, a South African NGO dedicated to the conservation of vultures, regularly deploys tracking devices on vultures to ascertain the foraging ranges of the species. Tracking data from five Cape Vultures over the period 2012 to 2016 confirms that they regularly forage and roost in the study area, both in South Africa and Botswana (Figure 4).

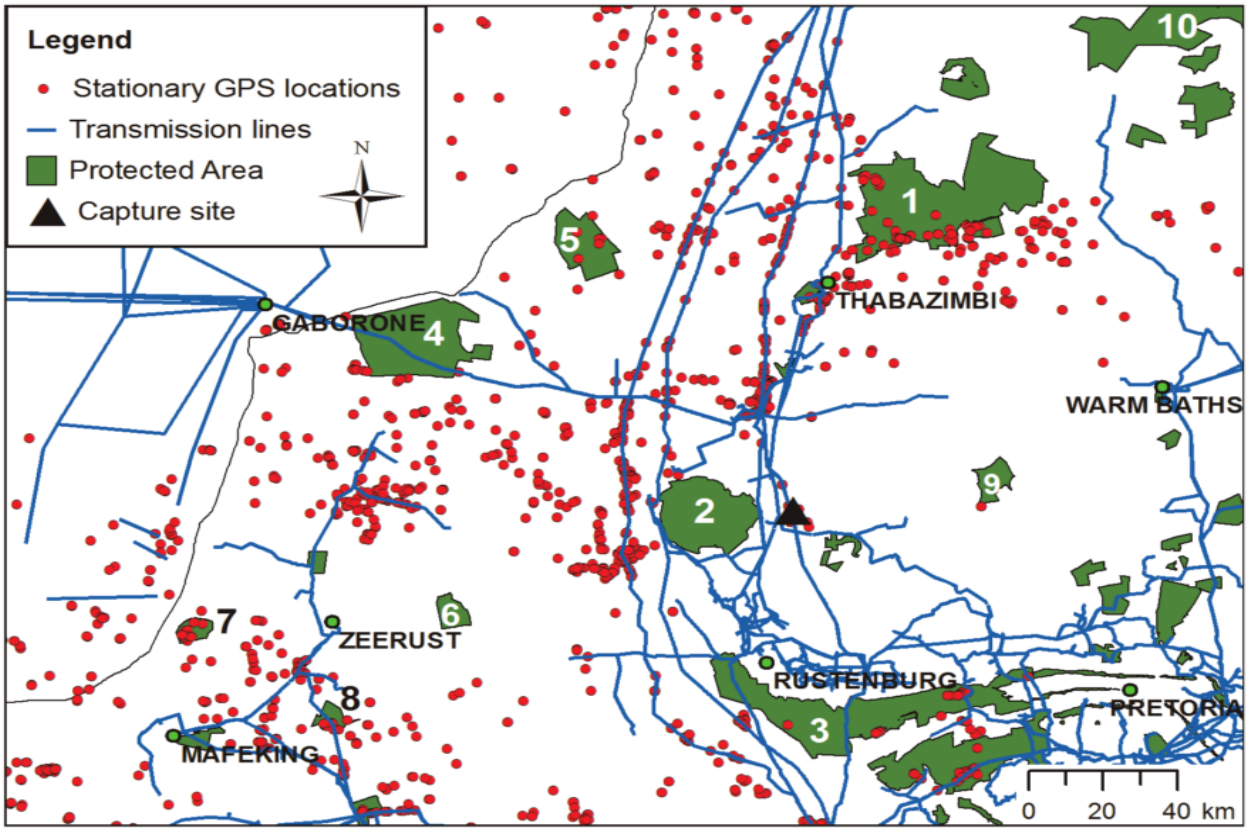

Figure 3. Stationary GPS locations of satellite tracked Cape Vultures in relation to protected areas and transmission power lines in the northern provinces of South Africa (Phipps *et al*, 2013).

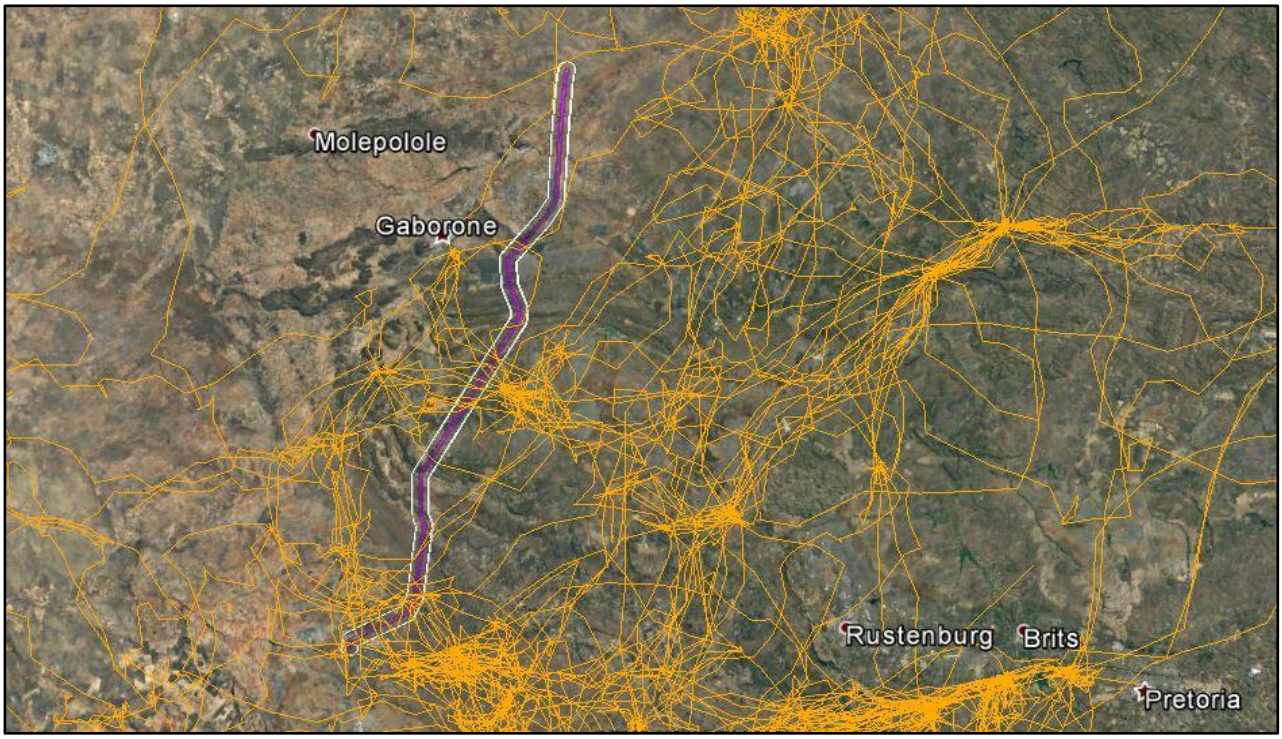

Figure 4. Flight activity of five Cape Vultures tracked with satellite devices between 2012 and 2016.
Vulture flight activity = orange lines
Proposed BOSA 400kV power line corridor Option C = purple line
2km Buffer = white polygon

Phakalane sewage lagoons, near Gaborone (BW010), is situated about 20km from the proposed corridor and coniststs of four large sewage-treatment lagoons, operational since late 1990, approximately 15 km north of Gaborone, close to the dormitory village of Phakalane. The lagoons are roughly rectangular (totalling 70 ha of water), generally steep-sided, and edged by high bunds. There are some exposed muddy edges, small areas of sand and gravel, several very small islands and remnants of dead and dying trees in one lagoon. There is marginal vegetation of *Typha*, *Phragmites* and scattered small trees and bushes. The site lies adjacent to the Ngotwane river, a small tributary of the Limpopo, into which the final effluent discharges. Riparian vegetation along this section of the Ngotwane is dominated by *Combretum* and there are some open areas of wet grassland and *Juncus*. Upriver in and south of Gaborone there are a series of artificial wetlands along the Ngotwane river. These are interlinked in that all are used by waterfowl which frequently move from one dam or sewage pond to another. These wetlands include Mogobane Dam, Ngotwane Dam, the large Gaborone Dam completed in 1964/65 and covering 19 km², various sewage ponds in Gaborone, notably Ngotwane, Maru-a-Pula and Tsholofelo, and associated wetlands such as the Typha swamp in Gaborone Game Reserve. Phakalane sewage ponds are the most important in this chain of wetlands.

Phakalane lagoons support a wide diversity of visiting waders, wildfowl and other waterbirds, including globally Red Listed Greater Flamingo *Phoenicopterus roseus* and Lesser Flamingo *Phoenicopterus roseus*. Although the total numbers are not exceptionally high, July 1994 saw nearly 1,600 waterbirds of 35 species and January 1995 over 3,000 birds of 36 species. Of particular note are the high numbers of the globally Red Listed Maccoa Duck *Oxyura maccoa*, particularly in the winter (usually 100–200, but with a maximum of 440 recorded in July 1993). There are also regularly high numbers of non-Red Listed Southern Pochard *Netta erythrophthalma*. Small numbers of duck breed in the lagoons whilst waterbirds, notably African Sacred Ibis *Threskiornis aethiopicus* and Cattle Egret *Bubulcus ibis*, roost on dead trees. In the early years herons and egrets bred in the dead trees in the lagoons but the heronries have largely disappeared as these trees have died and fallen. The *Typha* stands support large numbers of *Acrocephalus* warblers. A roost of more than 50,000 Barn Swallow *Hirundo rustica* occurs at Gaborone Dam, some birds also roosting at Phakalane (BirdLife International 2017c).

Bokaa Dam (BW009) is situated about 20km from the proposed corridor at its closest point. Bokaa Dam is a reservoir constructed during 1990 and 1991 by damming a tributary of the Ngotwane river just south of the village of Bokaa, less than 20 km north of Gaborone. The body of open water stretches for some 6km or more and is over 500m wide at its maximum; it has a north-west side-arm where the Kopong tributary joins the watercourse formed by the Metsemotinaba, Gakgatia and Gamoleele and other tributaries. The dam is surrounded by *Vachellia* savanna, which is used for grazing by many sheep, goats, donkeys and cattle, and away from the reservoir there are some cultivated areas. Some sections of the shore are open bare mud but there are patches of *Cyperus*, *Phragmites* and other emergent aquatic vegetation although this is rather sparse and degraded because of pressure from domestic stock. Although the reservoir has a perimeter fence, this is broken in several places, so stock have access to much of the reservoir edge. The west side of the north-west arm of the reservoir is fringed by taller trees which support a large mixed heronry. Waterfowl counts between 1991 and 1995 reached a maximum of approximately 4 000 birds. The Bokaa Dam is currently (December 2017) dry, but when filled, can on occasion attract globally Red Listed species such as Maccoa Duck, Greater Flamingo, Lesser Flamingo and the regionally threatened Pink-backed Pelican. Significant numbers of Great Crested Grebe *Podiceps cristatus* and Southern Pochard *Netta erythrophthalma* (BirdLife International 2017d).

It is not envisaged that the proposed 400kV BOSA powerline will impact directly on the avifauna moving between artificial wetlands in the Ngotwane River, as the proposed corridor is situated approximately 20km east of these water bodies. It is however possible that waterfowl move between the Bokaa Dam and the

Molatedi Dam in South Africa, which is 50km further west, which would take them directly across the proposed 400kV corridor.

4.2 Coordinated Waterbird Count (CWAC) Data (South Africa only)

A CWAC site is any body of water, other than the oceans, which supports a significant number (set at approximately 500 individual waterbirds, irrespective of the number of species) of birds which use the site for feeding, and/or breeding and roosting (Harrison *et al*. 2004). This definition includes natural pans, vleis, marshes, lakes, rivers, as well as a range of manmade impoundments (i.e. sewage works). The presence of a CWAC site within the study area is an indication of a large number of bird species occurring there and the overall sensitivity of the area.

There are no CWAC sites within the broader area. The closest sites are Leeupan and Barberspan which are approximately 75km south of the study area. Although these sites constitute one of the largest water fowl sanctuaries in Southern Africa, that can at times support up to 20 000 waterfowl (Marnewick *et al*. 2015), the distance between these sites and the proposed 400kV line precludes any impact on the avifauna at these sites.

4.3 Description of bird habitat classes

The study area extends over two primary vegetation divisions, namely the Savanna and Grassland biomes in addition to small pockets of Azonal vegetation in the form of Highveld Salt Pans (Mucina & Rutherford 2006). It is generally accepted that vegetation structure, rather than the actual plant species, influences bird species distribution and abundance (Harrison *et al.* 1997). From an avifaunal perspective, the Atlas of southern African Birds (SABAP1) recognises six primary vegetation divisions or biomes within southern Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). These vegetation descriptions do not focus on lists of plant species, but rather on factors which are relevant to bird distribution.

The following bird habitat classes were identified within the study area. Habitat descriptions are based largely on the available vegetation maps as well as, those habitats identified using high resolution Google Earth ©2016 imagery, LiDAR aerial imagery and information collected during the field trip. See Appendix 1 for a photographic record of various habitat classes.

4.3.1 Woodland

4.3.1.1 South Africa

The greatest proportion of the study area is situated in the Savanna biome which is characterised by a grassy under-storey and a distinct woody upper-storey of trees and tall shrubs (Harrison *et al.* 1997). Natural woodland occurring in the study area consists of the following vegetation units, namely Dwaalboom Thornveld, Zeerust Thornveld, Dwarsberg-Swartruggens Mountain Bushveld and Madikwe Dolomite Bushveld.

The floristic and structural attributes of Dwaalboom Thornveld is fairly homogenous and consists of low to medium high microphyllous bushveld that is dominated by taxa of the genus *Vachellia*. The herbaceous layer is dominated by graminoid taxa as opposed to forb species. The Zeerust Thornveld woodland type is characterised as a deciduous, open to dense short thorny woodland, dominated by *Vachellia* species with

herbaceous layer of mainly grasses on deep, high base-status and some clay soils on plains and lowlands. The Dwarsberg-Swartruggens Mountain Bushveld is comprised of a highly variable vegetation structure that is differentiated by diverse tree and shrub layers. Similarly, this vegetation unit is also dominated by *Vachellia* species. In some places, the woody layer may occur as bush clumps and the grass layer is generally very dense with a great variety of grass species. Madikwe Dolomite Bushveld has tree and shrub layers that are often not clearly distinct, especially on steeper slopes. They are dominated by deciduous trees, particularly *Combretum apiculatum* and *Kirkia wilmsii* with a continuous herbaceous layer, dominated by grasses. These vegetation units are not considered threatened, with only small percentages having been transformed by cultivation, urbanisation, spread of alien species and bush encroachment due to overgrazing by cattle.

Woodland supports a large variety of bird species (it is the most species-rich community in southern Africa) but very few bird species are restricted to this biome. Woodland is particularly rich in raptors, and SA Red Listed species which could be encountered in woodland in the broader area are Bateleur, Martial Eagle, Tawny Eagle, Lanner Falcon, Red-footed Falcon *Falco vespertinus*, Lappet-faced Vulture and African White-backed Vulture *Gyps africanus*. The woodland also supports many non-Red Listed raptor species, such as the Booted Eagle *Aquila pennatus*, Wahlberg's Eagle *Aquila wahlbergi*, Lesser Spotted Eagle *Aquila pomarina*, Steppe Eagle *Aquila nipalensis,* Brown Snake-Eagle, Black-chested Snake-Eagle and a multitude of medium-sized raptors, for example the migratory Steppe Buzzard *Buteo vulpinus*, Lizzard Buzzard *Kaupifalco monogrammicus*, African Harrier Hawk (Gymnogene) *Polyboroides typus,* Gabar Goshawk *Melierax gabar*, Shikra *Accipiter badius*, African Hawk-Eagle *Aquila spilogaster*, European Honey-Buzzard *Pernis apivorus,* Southern Pale Chanting Goshawk *Melierax canorus*, Pearl-spotted Owlet *Glaucidium perlatum,* Verreaux's Eagle-Owl *Bubo lacteus* and Spotted Eagle-Owl *Bubo africanus*. Apart from Red Listed raptors, the open areas within the woodland in the broader area could attract several other power line sensitive Red Listed species, i.e. Kori Bustard, Southern Ground Hornbill *Bucorvus leadbeateri*, White-bellied Korhaan, Short-clawed Lark, European Roller *Coracias garrulus*, Secretarybird and Abdim's Stork *Ciconia abdimii.*

4.3.1.3 Botswana

The entire study area in Botswana is located in the Savanna biome. The woodland consists of Tree Savanna comprised of mixed *Vachellia sp*. and *Combretum apiculatum* woodland. Globally Red Listed species which could be encountered in woodland in the broader area are Bateleur, Martial Eagle, Tawny Eagle, Lanner Falcon, Red-footed Falcon, Lappet-faced Vulture and African White-backed Vulture. Several non-Red Listed raptor species could also potentially occur such as the Booted Eagle, Wahlberg's Eagle, Lesser Spotted Eagle, Steppe Eagle, Brown Snake-Eagle, Black-chested Snake-Eagle and a multitude of medium-sized raptors, for example the migratory Steppe Buzzard, Southern Pale Chanting Goshawk, Lizzard Buzzard, African Harrier Hawk (Gymnogene), Gabar Goshawk, Shikra, African Hawk-Eagle, Red-footed Falcon, Verreaux's Eagle-Owl, Spotted Eagle-Owl and Pearl-spotted Owlet. Apart from raptors, open areas within the woodland could also attract other power line sensitive globally Red Listed species, i.e. Kori Bustard, Southern Ground Hornbill, Short-clawed Lark, European Roller and Secretarybird.

4.3.2 Grassland

4.3.2.1 South Africa

A smaller proportion of the study area is situated in the Grassland biome and consists predominantly of the Carltonville Dolomite Grassland and Klerksdorp Thornveld vegetation types (Mucina & Rutherford 2006). The

Carltonville Dolomite Grassland is a species-rich mosaic of plant community types occurring on undulating plains dissected by hard and compact sedimentary rock ridges. It is characterized by the presence of the following species, *Aristida congesta, Brachiaria serrata, Cynodon dactylon, Digitaria tricholaenoides, Diheteropogon amplectens, Eragrostis chloromelas, Eragrostis racemosa, Heteropogon contortus, Loudetia simplex, Schizachyrium sanguineum, Setaria sphacelata, Themeda triandra,* and a wide variety of herbaceous forbs and other grasses. Klerksdorp Thornveld occurs in two regions, the first in the Wolmaransstad, Ottosdal and Hartebeestfontein region and the other from the Botsolano Game Park north of Mafikeng to the vicinity of Madibogo in the south. Mucina & Rutherford describe the vegetation type as consisting of plains or slightly undulating plains with open to dense *Vachellia karoo* bush clumps in dry grassland. Fairly significant proportions of these vegetation types have been transformed, mostly by cultivation and urbanisation.

Grasslands represent a significant foraging area for many bird species. Specifically, open grassland in the broader area could attract the SA Red Listed Lanner Falcon, Red-footed Falcon, White-bellied Korhaan, Black-winged Pratincole *Glareola nordmanni*, European Roller, Yellow-throated Sandgrouse, Secretarybird and Abdim's Stork, the majority of which are power line sensitive species. The grassland patches are also a favourite foraging area for game birds such as francolins and Helmeted Guineafowl *Numida meleagris.* This in turn attracts large raptors e.g. Martial Eagle, because of both the presence and accessibility of prey.

4.3.2.2 Botswana

The Grassland biome does not extend into the Botswana portion of the study area.

4.3.3 Rivers

4.3.3.1 South Africa

The main river system in the broader area is the Marico River, with several tributaries including the Brakfonteinspruit, Kgolane, Pitsedisulejang, Tholwane, Springboklaagte, Lethlakane, Klein-Marico and many associated unnamed ephemeral drainage lines. The proposed corridor does not actually cross any of these rivers, but it does cross some ephemeral drainage lines. Rivers and drainage lines are important habitat for birds in that they act as corridors of microhabitat for waterbirds, while the riparian vegetation on the banks provide potential cover for skulking non-Red Listed species such as Black Crake *Amaurornis flavirostris* and Striated Heron *Butorides striata*. Ephemeral rivers and drainage lines generally only flow for short periods in the rainy season, but pools of water can persist for many months and aquatic organisms that are trapped in those pools could provide potential sources of food for various species. Relevant to this study and the rivers, drainage lines and surrounding riparian habitat could attract SA Red Listed species such as Black Stork*,* Yellow-billed Stork *Mycteria ibis*, Marabou Stork *Leptoptilos crumeniferus*, Half-collared Kingfisher *Alcedo semitorquata*, as well as many other non-Red Listed waterbirds including Reed Cormorant *Phalacrocorax africanus*, White-breasted Cormorant *Phalacrocorax crbo*, African Darter *Anhinga rufa*, African Black Duck *Anas sparsa*, Comb Duck *Sarkidiornis melanotos*, White-faced Duck *Dendrocygna viduata*, African Fish-Eagle *Haliaeetus vocifer*, Egyptian Goose *Alopochen aegyptiacus*, Spur-winged Goose *Plectropterus gambensis*, several heron, egret, ibis and stork species, African Openbill *Anastomus lamelligerus*, and African Spoonbill *Platalea alba*.

4.3.3.2 Botswana

The main river system is the Ngotwane River, with tributaries Dikolakolane, Metsemothlaba, Taung and several unnamed, associated ephemeral drainage lines. The proposed corridor crosses the Ngotwane River near Isang. Rivers and drainage lines are important habitat for birds in that they act as corridors of microhabitat for waterbirds, while the riparian vegetation on the banks provide potential cover for skulking species such as Black Crake and Striated Heron. Ephemeral rivers and drainage lines generally only flow for short periods in the rainy season, but pools of water can persist for many months and aquatic organisms that are trapped in those pools could provide potential sources of food for various species. Relevant to this study, the rivers, drainage lines and surrounding riparian habitat could on occasion attract species such as Black Stork, Yellow-billed Stork, Marabou, Reed Cormorant, White-breasted Cormorant, African Darter, African Black Duck, Comb Duck, White-faced Duck, African Fish-Eagle, Egyptian Goose, Spur-winged Goose, African Openbill, African Spoonbill and heron, egret, and ibis species. None of these species are currently globally Red Listed.

4.3.4 Wetlands and dams

4.3.4.1 South Africa

Wetlands are characterized by slow flowing seasonal water (or permanently wet) and tall emergent vegetation (rooted or floating) and provide habitat for many water birds. The precarious conservation status of many of the bird species that are dependent on wetlands reflects the critical status of wetlands worldwide, with many having already been destroyed. There are several localized wetlands occurring in the broader area, especially in the southern grassland section which are likely to represent attractive roosting and foraging areas for certain species year-round – not only after rainfall. Of the SA Red Listed species found within the broader area, Pallid Harrier *Circus macrourus,* Greater Painted-snipe *Rostratula benghalensis*, Yellow-billed Stork and Marabou Stork could potentially use these wetlands.

Many thousands of earthen and other dams exist in the southern African landscape. The broader area contains many dams, including some large ones e.g. the Molatedi Dam, Marico Bosveld Dam, Lehujwane Dam and the Kromellenboog Dam. Whilst dams have altered flow patterns of streams and rivers, and affected many bird species detrimentally, a number of species have benefited from their construction. The construction of these dams has probably resulted in a range expansion for many water bird species that were formerly restricted to areas of higher rainfall. Man-made impoundments, although artificial in nature, can be very important for variety of birds, particularly water birds. Apart from the water quality, the structure of the dam, and specifically the margins and the associated shoreline and vegetation, plays a big role in determining the species that will be attracted to the dam. Common species in the broader area that could use dams and dam edges (including sewage ponds) include Reed Cormorant, White-breasted Cormorant, African Darter, African Black Duck, Comb Duck, White-backed Duck, White-faced Duck, Egyptian Goose, Spur-winged Goose, several heron, egret, ibis and stork species, African Openbill, Osprey, African Spoonbill and Red-billed Teal *Anas erythrorhyncha*. SA Red Listed species in the broader area that may be attracted to dams include Lesser Flamingo *Phoenicopterus minor*, Greater Flamingo *Phoenicopterus ruber*, Pink-backed Pelican, Greater Painted-snipe, Black Stork, Marabou Stork and Yellow-billed Stork.

The proposed corridor itself is situated close to one large dam, namely the Lehujwane Dam, and the study area contains several small, localised wetlands.

4.3.4.2 Botswana

The broader area in Botswana is quite arid, but there are seasonal wetlands and pans present, including wetland areas associated with the ephemeral rivers and sewage works. The most important are the Phakalane sewage lagoons, near Gaborone, and the Ngotwane, Maru-a-Pula and Tsholofelo sewage ponds (see the discussion under 4.1).

The broader area also contains the Bokaa Dam, which is situated approximately 26km north-east of central Gaborone (see the discussion under 4.1).

There are no significant dams or wetlands in the study area itself. The proposed corridor itself is >20km away from any of the major dams or wetlands in the greater area. It is however possible that waterfowl move between the Bokaa Dam and the Molatedi Dam in South Africa, which is 50km further west, which would take them directly across the proposed 400kV corridor.

4.3.5 Agricultural clearings and old lands

4.3.5.1 South Africa

The tilling of soil is one of the most drastic and irrevocable transformations brought on the environment. It completely destroys the structure and species composition of the natural vegetation, either temporarily or permanently. However, arable or cultivated land may represent a significant feeding area for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources suddenly accessible to birds and other predators; the crop or pasture plants cultivated are often eaten themselves by birds, or attract insects which are in turn eaten by birds; during the dry season arable lands often represent the only green or attractive food sources in an otherwise dry landscape. The broader area contains extensive agricultural clearings mostly in the form commercial dryland cultivation, irrigated pivots and dryland subsistence cultivation that features prominently in those areas surrounding towns and settlements.

In general, agricultural areas are of lesser importance for the majority of SA Red Listed species recorded in the broader area, compared to the natural habitats (i.e. woodland, rivers and wetlands). The SA Red Listed species recorded in the broader area that are most likely to utilise agricultural lands and clearings are Pallid Harrier, Black-winged Pratincole, Abdim's Stork and Red-footed Falcon. The clearings, including those areas of abandoned old lands, could also be utilised by Kori Bustard, Lanner Falcon and Secretarybird and other large, non-Red Listed power line sensitive species such as White Stork *Ciconia ciconia* and Spur-winged Goose may also use freshly ploughed lands for foraging.

There are a number of agricultural clearings and old lands in the study area, particularly in the south.

4.3.5.2 Botswana

Dryland subsistence cultivation is the dominant form of agricultural activity in the broader area. The agricultural activity is largely centred around villages and towns. These areas have been cleared of trees and bushes to grow crops. Frequently these open areas have weedy forbs replacing grass cover. Ground cover may be sparse or completely absent. Cultivated areas provide diverse habitats: they may be recently ploughed, planted with growing crops or with stubble and weeds after harvesting. Cultivated areas may also contain fallow fields (with thick grass and herb cover after rain and scrubby with growth regeneration). Species such as White Stork

and Abdim's Stork, Capped Wheat-ear and Temminck's Courser are attracted to ploughed fields or bare fallow land, whilst weedy stubble and older fallow land may be used by open grassland species, e.g. the globally Red Listed Secretarybird, the non-Red Listed Northern Black Korhaan and the regionally Red Listed Short-clawed Lark (Tyler & Borello 1998).

Cultivated areas constitute the majority of habitat in the study area.

4.3.6 Mountains

4.3.6.1 South Africa

Topographically, the majority of the broader area is flat to undulating. However, mountainous areas and examples of ridges and rocky outcrops are found within the broader area e.g. the Malope, Barotwe, Mabotsa, Phata ya dipitsana, Sekwakgwe and Mogologadikwe hills in the south, and Rant van Tweedepoort and Abjaterskop in the centre. These are potentially suitable roosting and breeding habitat for the SA Red Listed Lanner Falcon, Verreaux's Eagle and non-Red Listed Peregrine Falcon *Falco peregrinus* and Rock Kestrel.

The study area contains mountainous terrain near the village of Borakalalo, where the corridor crosses between the Mogologadikwe Hills.

4.3.6.2 Botswana

The topography is generally flat but there are several rocky outcrops and hills in the broader area e.g. Kgale Hill, Modipane Koppie and Modipe Hill. The most prominent of these is Modipe Hill, close to the village of Modipane. Species which frequent this rocky habitat are Rock Kestrel, Mocking Chat *Thamnolaea cinnamomeiventris*, Short-toed Rock Thrush *Thamnolaea cinnamomeiventris,* Striped Pipit *Anthus lineiventris,* Verreaux's Eagle and the globally Red Listed Lanner Falcon (Tyler & Borello 1998).

The study area itself contains no rocky outcrops or hills, but it skirts the Modipe Hill to the east.

4.3.7 Exotic/Alien Trees

4.3.7.1 South Africa

Although stands of *Eucalyptus* are strictly speaking invader species, they have become important nesting and roosting substrate for several species of raptors, including SA Red Listed Martial Eagle and Verreaux's Eagle (pers.obs). Amur Falcon *Falco amurensis*, a non-Red Listed Palearctic migrant, will commonly roost in small stands of *Eucalyptus*, in addition, other non-Red Listed species e.g. Black Sparrowhawk *Accipiter melanoleucus*, Ovambo Sparrowhawk *Accipiter ovampensis,* and Little Sparrowhawk *Accipiter minullus* that may also utilise these trees for roosting and breeding purposes. Stands of alien trees are found all over the broader area, often in association with human habitation, and are also present in the study area itself.

4.3.7.2 Botswana

Stands of alien trees, consisting mostly of Eucalyptus, are present in the broader area, and attract species such as Ovambo Sparrowhawk and Black Sparrowhawk for purposes of breeding and roosting (Tyler & Borello 1998). The study area itself contains very few alien trees.

4.3.8 Towns and Settlements

4.3.8.1 South Africa

The broader area in South Africa contains many villages and towns. These areas include surface infrastructure such as roads and buildings. Built-up areas generally are of little value to sensitive SA Red Listed bird species due to their degraded nature and the associated disturbance factor. They do however play an important role in providing safe refuge and foraging opportunities for small passerine species that have become common in urban environments. The SA Red Listed Lanner Falcon could be attracted to poultry in the settlements.

4.3.8.2 Botswana

The broader area in Botswana contains numerous villages, but the study area itself contains no urban areas. Non-Red Listed Speckled Pigeons *Columba guinea*, Rock Martins *Ptyonoprogne fuligula* and Red-winged Starlings *Ptyonoprogne fuligula* may use buildings for nesting and roosting (Tyler & Borello 1998). The built-up areas generally are of little value to globally Red Listed bird species due to their degraded nature and the associated disturbance factor.

4.4 Avifauna occurring in the broader area

This assessment focuses on the impacts on regionally and globally threatened species, as these are the species of highest conservation concern. However, the mitigation measures proposed for the threatened species will also benefit the non-threatened species.

4.4.1 South Africa

It is estimated that a minimum of 385 bird species could occur in the broader area (see Appendix 2). Twenty-nine of these are considered to be of regional conservation concern according to the 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al*. 2015) and fifteen are considered to be of global conservation concern according to the IUCN Red Listed of Threatened Species (2017). For each of these species, the habitat classes where it is most likely to be encountered is indicated in Table 2, as well as the type of impact that could potentially be linked the construction and operation of the BOSA 400kV power line.

Table 2: Red Listed species that could potentially occur in the broader area in South Africa, with potential impacts

Name	Status			Habitat						Potential impact		
	Regional status SA (2015)	Global status (IUCN, 2017)	SABAP2 Av. reporting rate (%) – 76 pentads/467 cards	Woodland	Rivers, Wetlands & Dams	Grassland	Agricultural Lands	Mountains/ Ridges	Exotic tree stands (*Eucalyptus*)	Collisions	Displacement through disturbance	Displacement through habitat destruction
Bateleur *Terathopius ecaudatus*	EN	NT	0.86	x	-	-	-	-	-	x	x	
Bustard, Kori *Ardeotis kori*	NT	NT	9.42	Open woodland	-	-	Old agric. lands	-	-	x	x	-
Duck, Maccoa *Oxyura maccoa*	NT	NT	0.43	-	x	-	-	-	-	x	x	-
Eagle, Martial *Polemaetus bellicosus*	EN	VU	3	x	-	-	-	-	x	x	x	x
Eagle, Tawny *Aquila rapax*	EN	LC	1.5	x	-	-	-	-	-	x	x	x
Eagle, Verreaux's *Aquila verreauxii*	VU	LC	2.36	-	-	-	-	x	x	x	x	x
Falcon, Lanner *Falco biarmicus*	VU	LC	7.28	x	-	x	Old agric. lands and villages	x	-	x	-	-
Falcon, Red-footed *Falco vespertinus*	NT	NT	0.21	Open woodland	-	x	x	-	x	x	-	-
Flamingo, Lesser *Phoenicopterus minor*	NT	NT	0	-	x	-	-	-	-	x	-	-
Flamingo, Greater *Phoenicopterus ruber*	NT	LC	0.86	-	x	-	-	-	-	x	-	-
Ground Hornbill, Southern *Bucorvus leadbeateri*	EN	VU	0.21	x	-	-	-	-	-	x	x	x
Harrier, Pallid *Circus macrourus*	NT	NT	0.64	-	x (wetlands)	x	x	-	-	x	x	-
Kingfisher, Half-collared *Alcedo semitorquata*	NT	LC	0.21	-	x	-	-	-	-	-	x	-
Korhaan, White-bellied *Eupodotis senegalensis*	VU	LC	0	Open woodland	-	x	-	-	-	x	x	-
Lark, Short-clawed *Certhilauda chuana*	NT	LC	7.71	Open woodland	-	-	Old agric. lands	-	-	-	x	-

Name	Status			Habitat						Potential impact		
	Regional status SA (2015)	Global status (IUCN, 2017)	SABAP2 Av. reporting rate (%) – 76 pentads/467 cards	Woodland	Rivers, Wetlands & Dams	Grassland	Agricultural Lands	Mountains/ Ridges	Exotic tree stands (*Eucalyptus*)	Collisions	Displacement through disturbance	Displacement through habitat destruction
Painted-snipe, Greater *Rostratula benghalensis*	VU	LC	0.43	-	x	-	-	-	-	-	x	-
Pelican, Pink-backed *Pelecanus rufescens*	VU	LC	0.21	-	X (dams)	-	-	-	-	x	-	-
Pratincole, Black-winged *Glareola nordmanni*	NT	NT	0.21	-	-	x	x	-	-	x	x	-
Roller, European *Coracias garrulus*	NT	NT	5.57	Open woodland	-	x	-	-	-	-	x	-
Sandgrouse, Yellow-throated *Pterocles gutturalis*	NT	LC	10.06	-	-	x	x	-	-	x	-	-
Secretarybird *Sagittarius serpentarius*	VU	VU	6.21	Open woodland	-	x	Old agric. lands	-	-	x	x	-
Stork, Abdim's *Ciconia abdimii*	NT	LC	0.64	Open woodland	x (pans)	x	x	-	-	x	-	-
Stork, Black *Ciconia nigra*	VU	LC	0.86	-	x	-	-	x	-	x	x	-
Stork, Marabou *Leptoptilos crumeniferus*	NT	LC	3.21	x	x	-	-	-	-	x	x	-
Stork, Yellow-billed *Mycteria ibis*	EN	LC	0.43	-	x	-	-	-	-	x	x	-
Vulture, Cape *Gyps coprotheres*	EN	VU	6.85	Open woodland	-	x (feeding)	-	-	-	x	-	-
Vulture, Lappet-faced *Torgos tracheliotus*	EN	EN	9.21	x	-	x (feeding)	-	-	-	x	x	x
Vulture, White-backed *Gyps africanus*	EN	EN	13.49	x	-	x (feeding)	-	-	-	x	x	x
Lark, Melodious *Mirafra cheniana*	-	NT	1.28	-	-	x	x	-	-	-	-	-

4.4.2 Botswana

It is estimated that a minimum of 360 bird species could occur in the broader area (see Appendix 2). Although there has been an increase in the number of globally threatened birds in Botswana since 2000, generally the status of birds throughout the country is relatively good (Kootsositse *et al*. in press). This increase in species of conservation concern can be attributed to these species being listed as globally threatened, following declines elsewhere in the world and not necessarily a deterioration of the status of birds in Botswana (Hancock, 2008). According to the draft Red Data list of birds of Botswana, five of these species are considered to be of conservation concern, one is regarded as endangered, one is regarded as near-threatened, and three are regarded as threatened and declining (Tyler & Borello 2000). Seven species are regarded as of global conservation concern according to the IUCN Red Listed (2017). For each of these species, the habitat classes where it is most likely to be encountered is indicated in Table 3, as well as the type of impact that could potentially be linked the construction and operation of the BOSA 400kV power line.

Table 3: Red Listed species that could potentially occur in the broader area in Botswana, with potential impacts

Name	Status			Habitat					Potential impact		
	Regional status Botswana (Tyler & Borello 2000)	Global status (IUCN, 2017)	SABAP2 Av. reporting rate (%) 27 pentads/306 cards	Woodland	Rivers, Wetlands & Dams	Agricultural Lands	Ridges	Exotic tree stands (*Eucalyptus*)	Collisions	Displacement through disturbance	Displacement through habitat destruction
Bateleur *Terathopius ecaudatus*	BOC	NT	0.65	x	-	-	-	-	x	x	-
Bustard, Kori *Ardeotis kori*	Threatened or declining	NT	16.67	Open woodland	-	Old agric. lands	-	-	x	x	-
Duck, Maccoa *Oxyura maccoa*	-	NT	1.31	-	x	-	-	-	x	x	-
Eagle, Martial *Polemaetus bellicosus*	BOC	VU	3.92	x	-	x	-	x	x	x	x
Falcon, Red-footed *Falco vespertinus*	-	NT	0.65	Open woodland	-	x	-	x	x	-	-
Flamingo, Lesser *Phoenicopterus minor*	NT	NT	0	-	x	-	-	-	x	-	-
Flamingo, Greater *Phoenicopterus ruber*	Threatened or declining	LC	2.29	-	x	-	-	-	x	-	-
Ground Hornbill, Southern *Bucorvus leadbeateri*	Threatened or declining	VU	0.33	x	-	-	-	-	x	x	x
Harrier, Pallid *Circus macrourus*	-	NT	0.33	-	-	x	-	-	x	-	-
Lark, Short-clawed *Certhilauda chuana*	BOC	LC	1.31	Open woodland	-	-	-	-	-	x	-
Pelican, Pink-backed *Pelecanus rufescens*	BOC	LC	0	-	X (dams)	-	-	-	x	-	-
Pratincole, Black-winged *Glareola nordmanni*	-	NT	1.63	-	-	x	-	-	x	x	-
Roller, European *Coracias garrulus*	-	NT	11.44	Open woodland	-	-	-	-	-	x	-
Secretarybird *Sagittarius serpentarius*	-	VU	1.63	Open woodland	-	Old agric. lands	-	-	x	x	-
Vulture, Cape *Gyps coprotheres*	EN	VU	3.92	Open woodland	-	x (feeding)	-	-	x	-	-

	Status			Habitat					Potential impact		
Name	**Regional status Botswana (Tyler & Borello 2000)**	**Global status (IUCN, 2017)**	**SABAP2 Av. reporting rate 27 pentads/306 cards**	**Woodland**	**Rivers, Wetlands & Dams**	**Agricultural Lands**	**Ridges**	**Exotic tree stands (*Eucalyptus*)**	**Collisions**	**Displacement through disturbance**	**Displacement through habitat destruction**
Vulture, Lappet-faced *Torgos tracheliotus*	BOC	EN	4.9	x	-	x (feeding)	-	-	x	x	x
Vulture, White-backed *Gyps africanus*	-	EN	13.07	x	-	x (feeding)	-	-	x	x	x

5 DESCRIPTION OF EXPECTED IMPACTS

Because of their size and prominence, electrical infrastructure constitutes an important interface between wildlife and man. Negative interactions between wildlife and electricity structures take many forms, but two common problems in southern Africa are electrocution of birds (and other animals) and birds colliding with power lines. (Ledger and Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs and Ledger 1986b; Ledger, Hobbs and Smith, 1992; Verdoorn 1996; Kruger and Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Anderson 2001; Shaw 2013).

5.1 Electrocutions

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). Electrocution risk is strongly influenced by the power line voltage of the and design of the pole structure and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energized components.

5.1.1 South Africa

Due to the large size of the clearances on most overhead lines of above 132kV, electrocutions are generally ruled out as even the largest birds cannot physically bridge the gap between dangerous components. It can be concluded that electrocutions on the proposed BOSA 400kV power line will not be possible through conventional mechanisms. Electrocutions within the proposed Watershed B substation are possible, but should not affect the more sensitive Red Listed bird species as these species are unlikely to use the infrastructure within the substation yards for perching or roosting.

5.1.2 Botswana

Due to the large size of the clearances on most overhead lines of above 132kV, electrocutions are generally ruled out as even the largest birds cannot physically bridge the gap between dangerous components. It can be concluded that electrocutions on the proposed BOSA 400kV power line will not be possible through conventional mechanisms. Electrocutions within the existing Isang substation are possible, but should not affect the more sensitive Red Listed bird species as these species are unlikely to use the infrastructure within the substation yards for perching or roosting.

5.2 Collisions

Collisions are probably the biggest single threat posed by power lines to birds in southern Africa (van Rooyen 2004; Shaw 2013). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004; Anderson 2001; Shaw 2013).

In a recent PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with power lines:

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the low-resolution and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 1994).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Bevanger 1994)."

As mentioned by Shaw (2013) in the extract above, several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e. whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is essential to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin *&* Shaw 2010). Visual fields were determined in three bird species representative of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards, Blue Cranes and White

Storks. In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward-facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35° respectively are sufficient to render the birds blind in the direction of travel; in storks head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families especially raptors (*Accipitridae*) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to power line collisions.

Thus, visual field topographies which have evolved primarily to meet visual challenges associated with foraging may render certain bird species particularly vulnerable to collisions with human artefacts, such as power lines and wind turbines that extend into the otherwise open airspace above their preferred habitats. For these species placing devices upon power lines to render them more visible may have limited success since no matter what the device the birds may not see them. It may be that in certain situations it may be necessary to distract birds away from the obstacles, or encourage them to land nearby (for example by the use of decoy models of conspecifics, or the provision of sites attractive for roosting) since increased marking of the obstacle cannot be guaranteed to render it visible if the visual field configuration prevents it being detected. Perhaps most importantly, the results indicate that collision mitigation may need to vary substantially for different collision prone species, taking account of species specific behaviours, habitat and foraging preferences, since an effective all-purpose marking device is probably not realistic if some birds do not see the obstacle at all (Martin & Shaw 2010).

Despite speculation that line marking might be ineffective for some species due to differences in visual fields and behaviour, or have only a small reduction in mortality in certain situations for certain species, particularly bustards (Martin & Shaw 2010; Barrientos *et al.* 2012; Shaw 2013), it is generally accepted that marking a line with PVC spiral type Bird Flight Diverters (BFDs) can reduce the collision mortality rates (Sporer *et al.* 2013; Barrientos *et al.* 2012, Alonso & Alonso 1999; Koops & De Jong 1982). Regardless of statistical significance, a slight mortality reduction may be very biologically relevant in areas, species or populations of high conservation concern (e.g. Ludwig's Bustard) (Barrientos *et al.* 2012). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. A recent study reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease in bird collisions. At unmarked lines, there were 0.21 deaths/1000 birds (n = 339,830) that flew among lines or over lines. At marked lines, the mortality rate was 78% lower (n = 1,060,746) (Barrientos *et al.* 2011). Koops and De Jong (1982) found that the spacing of the BFDs was critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5 metres, whereas using the same devices at 10 metre intervals only reduces the mortality by 57%. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important, as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g. at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al.* 2010).

A potential impact of the proposed power lines is collisions with the earth wire present on the proposed power line. Quantifying this impact in terms of the likely number of birds that will be impacted, is very difficult because such a huge number of variables play a role in determining the risk, for example weather, rainfall, wind, age, flocking behaviour, power line height, light conditions, topography, population density and so forth. However, from incidental record keeping by the Endangered Wildlife Trust: Wildlife & Energy Programme (South African NGO) it is possible to give a measure of what species are likely to be impacted upon (Figure 5 - Jenkins *et al.* 2010). This only gives a measure of the general susceptibility of the species to power line collisions, and not an absolute measurement for any specific line.

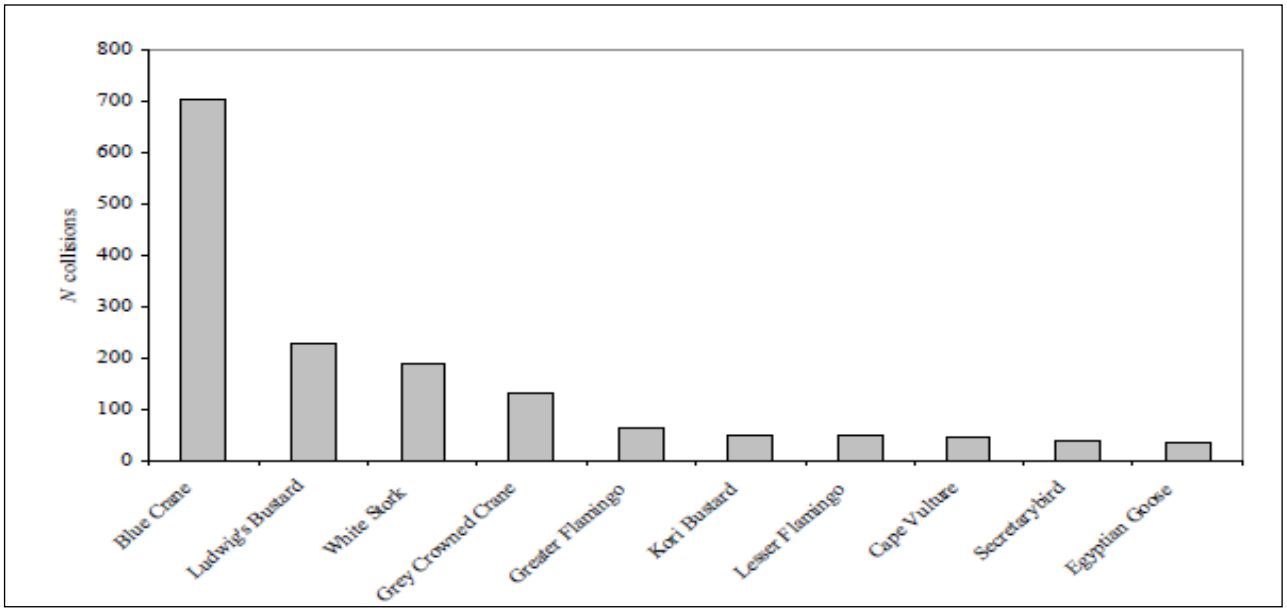

Figure 5: The top ten collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

5.2.1 South Africa

Relevant to this development, collisions are likely to be linked to specific habitat types and/or specific sets of circumstances. The following potential collision scenarios, involving Red Listed species, present themselves in the study area (see also Table 2):

- Lines crossing rivers. These are important habitat for a variety of waterfowl, including Red List species such as Black Stork and Yellow-billed Stork, and the constant movement of birds up and down the river in search of food creates a collision risk.
- Proximity of breeding Red Listed raptors and vultures to the proposed power lines e.g. Martial Eagle and White-backed Vulture. In this scenario, the young, recently fledged birds would be most at risk of collisions in the woodland biome.
- Lines crossing or skirting areas of natural grassland or old and fallow lands in commercial farming areas could put species such as White-bellied Korhaan and Secretarybird at risk.
- Lines crossing agricultural fields surrounded by natural woodland, which often attract Kori Bustard, a species which is highly susceptible to the collision impact.
- Vultures feeding on a carcass in close proximity to the proposed lines, e.g. White-backed Vulture, Cape Vulture and Lappet-faced Vulture. Vultures descending to a carcass are at risk of collisions with a nearby

power line. Birds will also be at risk when rapidly taking off at the carcass if disturbed by people or mammalian predators.

- Vultures have taken to roosting and perching (sometimes overnight) on existing 400kV transmission infrastructure (Figure 4 - Phipps *et al.* 2013). Camera trap footage of two 400kV power lines located at the Rhino & Lion Park in the Cradle of Humankind, revealed that the vultures roost on the earth peaks and are flying extremely close to the earth wires when landing and taking off from the earth peaks (Smallie & Strugnell, 2011). It is highly likely that the vultures in the study area will behave in a similar manner, resulting in them being vulnerable to collisions with the proposed BOSA 400kV overhead earth wires, should they choose to roost on the new powerline.

5.2.2 Botswana

Relevant to this development, collisions are likely to be linked to specific habitat types and/or specific sets of circumstances. The following potential collision scenarios, involving Red Listed species, present themselves in the study area (see also Table 3):

- Lines crossing rivers. These are important habitat for a variety of waterfowl, and the constant movement of birds up and down the river in search of food creates a collision risk.
- Proximity of breeding Red Listed raptors and vultures to the proposed power lines e.g. Martial Eagle and White-backed Vulture. In this scenario, the young, recently fledged birds would be most at risk of collisions in the woodland biome.
- Lines crossing agricultural fields surrounded by natural woodland, which often attract Kori Bustard, a species which is highly susceptible to the collision impact..
- Vultures feeding on a carcass in close proximity to the proposed lines e.g. White-backed Vulture, Cape Vulture and Lappet-faced Vulture. Vultures descending to a carcass are at risk of collisions with a nearby power line. Birds will also be at risk when rapidly taking off at the carcass if disturbed by people or mammalian predators.
- Vultures have taken to roosting and perching (sometimes overnight) on existing 400kV transmission infrastructure (Figure 4 - Phipps et al. 2013). Camera trap footage of two 400kV power lines located at the Rhino & Lion Park in the Cradle of Humankind, revealed that the vultures roost on the earth peaks and are flying extremely close to the earth wires when landing and taking off from the earth peaks (Smallie & Strugnell, 2011). It is highly likely that the vultures in the study area will behave in a similar manner, resulting in them being vulnerable to collisions with the proposed BOSA 400kV overhead earth wires, should they choose to roost on the new powerline.

5.3 Displacement due to habitat transformation and disturbance

During the construction phase and maintenance of power lines and substations, some habitat destruction and transformation inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the levelling of substation yards. Servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, to prevent vegetation from intruding into the legally prescribed clearance gap between the ground and the conductors and to minimize the risk of fire under the line, which can result in electrical flashovers. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude through transformation of habitat, which could result in temporary or permanent displacement.

5.3.1 South Africa

In the present instance, the risk of displacement of Red Listed species due to habitat transformation is likely to be fairly limited given the low reporting rate for Red Listed species in the broader area. The biggest potential impact would be the removal of large trees that could potentially serve as nesting substrate for large Red Listed raptors such as those listed in Table 2 (and many other non-threatened avifauna), although again it is noted that reporting rates for these species are very low.

Historically (i.e. before the establishment of the current settlements and industries) the broader area comprised largely of undisturbed woodland. As a result, it almost certainly supported a number of power line sensitive species, particularly Red Listed raptor species such as Martial Eagle, Tawny Eagle, Bateleur, Lappet-faced Vulture and also non-raptors such as Southern Ground Hornbill and Kori Bustard. However, the area has been transformed to accommodate a change in land use (i.e. urban settlement and agriculture) which reduced the number and variety of species originally inhabiting the area, on account of the loss of habitat and decline in food availability. However intact (if disturbed) areas of woodland habitat still remain in the broader area, therefore the remaining Red Listed species will still utilize the area, albeit only irregularly for some species. Vultures are regularly present (Figure 4), not so much because of the remaining woodland, but because of the high numbers of livestock and existing high voltage structures which provide convenient perches and roosts. The clearing of woodland (mostly small trees and woody shrub) under the new line should have a limited impact on the avifauna, provided that large trees are not removed. The biggest impact is likely to be where riparian vegetation needs to be cleared, particularly large trees, as these trees are important breeding and roosting substrate, especially for raptors.

The habitat at the three proposed Watershed B substation alternatives, namely disturbed open woodland on old agricultural clearings, does not contain unique features that will make it critically important for avifauna, particularly the Red Listed species mentioned in the previous paragraphs. This habitat is common in the area and due to the mobility of the large raptor species; they could conceivably forage in similar habitat adjacent to the substation. The species that are most likely to be affected by the loss of habitat are the smaller, non-threatened passerines that are currently potentially resident in the area to be taken up by the proposed substation. It is not envisaged that any Red Listed species will be displaced from the broader area by the habitat transformation that will take place as a result of the construction of the proposed Watershed B substation.

Apart from direct habitat destruction, the abovementioned construction and maintenance activities also impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities in close proximity could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests. The relatively low reporting rates for Red Listed species in the study area are an indication that they are not regularly utilising the area for breeding. However, if the alignment is authorised, a detailed inspection would be required to establish if there are any breeding Red Listed species that could be disturbed. In such an event, appropriate mitigation measures would need to be implemented (such as postponing the construction of the line to avoid peak breeding season).

Relevant to this study, the type of impact that could potentially affect each of the Red Listed species, recorded in the study area, as a result of the construction and operation of the BOSA 400kV power line and its associated substations are indicated in Table 2.

5.3.2 Botswana

In the present instance, the risk of displacement of Red Listed species due to habitat transformation is likely to be fairly limited given the relatively low reporting rate for Red Listed species in the broader area. It has been found that densities for most species, such as large raptors, are considerably higher in protected areas than in unprotected areas (Herremans, 1998; Herremans-Tonnoeyr, 2000). The biggest potential impact would be the removal of large trees that could potentially serve as nesting substrate for large Red Listed raptors such as those listed in Table 3 (and many other non-threatened avifauna).

Historically (i.e. before the establishment of the current settlements and industries) the broader area comprised entirely of undisturbed woodland. As a result, it would have supported a number of power line sensitive species, particularly globally Red Listed raptor species such as Martial Eagle, White-backed Vulture, Bateleur, Lappet-faced Vulture and also non-raptors such as Southern Ground Hornbill and Kori Bustard. However, the area has been transformed to accommodate a change in land use (i.e. urban settlement and agriculture) which reduced the number and variety of species originally inhabiting the area, on account of the loss of habitat and decline in food availability. However intact (if disturbed) areas of woodland habitat still remain in the broader area, therefore the remaining Red Listed species still utilize the broader area, albeit only irregularly for some species. Vultures are regularly present (Figure 4), not so much because of the remaining woodland, but because of the high numbers of livestock and existing high voltage structures which provide convenient perches and roosts. The clearing of woodland (mostly small trees and woody shrub) under the new line should have a limited impact on the avifauna, provided that not too many large trees are removed. The biggest impact is likely to be where riparian vegetation needs to be cleared, particularly large trees, as these trees are important breeding and roosting substrate, especially for raptors.

Apart from direct habitat destruction, the abovementioned construction and maintenance activities also impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities in close proximity could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests. The relatively low reporting rates for Red Listed species in the study area are an indication that they are not regularly utilising the area for breeding. However, if the alignment is authorised, a detailed inspection would be required to establish if there are any breeding Red Listed species that could be disturbed. In such an event, appropriate mitigation measures would need to be implemented (such as postponing the construction of the line to avoid peak breeding season).

Relevant to this study, the type of impact that could potentially affect each of the Red Listed species, recorded in the study area, as a result of the construction and operation of the BOSA 400kV power line and its associated substations are indicated in Table 3.

6 ASSESSMENT OF POTENTIAL IMPACTS

The methodology for assessing the potential impacts of the proposed BOSA TX 400kV line is attached as Appendix 3. The impact assessment tables below provide a summary of the assessment process for each impact. The sections of line falling in South Africa and Botswana are assessed separately.

6.1 South Africa

6.1.1 Assessment of direct impacts

Table 6-1: Electrocution

IMPACT DESCRIPTION: Electrocution of Red Listed species in the Watershed B Substation				
Predicted for project phase:	Pre-construction	Construction	Operation	Decommissioning
PRE-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Negligible	Significance: Very low
Extent	Local			
Intensity	Negligible			
Probability	Very unlikely			
MITIGATION:				
With regard to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if on-going impacts are recorded once operational, site specific mitigation be applied reactively. This is an acceptable approach because Red Listed bird species are unlikely to frequent the substation and be electrocuted.				
POST-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Negligible	Significance: Very low
Extent	Local			
Intensity	Negligible			
Probability	Very unlikely			

Table 6-2: Displacement

<table>
<tr><th colspan="5">IMPACT DESCRIPTION: Displacement of Red Listed species due to habitat destruction and disturbance</th></tr>
<tr><td>Predicted for project phase:</td><td>Pre-construction</td><td>Construction</td><td>Operation</td><td>Decommissioning</td></tr>
<tr><td colspan="5">PRE-MITIGATION</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td>Duration</td><td>Short-term</td><td colspan="2"></td><td rowspan="4">Significance:
Low - negative</td></tr>
<tr><td>Extent</td><td>Site-specific</td><td colspan="2"></td></tr>
<tr><td>Intensity</td><td>Moderate - negative</td><td colspan="2">Consequence:
Slightly detrimental</td></tr>
<tr><td>Probability</td><td>Fairly likely</td><td colspan="2"></td></tr>
<tr><td colspan="5">MITIGATION:
• The primary means of mitigating this impact is through the selection of the optimal route for the lines through this area, explained in Section 1.2 above. This will ensure that sensitive habitats (e.g. riparian vegetation and water bodies) are avoided as far as possible.
• Construction activity should be restricted to the immediate footprint of the infrastructure.
• Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of Red Listed species.
• Measures to control noise should be applied according to current best practice in the industry.
• Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
• The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.
• The final powerline alignment must be inspected on foot by the avifaunal specialist prior to construction to ascertain if any Red Listed species nests are present. All relevant detail must be recorded i.e. species, coordinates and nest status. Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where such breeding Red Data species could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active.</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td>Duration</td><td>Short-term</td><td colspan="2"></td><td rowspan="4">Significance:
Very low</td></tr>
<tr><td>Extent</td><td>Site-specific</td><td colspan="2"></td></tr>
<tr><td>Intensity</td><td>Moderate - negative</td><td colspan="2">Consequence:
Slightly detrimental</td></tr>
<tr><td>Probability</td><td>Very unlikely</td><td colspan="2"></td></tr>
</table>

Table 6-3: Collision

IMPACT DESCRIPTION: Mortality of Red List species due to collsions with the earthwire of the 400kV powerline				
Predicted for project phase:	Pre-construction	Construction	Operation	Decommissioning
PRE-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Highly detrimental	Significance: Moderate - negative
Extent	Local			
Intensity	High - negative			
Probability	Fairly likely			
MITIGATION:				
High risk sections of power line must be identified by a qualified avifaunal specialist during the walk-through phase of the project, once the alignment has been finalized. If power line marking is required, bird flight diverters must be installed on the full span length on each of the conductors (according to Botswana Power Corporation guidelines, or, if the former have not yet been developed, according to the Eskom Guidelines (see Appendix 4). Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.				
POST-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Highly detrimental	Significance: Low - negative
Extent	Local			
Intensity	High - negative			
Probability	Unlikely			

6.1.2 Assessment of cumulative impacts

Electrocution

The proposed powerline will not increase the risk of powerline electrocutions for Red Listed avifauna, therefore the cumulative impact of this potential impact is zero for all practical reasons.

Displacement due to habitat destruction and disturbance

Although each power line probably affects a relatively small proportion of the landscape, there are already several existing activities, e.g. agriculture, and infrastructure, e.g. powerlines, roads and mining, in the broader area, that have resulted in significant habitat transformation. An additional 400kV powerline will add to these impacts, and will result in additional fragmentation of the habitat. The additional powerline will therefore result in a moderate increase of the cumulative displacement impact of existing anthropogenic activities on Red Listed avifauna in the area.

Collision

The cumulative impact of collision mortality on several Red Listed species in the greater area is likely to be moderate, although the actual figures are not known. It is for example not known how many vultures are killed annually through powerline collisions in the broader area, although the number of flights across and especially roosting on existing powerlines could be significant. Specific concern exists for vultures because, while they are more vulnerable to electrocutions than collisions, they are also vulnerable to collisions, especially in high risk areas such as in close proximity to vulture restaurants or at powerline roosts. The additional powerline will likely result in a moderate increase of the cumulative collision impact of existing powerlines on Red Listed avifauna in the broader area.

6.1.3 No-Go option

Should the proposed 400kV powerline not be constructed, the ecological integrity of the area as it currently exists will be maintained as far as avifauna is concerned. No additional negative impacts on Red Listed avifauna are foreseen as a result of the development not taking place.

6.2 Botswana

6.2.1 Assessment of direct impacts

Table 6-4: Electrocution

IMPACT DESCRIPTION: Electrocution of Red List species in the Isang substation				
Predicted for project phase:	Pre-construction	Construction	Operation	Decommissioning
PRE-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Moderately detrimental	Significance: Very low
Extent	Local			
Intensity	Moderate - negative			
Probability	Very unlikely			
MITIGATION:				
With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if on-going impacts are recorded once operational, site specific mitigation be applied reactively. This is an acceptable approach because Red List bird species are unlikely to frequent the substation and be electrocuted.				
POST-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Moderately detrimental	Significance: Very low
Extent	Site-specific			
Intensity	Moderate - negative			
Probability	Very unlikely			

Table 6-5: Displacement

IMPACT DESCRIPTION: Displacement of Red List species due to habitat destruction and disturbance				
Predicted for project phase:	Pre-construction	Construction	Operation	Decommissioning
PRE-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Short-term		Consequence: Slightly detrimental	Significance: Low - negative
Extent	Site-specific			
Intensity	Moderate - negative			
Probability	Fairly likely			
MITIGATION:				
• The primary means of mitigating this impact is through the selection of the optimal route for the lines through this area, explained in Section 1.2 above This will ensure that sensitive habitats (e.g. riparian vegetation and water bodies) are avoided as far as possible. • Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of Red List species. • Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned. • The final powerline alignment must be inspected on foot by the avifaunal specialist prior to construction to ascertain if any Red List species nests are present. All relevant detail must be recorded i.e. species, coordinates and nest status. Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist, BirdLife Botswana and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where such breeding Red Data species could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active.				
POST-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Short-term		Consequence: Slightly detrimental	Significance: Very low
Extent	Site-specific			
Intensity	Moderate - negative			
Probability	Very unlikely			

Table 6-6: Collisions

IMPACT DESCRIPTION: Mortality of Red List species due to collsions with the earthwire of the 400kV powerline				
Predicted for project phase:	Pre-construction	Construction	Operation	Decommissioning
PRE-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Highly detrimental	Significance: Moderate - negative
Extent	Local			
Intensity	High - negative			
Probability	Fairly likely			
MITIGATION:				
High risk sections of power line must be identified by a qualified avifaunal specialist during the walk-through phase of the project, once the alignment has been finalized. If power line marking is required, bird flight diverters must be installed on the full span length on each of the conductors (according to Botswana Power Corporation guidelines, or, if the former have not yet been developed, according to the Eskom Guidelines (see Appendix 4). Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.				
POST-MITIGATION				
Dimension	**Rating**	**Motivation**		
Duration	Long-term		Consequence: Highly detrimental	Significance: Low - negative
Extent	Local			
Intensity	High - negative			
Probability	Unlikely			

6.2.2 Assessment of cumulative impacts

Electrocution

The proposed powerline will not increase the risk of powerline electrocutions for Red Listed avifauna, therefore the cumulative impact of this potential impact is zero for all practical reasons.

Displacement due to habitat destruction and disturbance

Although each power line probably affects a relatively small proportion of the landscape, there are already several existing activities, e.g. agriculture, and infrastructure, e.g. powerlines, roads and urban development in the greater area, that has resulted in significant habitat transformation. An additional 400kV powerline will add to these impacts, and will result in additional fragmentation of the habitat. The additional powerline will therefore result in a moderate increase of the cumulative displacement impact of existing anthropogenic activities on Red Listed avifauna in the area.

Collision

The cumulative impact of collision mortality on several Red Listed species in the greater area is likely to be moderate, although the actual figures are not known. It is for example not known how many vultures are killed annually through powerline collisions in the greater area, although the number of flights across and especially roosting on existing powerlines could be significant. Specific concern exists for vultures because, while they are more vulnerable to electrocutions than collisions, they are also vulnerable to collisions, especially in high risk areas such as in close proximity to vulture restaurants or at powerline roosts. The additional powerline will likely result in a moderate increase of the cumulative collision impact of existing powerlines on Red Listed avifauna in the greater area.

6.2.3 No-Go option

Should the proposed 400kV powerline not be constructed, the ecological integrity of the area as it currently exists will be maintained as far as avifauna is concerned. No additional negative impacts on Red Listed avifauna are foreseen as a result of the development not taking place.

7 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

7.1 South Africa

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
Displacement of Red Listed avifauna due to habitat destruction and disturbance associated with the construction of the powerlines	• Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned. • Prior to construction commencing, a walk-through should be performed by the avifaunal specialist to record any large raptor nests that could be impacted by the construction of the proposed powerline • Should any nests be recorded, it would require management of the potential impacts on the breeding birds once	Construction manager Environmental Control Officer Avifaunal Specialist	Construction	Yes	None

	construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where breeding priority raptors could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active				
Collisions of Red Listed avifauna with the earthwire of the proposed 400kV powerlines	• A walk-through must be conducted by the avifaunal specialist after final pole positions have been determined, to demarcate sections of line that will need to be mitigated with Bird Flight Diverters (BFDs).	Construction manager Environmental Control Officer Site management Avifaunal specialist	Construction and Operation	Yes	• The powerline should be inspected once a year for a minimum of two years by the avifaunal specialist to establish if there is any significant collision mortality, which may require additional mitigation. Thereafter the frequency of inspections will be informed by the results of the first two years. • The detailed protocol to be followed for the inspections will be compiled by the avifaunal specialist prior to the first inspection.
Electrocution of Red Listed avifauna on the powerlines	None are required				

7.2 Botswana

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
Displacement of Red Listed avifauna due to habitat destruction and disturbance associated with the construction of the powerlines	• Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned. • Prior to construction commencing, a walk-through should be performed by the avifaunal specialist to record any large raptor nests that could be impacted by the construction of the proposed powerline. BirdLife Botswana should be consulted prior to the walk-through with a view to inviting them to participate in the walk-through exercise. • Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the	Construction manager Environmental Control Officer Avifaunal Specialist	Construction	Yes	None

	avifaunal specialist (in consultation with BirdLife Botswana) and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where breeding priority raptors could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active				
Collisions of Red Listed avifauna with the earthwire of the proposed 400kV powerlines	• A walk-through must be conducted by the avifaunal specialist after final tower positions have been determined, to demarcate sections of line that will need to be mitigated with Bird Flight Diverters (BFDs). BirdLife Botswana should be consulted prior to the walk-through with a view to inviting them to participate in the walk-through exercise.	Construction manager Environmental Control Officer Site management Avifaunal specialist	Construction and Operation	Yes	• The powerline should be inspected once a year for a minimum of two years by an avifaunal specialist to establish if there is any significant collision mortality, which may require additional mitigation. Thereafter the frequency of inspections will be informed by the results of the first two years. BirdLife Botswana should be consulted with a view to inviting them to participate in the monitoring. • The detailed protocol to be followed for the inspections will be compiled by the avifaunal specialist in consultation with BirdLife Botswana prior to the first inspection.
Electrocution of Red Listed avifauna on the powerlines	None are required				

8 CONCLUSIONS

8.1.1 South Africa

In general, the habitat in which the proposed Watershed B substation and the BOSA 400kV power line corridor are located is moderately sensitive from a potential bird impact perspective. The natural habitats are likely to support a diversity of Red Listed power line sensitive species. However, there is evidence of anthropogenic impacts in the broader area, particularly in the form of urbanisation, mining, cultivation and pastoral activities which is evident in the disturbed state of the natural habitat. The levels of disturbance associated with these land use practices are significant and have therefore had a negative impact on avifaunal diversity and abundance reflected in the low reporting rates for the majority of the power line sensitive Red List species.

Potential impacts affecting Red Listed avifauna requiring mitigation, relating to the construction and operation of the proposed power line include:

- Mortality due to collision of large terrestrial birds, vultures and waterbirds with the overhead power line during the operational phase; and
- Displacement as a result of habitat transformation and disturbance during the construction of the powerline.

The impact of the mortality of Red Listed avifauna due to collisions with the powerline is rated as Moderate negative pre-mitigation, but it can be reduced to Low negative after the application of mitigation measures. Mitigation measures include the following:

- High risk sections of power line must be identified by a qualified avifaunal specialist during the construction phase via a walk-through, once the tower positions have been finalized.
- If power line marking is required, bird flight diverters must be installed on the full span length on each of the conductors according to the Eskom Guidelines (see Appendix 4).
- Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.
- The powerline should be inspected once a year for a minimum of two years by an avifaunal specialist to establish if there is any significant collision mortality, which may require the marking of additional sections. Thereafter the frequency of inspections will be informed by the results of the first two years.

The impact of displacement due to disturbance and habitat destruction is rated as Low negative, and it can be further reduced to Very Low – negative through the application of mitigation measures. Mitigation measures include the following:

- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.
- Prior to construction commencing, a walk-through should be performed by an avifaunal specialist to record any large raptor nests that could be impacted by the construction of the proposed powerline. Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the

avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where breeding priority raptors could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active

The construction and operation of the proposed 400kV powerline should result in manageable impacts on Red Listed avifauna, provided the recommended mitigation measures are diligently implemented, including the monitoring requirements as detailed in the EMP.

8.1.2 Botswana

In general, the habitat in which the proposed BOSA 400kV power line corridor are located is moderately sensitive from a potential bird impact perspective. The natural habitats are likely to support a diversity of Red Listed power line sensitive species. However, there is evidence of anthropogenic impacts in the broader area, particularly in the form of urbanisation, cultivation and pastoral activities which is evident in the disturbed state of the natural habitat in places. The levels of disturbance associated with these land use practices are significant and have therefore had a negative impact on avifaunal diversity and abundance reflected in the low reporting rates for the majority of the power line sensitive Red Listed species.

Potential impacts affecting Red Listed avifauna requiring mitigation, relating to the construction and operation of the proposed power line include:

- Mortality due to collision of large terrestrial birds, vultures and waterbirds with the overhead power line during the operational phase; and
- Displacement as a result of habitat transformation and disturbance during the construction of the powerline.

The impact of the mortality of Red Listed avifauna due to collisions with the powerline is rated as Moderate negative pre-mitigation, but it can be reduced to Low negative after the application of mitigation measures. Mitigation measures include the following:

- High risk sections of power line must be identified by a qualified avifaunal specialist during the construction phase via a walk-through, once the tower positions have been finalized. BirdLife Botswana should be consulted prior to the walk-through with a view to inviting them to participate in the walk-through exercise.
- If power line marking is required, bird flight diverters must be installed on the full span length on each of the conductors according to the Botswana Power Corporation guidelines, (or Eskom Guidelines, if the former have not yet been developed (see Appendix 4).
- Light and dark colour devices must be alternated so as to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.
- The powerline should be inspected once a year for a minimum of two years by an avifaunal specialist establish if there is any significant collision mortality, which may require the marking of additional sections. Thereafter the frequency of inspections will be informed by the results of the first two years. BirdLife Botswana should be consulted with a view to inviting them to participate in the monitoring exercise.

The impact of displacement due to disturbance and habitat destruction is rated as Low negative, and it can be further reduced to Very Low – negative through the application of mitigation measures. Mitigation measures include the following:

- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.
- Prior to construction commencing, a walk-through should be performed by an avifaunal specialist to record any large raptor nests that could be impacted by the construction of the proposed powerline. Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where breeding priority raptors could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active. BirdLife Botswana should be consulted with a view to inviting them to participate in the walk-through exercise.

The construction and operation of the proposed 400kV powerline should result in manageable impacts on Red Listed avifauna, provided the recommended mitigation measures are diligently implemented, including the monitoring requirements as detailed in the EMP.

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APPENDIX 1: BIRD HABITATS

Figure 1: An agricultural clearing near the proposed Watershed B substation.

Figure 2: Commercial agriculture in the South African section of the study area

Figure 3: Woodland in the South African section of the study area.

Figure 4: An example of a large water body, the Kromellenboog Dam in the greater study area in South Africa.

Figure 5: A wetland in the South African section of the study area.

Figure 6: Grassland in the South African section of the study area.

Figure 7: The Ngotwane River in the broader area in Botswana.

Figure 8: Subsistence agriculture in Botswana.

Figure 9: Alien trees in the South African study area.

Figure 10: The Modipe Hill in the broader study area in Botswana.

APPENDIX 2: SPECIES IN THE BROADER AREA

SOUTH AFRICA

NT = Near threatened, VU = Vulnerable, EN = Endangered

Species	Taxonomic name	Global conservation status (IUCN 2017)	Regional conservation status (Taylor *et al*. 2015)	SABAP2 reporting rate
Eagle, Verreaux's	*Aquila verreauxii*	LC	VU	2.36
Falcon, Lanner	*Falco biarmicus*	LC	VU	7.28
Korhaan, White-bellied	*Eupodotis senegalensis*	LC	VU	0
Pelican, Pink-backed	*Pelecanus rufescens*	LC	VU	0.21
Secretarybird	*Sagittarius serpentarius*	VU	VU	6.21
Stork, Black	*Ciconia nigra*	LC	VU	0.86
Bustard, Kori	*Ardeotis kori*	NT	NT	9.42
Duck, Maccoa	*Oxyura maccoa*	NT	NT	0.43
Falcon, Red-footed	*Falco vespertinus*	NT	NT	0.21
Flamingo, Greater	*Phoenicopterus ruber*	LC	NT	0.86
Flamingo, Lesser	*Phoenicopterus minor*	NT	NT	0
Harrier, Pallid	*Circus macrourus*	NT	NT	0.64
Kingfisher, Half-collared	*Alcedo semitorquata*	LC	NT	0.21
Lark, Short-clawed	*Certhilauda chuana*	LC	NT	7.71
Painted-snipe, Greater	*Rostratula benghalensis*	LC	NT	0.43
Pratincole, Black-winged	*Glareola nordmanni*	NT	NT	0.21
Roller, European	*Coracias garrulus*	NT	NT	5.57
Sandgrouse, Yellow-throated	*Pterocles gutturalis*	LC	NT	10.06
Stork, Abdim's	*Ciconia abdimii*	LC	NT	0.64
Stork, Marabou	*Leptoptilos crumeniferus*	LC	NT	3.21
Lark, Melodious	*Mirafra cheniana*	NT	-	1.28
Bateleur	*Terathopius ecaudatus*	NT	EN	0.86
Eagle, Martial	*Polemaetus bellicosus*	VU	EN	3
Eagle, Tawny	*Aquila rapax*	LC	EN	1.5
Ground-hornbill, Southern	*Bucorvus leadbeateri*	VU	EN	0.21
Stork, Yellow-billed	*Mycteria ibis*	LC	EN	0.43
Vulture, Cape	*Gyps coprotheres*	VU	EN	6.85
Vulture, Lappet-faced	*Torgos tracheliotus*	EN	EN	9.21
Vulture, White-backed	*Gyps africanus*	EN	EN	13.49
Apalis, Bar-throated	*Apalis thoracica*			3.43
Avocet, Pied	*Recurvirostra avosetta*			0.43
Babbler, Arrow-marked	*Turdoides jardineii*			41.54
Babbler, Southern Pied	*Turdoides bicolor*			41.97
Barbet, Acacia Pied	*Tricholaema leucomelas*			49.68
Barbet, Black-collared	*Lybius torquatus*			22.7
Barbet, Crested	*Trachyphonus vaillantii*			60.39
Batis, Chinspot	*Batis molitor*			49.25
Batis, Pririt	*Batis pririt*			1.71

Bee-eater, Blue-cheeked	*Merops persicus*			0.86
Bee-eater, European	*Merops apiaster*			32.33
Bee-eater, Little	*Merops pusillus*			7.92
Bee-eater, Swallow-tailed	*Merops hirundineus*			1.71
Bee-eater, White-fronted	*Merops bullockoides*			0.43
Bishop, Southern Red	*Euplectes orix*			6.85
Bishop, Yellow-crowned	*Euplectes afer*			3.43
Bittern, Little	*Ixobrychus minutus*			1.93
Bokmakierie	*Telophorus zeylonus*			7.07
Boubou, Southern	*Laniarius ferrugineus*			14.78
Brubru	*Nilaus afer*			24.63
Buffalo-weaver, Red-billed	*Bubalornis niger*			27.84
Bulbul, African Red-eyed	*Pycnonotus nigricans*			50.96
Bulbul, Dark-capped	*Pycnonotus tricolor*			28.48
Bunting, Cape	*Emberiza capensis*			0.21
Bunting, Cinnamon-breasted	*Emberiza tahapisi*			27.62
Bunting, Golden-breasted	*Emberiza flaviventris*			34.05
Bunting, Lark-like	*Emberiza impetuani*			8.57
Bush-shrike, Grey-headed	*Malaconotus blanchoti*			11.78
Bush-shrike, Orange-breasted	*Telophorus sulfureopectus*			7.92
Buttonquail, Kurrichane	*Turnix sylvaticus*			5.35
Buzzard, Jackal	*Buteo rufofuscus*			0
Buzzard, Lizard	*Kaupifalco monogrammicus*			0.21
Buzzard, Steppe	*Buteo vulpinus*			17.13
Camaroptera, Green-backed	*Camaroptera brachyura*			0.21
Camaroptera, Grey-backed	*Camaroptera brevicaudata*			21.2
Canary, Black-throated	*Crithagra atrogularis*			36.19
Canary, Yellow	*Crithagra flaviventris*			16.7
Canary, Yellow-fronted	*Crithagra mozambicus*			26.12
Chat, Anteating	*Myrmecocichla formicivora*			17.13
Chat, Familiar	*Cercomela familiaris*			30.84
Cisticola, Cloud	*Cisticola textrix*			0.21
Cisticola, Desert	*Cisticola aridulus*			16.92
Cisticola, Lazy	*Cisticola aberrans*			0.64
Cisticola, Levaillant's	*Cisticola tinniens*			1.93
Cisticola, Rattling	*Cisticola chiniana*			49.46
Cisticola, Tinkling	*Cisticola rufilatus*			3.21
Cisticola, Wailing	*Cisticola lais*			0.21
Cisticola, Zitting	*Cisticola juncidis*			14.78
Cliff-chat, Mocking	*Thamnolaea cinnamomeiventris*			4.5
Cliff-swallow, South African	*Hirundo spilodera*			2.36
Coot, Red-knobbed	*Fulica cristata*			17.34
Cormorant, Reed	*Phalacrocorax africanus*			6.85
Cormorant, White-breasted	*Phalacrocorax carbo*			3.85

Coucal, Burchell's	*Centropus burchellii*			11.99
Courser, Bronze-winged	*Rhinoptilus chalcopterus*			1.71
Courser, Double-banded	*Rhinoptilus africanus*			7.28
Courser, Temminck's	*Cursorius temminckii*			3.43
Crake, African	*Crecopsis egregia*			0.43
Crake, Black	*Amaurornis flavirostris*			11.35
Crombec, Long-billed	*Sylvietta rufescens*			49.89
Crow, Cape	*Corvus capensis*			1.28
Crow, Pied	*Corvus albus*			66.6
Cuckoo, African	*Cuculus gularis*			0.64
Cuckoo, Black	*Cuculus clamosus*			11.35
Cuckoo, Diderick	*Chrysococcyx caprius*			28.48
Cuckoo, Great Spotted	*Clamator glandarius*			3.21
Cuckoo, Jacobin	*Clamator jacobinus*			17.13
Cuckoo, Klaas's	*Chrysococcyx klaas*			8.99
Cuckoo, Levaillant's	*Clamator levaillantii*			3
Cuckoo, Red-chested	*Cuculus solitarius*			13.28
Darter, African	*Anhinga rufa*			3.21
Dove, Laughing	*Streptopelia senegalensis*			78.37
Dove, Namaqua	*Oena capensis*			30.41
Dove, Red-eyed	*Streptopelia semitorquata*			46.04
Dove, Rock	*Columba livia*			3
Drongo, Fork-tailed	*Dicrurus adsimilis*			51.82
Duck, African Black	*Anas sparsa*			0
Duck, Comb	*Sarkidiornis melanotos*			2.78
Duck, Fulvous	*Dendrocygna bicolor*			0.21
Duck, White-faced	*Dendrocygna viduata*			15.63
Duck, Yellow-billed	*Anas undulata*			18.2
Eagle, Booted	*Aquila pennatus*			1.28
Eagle, Lesser Spotted	*Aquila pomarina*			0.21
Eagle, Steppe	*Aquila nipalensis*			0.64
Eagle, Wahlberg's	*Aquila wahlbergi*			7.07
Eagle-owl, Spotted	*Bubo africanus*			9.85
Eagle-owl, Verreaux's	*Bubo lacteus*			1.07
Egret, Cattle	*Bubulcus ibis*			21.41
Egret, Great	*Egretta alba*			1.71
Egret, Little	*Egretta garzetta*			3
Eremomela, Burnt-necked	*Eremomela usticollis*			24.41
Eremomela, Yellow-bellied	*Eremomela icteropygialis*			5.14
Falcon, Amur	*Falco amurensis*			2.57
Falcon, Peregrine	*Falco peregrinus*			0.64
Finch, Cuckoo	*Anomalospiza imberbis*			0.21
Finch, Cut-throat	*Amadina fasciata*			1.5
Finch, Red-headed	*Amadina erythrocephala*			9.85

Finch, Scaly-feathered	*Sporopipes squamifrons*			32.33
Firefinch, African	*Lagonosticta rubricata*			0.64
Firefinch, Jameson's	*Lagonosticta rhodopareia*			8.14
Firefinch, Red-billed	*Lagonosticta senegala*			16.92
Fish-eagle, African	*Haliaeetus vocifer*			4.71
Flycatcher, Chat	*Bradornis infuscatus*			0.64
Flycatcher, Fairy	*Stenostira scita*			0.86
Flycatcher, Fiscal	*Sigelus silens*			21.63
Flycatcher, Marico	*Bradornis mariquensis*			43.47
Flycatcher, Pale	*Bradornis pallidus*			0.21
Flycatcher, Southern Black	*Melaenornis pammelaina*			5.78
Flycatcher, Spotted	*Muscicapa striata*			24.2
Francolin, Coqui	*Peliperdix coqui*			6.64
Francolin, Crested	*Dendroperdix sephaena*			48.82
Francolin, Orange River	*Scleroptila levaillantoides*			4.28
Go-away-bird, Grey	*Corythaixoides concolor*			74.3
Goose, Egyptian	*Alopochen aegyptiacus*			36.4
Goose, Spur-winged	*Plectropterus gambensis*			19.49
Goshawk, Gabar	*Melierax gabar*			16.7
Goshawk, Southern Pale Chanting	*Melierax canorus*			20.77
Grebe, Black-necked	*Podiceps nigricollis*			0.21
Grebe, Great Crested	*Podiceps cristatus*			1.5
Grebe, Little	*Tachybaptus ruficollis*			7.71
Green-pigeon, African	*Treron calvus*			4.71
Greenshank, Common	*Tringa nebularia*			3.64
Guineafowl, Helmeted	*Numida meleagris*			66.81
Gull, Grey-headed	*Larus cirrocephalus*			0.21
Hamerkop	*Scopus umbretta*			4.28
Harrier-Hawk, African	*Polyboroides typus*			1.28
Hawk-eagle, African	*Aquila spilogaster*			4.93
Helmet-shrike, White-crested	*Prionops plumatus*			1.5
Heron, Black	*Egretta ardesiaca*			0.43
Heron, Black-headed	*Ardea melanocephala*			10.06
Heron, Goliath	*Ardea goliath*			0.64
Heron, Grey	*Ardea cinerea*			16.7
Heron, Purple	*Ardea purpurea*			0.64
Heron, Squacco	*Ardeola ralloides*			1.28
Heron, Striated	*Butorides striata*			0.86
Hobby, Eurasian	*Falco subbuteo*			1.5
Honeybird, Brown-backed	*Prodotiscus regulus*			0.21
Honey-buzzard, European	*Pernis apivorus*			0.64
Honeyguide, Greater	*Indicator indicator*			4.71
Honeyguide, Lesser	*Indicator minor*			8.35
Hoopoe, African	*Upupa africana*			43.25

Hornbill, African Grey	*Tockus nasutus*			47.32
Hornbill, Red-billed	*Tockus erythrorhynchus*			34.05
Hornbill, Southern Yellow-billed	*Tockus leucomelas*			60.81
House-martin, Common	*Delichon urbicum*			5.57
Ibis, African Sacred	*Threskiornis aethiopicus*			3.43
Ibis, Glossy	*Plegadis falcinellus*			0.21
Ibis, Hadeda	*Bostrychia hagedash*			32.55
Indigobird, Dusky	*Vidua funerea*			0.43
Indigobird, Purple	*Vidua purpurascens*			0.21
Indigobird, Village	*Vidua chalybeata*			1.71
Jacana, African	*Actophilornis africanus*			0.43
Kestrel, Greater	*Falco rupicoloides*			7.28
Kestrel, Lesser	*Falco naumanni*			2.78
Kestrel, Rock	*Falco rupicolus*			3.21
Kingfisher, Brown-hooded	*Halcyon albiventris*			6.85
Kingfisher, Giant	*Megaceryle maximus*			0.86
Kingfisher, Malachite	*Alcedo cristata*			0.21
Kingfisher, Pied	*Ceryle rudis*			3.85
Kingfisher, Striped	*Halcyon chelicuti*			1.93
Kingfisher, Woodland	*Halcyon senegalensis*			3
Kite, Black	*Milvus migrans*			1.07
Kite, Black-shouldered	*Elanus caeruleus*			37.47
Kite, Yellow-billed	*Milvus aegyptius*			14.13
Korhaan, Northern Black	*Afrotis afraoides*			24.63
Korhaan, Red-crested	*Lophotis ruficrista*			37.04
Lapwing, African Wattled	*Vanellus senegallus*			3.64
Lapwing, Blacksmith	*Vanellus armatus*			56.96
Lapwing, Crowned	*Vanellus coronatus*			52.03
Lark, Dusky	*Pinarocorys nigricans*			0.64
Lark, Eastern Clapper	*Mirafra fasciolata*			8.35
Lark, Fawn-coloured	*Calendulauda africanoides*			3
Lark, Monotonous	*Mirafra passerina*			9.21
Lark, Pink-billed	*Spizocorys conirostris*			0.21
Lark, Red-capped	*Calandrella cinerea*			2.57
Lark, Rufous-naped	*Mirafra africana*			23.34
Lark, Sabota	*Calendulauda sabota*			36.62
Lark, Spike-heeled	*Chersomanes albofasciata*			7.28
Longclaw, Cape	*Macronyx capensis*			4.5
Mannikin, Bronze	*Spermestes cucullatus*			0.43
Martin, Banded	*Riparia cincta*			5.14
Martin, Brown-throated	*Riparia paludicola*			2.36
Martin, Rock	*Hirundo fuligula*			2.78
Martin, Sand	*Riparia riparia*			0.21
Masked-weaver, Lesser	*Ploceus intermedius*			3

Masked-weaver, Southern	*Ploceus velatus*			53.1
Moorhen, Common	*Gallinula chloropus*			11.35
Moorhen, Lesser	*Gallinula angulata*			0.43
Mousebird, Red-faced	*Urocolius indicus*			52.25
Mousebird, Speckled	*Colius striatus*			6.85
Mousebird, White-backed	*Colius colius*			12.85
Myna, Common	*Acridotheres tristis*			32.33
Neddicky, Neddicky	*Cisticola fulvicapilla*			30.62
Night-Heron, Black-crowned	*Nycticorax nycticorax*			1.71
Nightjar, European	*Caprimulgus europaeus*			0.64
Nightjar, Fiery-necked	*Caprimulgus pectoralis*			6.64
Nightjar, Freckled	*Caprimulgus tristigma*			2.78
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*			11.13
Olive-pigeon, African	*Columba arquatrix*			0.86
Openbill, African	*Anastomus lamelligerus*			0.21
Oriole, Black-headed	*Oriolus larvatus*			26.55
Oriole, Eurasian Golden	*Oriolus oriolus*			0.43
Ostrich, Common	*Struthio camelus*			28.27
Owl, Barn	*Tyto alba*			12.21
Owl, Marsh	*Asio capensis*			5.35
Owlet, Pearl-spotted	*Glaucidium perlatum*			24.84
Oxpecker, Red-billed	*Buphagus erythrorhynchus*			39.4
Palm-swift, African	*Cypsiurus parvus*			12.21
Paradise-flycatcher, African	*Terpsiphone viridis*			8.14
Paradise-whydah, Long-tailed	*Vidua paradisaea*			23.77
Parrot, Meyer's	*Poicephalus meyeri*			5.35
Penduline-tit, Cape	*Anthoscopus minutus*			5.35
Petronia, Yellow-throated	*Petronia superciliaris*			6.64
Pigeon, Speckled	*Columba guinea*			47.11
Pipit, African	*Anthus cinnamomeus*			19.91
Pipit, Buffy	*Anthus vaalensis*			7.92
Pipit, Bushveld	*Anthus caffer*			0.64
Pipit, Long-billed	*Anthus similis*			0.21
Pipit, Plain-backed	*Anthus leucophrys*			5.57
Pipit, Striped	*Anthus lineiventris*			0.43
Plover, Common Ringed	*Charadrius hiaticula*			0.21
Plover, Kittlitz's	*Charadrius pecuarius*			0.64
Plover, Three-banded	*Charadrius tricollaris*			18.63
Plover, White-fronted	*Charadrius marginatus*			0.43
Pochard, Southern	*Netta erythrophthalma*			1.28
Prinia, Black-chested	*Prinia flavicans*			48.61
Prinia, Tawny-flanked	*Prinia subflava*			13.06
Puffback, Black-backed	*Dryoscopus cubla*			20.99
Pygmy-Kingfisher, African	*Ispidina picta*			0.43

Pytilia, Green-winged	*Pytilia melba*			39.19
Quail, Common	*Coturnix coturnix*			4.93
Quail, Harlequin	*Coturnix delegorguei*			4.5
Quailfinch, African	*Ortygospiza atricollis*			23.98
Quelea, Red-billed	*Quelea quelea*			35.12
Reed-warbler, African	*Acrocephalus baeticatus*			0.86
Reed-warbler, Great	*Acrocephalus arundinaceus*			0.21
Robin-chat, Cape	*Cossypha caffra*			4.07
Robin-chat, White-throated	*Cossypha humeralis*			20.99
Cuckoo-shrike, Black	*Campephaga flava*			2.78
Fiscal, Common (Southern)	*Lanius collaris*			26.12
Rock-thrush, Short-toed	*Monticola brevipes*			17.34
Roller, Lilac-breasted	*Coracias caudatus*			33.19
Roller, Purple	*Coracias naevius*			15.42
Ruff, Ruff	*Philomachus pugnax*			2.14
Rush-warbler, Little	*Bradypterus baboecala*			0.64
Sandgrouse, Burchell's	*Pterocles burchelli*			2.78
Sandgrouse, Double-banded	*Pterocles bicinctus*			14.35
Sandgrouse, Namaqua	*Pterocles namaqua*			2.78
Sandpiper, Common	*Actitis hypoleucos*			1.5
Sandpiper, Marsh	*Tringa stagnatilis*			0.43
Sandpiper, Wood	*Tringa glareola*			10.71
Scimitarbill, Common	*Rhinopomastus cyanomelas*			9.21
Scops-owl, African	*Otus senegalensis*			2.78
Scops-owl, Southern White-faced	*Ptilopsus granti*			4.71
Scrub-robin, Kalahari	*Cercotrichas paena*			40.26
Scrub-robin, White-browed	*Cercotrichas leucophrys*			34.9
Seedeater, Streaky-headed	*Crithagra gularis*			1.07
Shelduck, South African	*Tadorna cana*			8.14
Shikra, Shikra	*Accipiter badius*			2.14
Shoveler, Cape	*Anas smithii*			1.07
Shrike, Crimson-breasted	*Laniarius atrococcineus*			66.81
Shrike, Lesser Grey	*Lanius minor*			28.05
Shrike, Magpie	*Corvinella melanoleuca*			43.47
Shrike, Red-backed	*Lanius collurio*			34.26
Shrike, Southern White-crowned	*Eurocephalus anguitimens*			11.78
Snake-eagle, Black-chested	*Circaetus pectoralis*			20.13
Snake-eagle, Brown	*Circaetus cinereus*			10.06
Sparrow, Cape	*Passer melanurus*			18.42
Sparrow, Great	*Passer motitensis*			10.71
Sparrow, House	*Passer domesticus*			22.7
Sparrow, Southern Grey-headed	*Passer diffusus*			62.74
Sparrowhawk, Black	*Accipiter melanoleucus*			0.43

Sparrowhawk, Little	*Accipiter minullus*			1.28
Sparrowhawk, Ovambo	*Accipiter ovampensis*			0.43
Sparrowlark, Chestnut-backed	*Eremopterix leucotis*			9.42
Sparrowlark, Grey-backed	*Eremopterix verticalis*			1.28
Sparrow-weaver, White-browed	*Plocepasser mahali*			60.17
Spoonbill, African	*Platalea alba*			7.71
Spurfowl, Natal	*Pternistis natalensis*			38.12
Spurfowl, Swainson's	*Pternistis swainsonii*			62.96
Starling, Burchell's	*Lamprotornis australis*			9.21
Starling, Cape Glossy	*Lamprotornis nitens*			77.73
Starling, Greater Blue-eared	*Lamprotornis chalybaeus*			0.43
Starling, Pied	*Spreo bicolor*			0.64
Starling, Red-winged	*Onychognathus morio*			12.42
Starling, Violet-backed	*Cinnyricinclus leucogaster*			12.85
Starling, Wattled	*Creatophora cinerea*			16.92
Stilt, Black-winged	*Himantopus himantopus*			10.71
Stint, Little	*Calidris minuta*			1.28
Stonechat, African	*Saxicola torquatus*			8.14
Stork, White	*Ciconia ciconia*			1.93
Sunbird, Amethyst	*Chalcomitra amethystina*			3.85
Sunbird, Marico	*Cinnyris mariquensis*			33.62
Sunbird, White-bellied	*Cinnyris talatala*			28.91
Swallow, Barn	*Hirundo rustica*			33.83
Swallow, Greater Striped	*Hirundo cucullata*			22.27
Swallow, Lesser Striped	*Hirundo abyssinica*			24.41
Swallow, Pearl-breasted	*Hirundo dimidiata*			1.93
Swallow, Red-breasted	*Hirundo semirufa*			26.12
Swallow, White-throated	*Hirundo albigularis*			3.21
Swamphen, African Purple	*Porphyrio madagascariensis*			0.86
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*			1.71
Swift, African Black	*Apus barbatus*			2.57
Swift, Alpine	*Tachymarptis melba*			0.21
Swift, Common	*Apus apus*			3.64
Swift, Horus	*Apus horus*			0.86
Swift, Little	*Apus affinis*			22.48
Swift, White-rumped	*Apus caffer*			21.41
Tchagra, Black-crowned	*Tchagra senegalus*			8.78
Tchagra, Brown-crowned	*Tchagra australis*			40.69
Teal, Red-billed	*Anas erythrorhyncha*			18.63
Tern, Whiskered	*Chlidonias hybrida*			0.43
Thick-knee, Spotted	*Burhinus capensis*			28.48
Thrush, Groundscraper	*Psophocichla litsipsirupa*			28.48
Thrush, Karoo	*Turdus smithi*			8.78
Thrush, Kurrichane	*Turdus libonyanus*			15.85

Tinkerbird, Yellow-fronted	*Pogoniulus chrysoconus*			15.2
Tit, Ashy	*Parus cinerascens*			26.77
Tit, Southern Black	*Parus niger*			12.42
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*			51.82
Tit-flycatcher, Grey	*Myioparus plumbeus*			5.78
Turtle-dove, Cape	*Streptopelia capicola*			77.94
Wagtail, African Pied	*Motacilla aguimp*			0.86
Wagtail, Cape	*Motacilla capensis*			10.06
Warbler, Garden	*Sylvia borin*			0.86
Warbler, Icterine	*Hippolais icterina*			2.14
Warbler, Marsh	*Acrocephalus palustris*			0.43
Warbler, Olive-tree	*Hippolais olivetorum*			1.5
Warbler, Willow	*Phylloscopus trochilus*			10.28
Waxbill, Black-faced	*Estrilda erythronotos*			28.05
Waxbill, Blue	*Uraeginthus angolensis*			70.66
Waxbill, Common	*Estrilda astrild*			8.35
Waxbill, Orange-breasted	*Amandava subflava*			0.21
Waxbill, Violet-eared	*Granatina granatina*			31.05
Weaver, Cape	*Ploceus capensis*			0.43
Weaver, Red-headed	*Anaplectes rubriceps*			3.21
Weaver, Sociable	*Philetairus socius*			4.07
Weaver, Thick-billed	*Amblyospiza albifrons*			0.21
Weaver, Village	*Ploceus cucullatus*			12.42
Wheatear, Capped	*Oenanthe pileata*			6
White-eye, Cape	*Zosterops virens*			15.85
White-eye, Orange River	*Zosterops pallidus*			0.43
Whitethroat, Common	*Sylvia communis*			1.5
Whydah, Pin-tailed	*Vidua macroura*			10.06
Whydah, Shaft-tailed	*Vidua regia*			22.91
Widowbird, Long-tailed	*Euplectes progne*			9.21
Widowbird, Red-collared	*Euplectes ardens*			0.21
Widowbird, White-winged	*Euplectes albonotatus*			10.71
Wood-dove, Emerald-spotted	*Turtur chalcospilos*			8.99
Wood-hoopoe, Green	*Phoeniculus purpureus*			21.63
Woodpecker, Bearded	*Dendropicos namaquus*			15.42
Woodpecker, Bennett's	*Campethera bennettii*			3.21
Woodpecker, Cardinal	*Dendropicos fuscescens*			14.99
Woodpecker, Golden-tailed	*Campethera abingoni*			10.28
Wren-warbler, Barred	*Calamonastes fasciolatus*			25.91

BOTSWANA

Species	Taxonomic name	Global conservation status (IUCN, 2017)	Regional conservation status (Tyler & Borello 2000)	SABAP 2 Reporting rate
Vulture, Lappet-faced	*Torgos tracheliotus*	Endangered	Bird of Concern	4.9
Vulture, White-backed	*Gyps africanus*	Endangered		13.07
Pelican, Pink-backed	*Pelecanus rufescens*	Least Concern	Bird of Concern	0
Bateleur	*Terathopius ecaudatus*	Near threatened	Bird of Concern	0.65
Flamingo, Lesser	*Phoenicopterus minor*	Near threatened	Near threatened	0
Bustard, Kori	*Ardeotis kori*	Near threatened	Threatened or declining	16.67
Duck, Maccoa	*Oxyura maccoa*	Near threatened		1.31
Falcon, Red-footed	*Falco vespertinus*	Near threatened		0.65
Harrier, Pallid	*Circus macrourus*	Near threatened		0.33
Pratincole, Black-winged	*Glareola nordmanni*	Near threatened		1.63
Roller, European	*Coracias garrulus*	Near threatened		11.44
Eagle, Martial	*Polemaetus bellicosus*	Vulnerable	Bird of Concern	3.92
Vulture, Cape	*Gyps coprotheres*	Vulnerable	Endangered	4.9
Ground-hornbill, Southern	*Bucorvus leadbeateri*	Vulnerable	Threatened or declining	0.33
Secretarybird	*Sagittarius serpentarius*	Vulnerable		1.63
Lark, Short-clawed	*Certhilauda chuana*		Bird of Concern	1.31
Flamingo, Greater	*Phoenicopterus ruber*		Threatened or declining	2.29
Apalis, Bar-throated	*Apalis thoracica*			4.25
Avocet, Pied	*Recurvirostra avosetta*			2.94
Babbler, Arrow-marked	*Turdoides jardineii*			38.56
Babbler, Southern Pied	*Turdoides bicolor*			66.99
Barbet, Acacia Pied	*Tricholaema leucomelas*			49.35
Barbet, Black-collared	*Lybius torquatus*			12.09
Barbet, Crested	*Trachyphonus vaillantii*			39.22
Batis, Chinspot	*Batis molitor*			52.29
Bee-eater, Blue-cheeked	*Merops persicus*			10.13
Bee-eater, European	*Merops apiaster*			37.91
Bee-eater, Little	*Merops pusillus*			11.11
Bee-eater, Southern Carmine	*Merops nubicoides*			0.33
Bee-eater, Swallow-tailed	*Merops hirundineus*			3.92
Bee-eater, White-fronted	*Merops bullockoides*			0
Bishop, Southern Red	*Euplectes orix*			2.94

Bishop, Yellow-crowned	*Euplectes afer*			2.29
Bittern, Little	*Ixobrychus minutus*			2.61
Boubou, Southern	*Laniarius ferrugineus*			5.56
Brubru	*Nilaus afer*			20.92
Buffalo-weaver, Red-billed	*Bubalornis niger*			41.5
Bulbul, African Red-eyed	*Pycnonotus nigricans*			43.46
Bulbul, Dark-capped	*Pycnonotus tricolor*			1.96
Bunting, Cape	*Emberiza capensis*			0.98
Bunting, Cinnamon-breasted	*Emberiza tahapisi*			26.8
Bunting, Golden-breasted	*Emberiza flaviventris*			48.69
Bunting, Lark-like	*Emberiza impetuani*			9.8
Bush-shrike, Grey-headed	*Malaconotus blanchoti*			12.09
Bush-shrike, Orange-breasted	*Telophorus sulfureopectus*			2.94
Buttonquail, Kurrichane	*Turnix sylvaticus*			7.19
Buzzard, Jackal	*Buteo rufofuscus*			0.65
Buzzard, Steppe	*Buteo vulpinus*			26.14
Camaroptera, Grey-backed	*Camaroptera brevicaudata*			18.3
Canary, Black-throated	*Crithagra atrogularis*			39.87
Canary, Yellow	*Crithagra flaviventris*			2.61
Canary, Yellow-fronted	*Crithagra mozambicus*			32.68
Chat, Anteating	*Myrmecocichla formicivora*			1.96
Chat, Familiar	*Cercomela familiaris*			43.14
Cisticola, Desert	*Cisticola aridulus*			15.69
Cisticola, Lazy	*Cisticola aberrans*			2.61
Cisticola, Rattling	*Cisticola chiniana*			54.58
Cisticola, Tinkling	*Cisticola rufilatus*			1.31
Cisticola, Zitting	*Cisticola juncidis*			11.76
Cliff-chat, Mocking	*Thamnolaea cinnamomeiventris*			7.52
Cliff-swallow, South African	*Hirundo spilodera*			2.61
Coot, Red-knobbed	*Fulica cristata*			17.65
Cormorant, Reed	*Phalacrocorax africanus*			1.31
Cormorant, White-breasted	*Phalacrocorax carbo*			1.96
Coucal, Burchell's	*Centropus burchellii*			13.4
Courser, Bronze-winged	*Rhinoptilus chalcopterus*			2.94
Courser, Double-banded	*Rhinoptilus africanus*			0.98
Courser, Temminck's	*Cursorius temminckii*			2.61
Crake, African	*Crecopsis egregia*			0.65
Crake, Black	*Amaurornis flavirostris*			16.34
Crombec, Long-billed	*Sylvietta rufescens*			57.52
Crow, Pied	*Corvus albus*			65.36
Cuckoo, African	*Cuculus gularis*			5.88
Cuckoo, Black	*Cuculus clamosus*			16.67
Cuckoo, Common	*Cuculus canorus*			0.33
Cuckoo, Diderick	*Chrysococcyx caprius*			26.14
Cuckoo, Great Spotted	*Clamator glandarius*			1.31
Cuckoo, Jacobin	*Clamator jacobinus*			19.61
Cuckoo, Klaas's	*Chrysococcyx klaas*			7.52
Cuckoo, Levaillant's	*Clamator levaillantii*			3.27
Cuckoo, Red-chested	*Cuculus solitarius*			15.03
Cuckoo-shrike, Black	*Campephaga flava*			0.65
Darter, African	*Anhinga rufa*			0.65

Dove, Laughing	*Streptopelia senegalensis*			72.55
Dove, Namaqua	*Oena capensis*			37.25
Dove, Red-eyed	*Streptopelia semitorquata*			31.37
Dove, Rock	*Columba livia*			0.65
Drongo, Fork-tailed	*Dicrurus adsimilis*			61.11
Duck, African Black	*Anas sparsa*			0
Duck, Comb	*Sarkidiornis melanotos*			12.09
Duck, Fulvous	*Dendrocygna bicolor*			0.33
Duck, White-backed	*Thalassornis leuconotus*			0
Duck, White-faced	*Dendrocygna viduata*			24.18
Duck, Yellow-billed	*Anas undulata*			33.99
Eagle, Booted	*Aquila pennatus*			1.31
Eagle, Lesser Spotted	*Aquila pomarina*			0.98
Eagle, Steppe	*Aquila nipalensis*			0.98
Eagle, Tawny	*Aquila rapax*			6.21
Eagle, Verreaux's	*Aquila verreauxii*			4.9
Eagle, Wahlberg's	*Aquila wahlbergi*			13.07
Eagle-owl, Spotted	*Bubo africanus*			15.69
Eagle-owl, Verreaux's	*Bubo lacteus*			2.29
Egret, Cattle	*Bubulcus ibis*			14.71
Egret, Great	*Egretta alba*			1.96
Egret, Little	*Egretta garzetta*			2.94
Egret, Yellow-billed	*Egretta intermedia*			1.96
Eremomela, Burnt-necked	*Eremomela usticollis*			27.12
Eremomela, Yellow-bellied	*Eremomela icteropygialis*			1.31
Falcon, Amur	*Falco amurensis*			4.9
Falcon, Lanner	*Falco biarmicus*			15.03
Falcon, Peregrine	*Falco peregrinus*			1.31
Finch, Cut-throat	*Amadina fasciata*			2.94
Finch, Red-headed	*Amadina erythrocephala*			6.54
Finch, Scaly-feathered	*Sporopipes squamifrons*			45.75
Firefinch, African	*Lagonosticta rubricata*			0.98
Firefinch, Jameson's	*Lagonosticta rhodopareia*			9.8
Firefinch, Red-billed	*Lagonosticta senegala*			17.97
Fiscal, Common (Southern)	*Lanius collaris*			3.59
Fish-eagle, African	*Haliaeetus vocifer*			2.94
Flycatcher, Fairy	*Stenostira scita*			1.31
Flycatcher, Fiscal	*Sigelus silens*			9.15
Flycatcher, Marico	*Bradornis mariquensis*			63.07
Flycatcher, Southern Black	*Melaenornis pammelaina*			1.31
Flycatcher, Spotted	*Muscicapa striata*			24.51
Francolin, Coqui	*Peliperdix coqui*			1.63
Francolin, Crested	*Dendroperdix sephaena*			53.27
Francolin, Orange River	*Scleroptila levaillantoides*			0.33
Go-away-bird, Grey	*Corythaixoides concolor*			71.57
Goose, Egyptian	*Alopochen aegyptiacus*			62.09
Goose, Spur-winged	*Plectropterus gambensis*			30.07
Goshawk, Gabar	*Melierax gabar*			31.05
Goshawk, Southern Pale Chanting	*Melierax canorus*			40.2
Grebe, Great Crested	*Podiceps cristatus*			0.98
Grebe, Little	*Tachybaptus ruficollis*			16.01

Greenbul, Yellow-bellied	*Chlorocichla flaviventris*			0.33
Green-pigeon, African	*Treron calvus*			4.25
Greenshank, Common	*Tringa nebularia*			10.13
Guineafowl, Helmeted	*Numida meleagris*			73.53
Gull, Grey-headed	*Larus cirrocephalus*			0
Hamerkop, Hamerkop	*Scopus umbretta*			1.31
Harrier-Hawk, African	*Polyboroides typus*			1.31
Hawk-eagle, African	*Aquila spilogaster*			8.82
Helmet-shrike, White-crested	*Prionops plumatus*			0.65
Heron, Black	*Egretta ardesiaca*			0.33
Heron, Black-headed	*Ardea melanocephala*			14.71
Heron, Goliath	*Ardea goliath*			0.65
Heron, Green-backed	*Butorides striata*			0.65
Heron, Grey	*Ardea cinerea*			16.67
Heron, Purple	*Ardea purpurea*			0
Heron, Squacco	*Ardeola ralloides*			1.96
Hobby, Eurasian	*Falco subbuteo*			2.94
Honey-buzzard, European	*Pernis apivorus*			0.98
Honeyguide, Greater	*Indicator indicator*			2.29
Honeyguide, Lesser	*Indicator minor*			10.78
Hoopoe, African	*Upupa africana*			34.31
Hornbill, African Grey	*Tockus nasutus*			43.46
Hornbill, Red-billed	*Tockus erythrorhynchus*			47.71
Hornbill, Southern Yellow-billed	*Tockus leucomelas*			76.8
House-martin, Common	*Delichon urbicum*			5.56
Ibis, African Sacred	*Threskiornis aethiopicus*			1.96
Ibis, Glossy	*Plegadis falcinellus*			3.59
Ibis, Hadeda	*Bostrychia hagedash*			9.8
Indigobird, Purple	*Vidua purpurascens*			0.98
Indigobird, Village	*Vidua chalybeata*			0.65
Jacana, African	*Actophilornis africanus*			0.65
Kestrel, Greater	*Falco rupicoloides*			3.92
Kestrel, Lesser	*Falco naumanni*			2.94
Kestrel, Rock	*Falco rupicolus*			4.25
Kingfisher, Brown-hooded	*Halcyon albiventris*			2.29
Kingfisher, Giant	*Megaceryle maximus*			0
Kingfisher, Malachite	*Alcedo cristata*			0
Kingfisher, Pied	*Ceryle rudis*			3.27
Kingfisher, Striped	*Halcyon chelicuti*			0
Kingfisher, Woodland	*Halcyon senegalensis*			2.29
Kite, Black	*Milvus migrans*			1.31
Kite, Black-shouldered	*Elanus caeruleus*			43.79
Kite, Yellow-billed	*Milvus aegyptius*			11.44
Korhaan, Northern Black	*Afrotis afraoides*			8.82
Korhaan, Red-crested	*Lophotis ruficrista*			58.5
Lapwing, African Wattled	*Vanellus senegallus*			0.98
Lapwing, Blacksmith	*Vanellus armatus*			72.22
Lapwing, Crowned	*Vanellus coronatus*			44.44
Lark, Dusky	*Pinarocorys nigricans*			0.33
Lark, Fawn-coloured	*Calendulauda africanoides*			3.92
Lark, Monotonous	*Mirafra passerina*			10.78
Lark, Red-capped	*Calandrella cinerea*			0.98

Lark, Rufous-naped	*Mirafra africana*			9.8
Lark, Sabota	*Calendulauda sabota*			49.35
Martin, Banded	*Riparia cincta*			0
Martin, Brown-throated	*Riparia paludicola*			0.98
Martin, Rock	*Hirundo fuligula*			0
Martin, Sand	*Riparia riparia*			0
Masked-weaver, Lesser	*Ploceus intermedius*			3.27
Masked-weaver, Southern	*Ploceus velatus*			32.35
Moorhen, Common	*Gallinula chloropus*			15.69
Moorhen, Lesser	*Gallinula angulata*			0.33
Mousebird, Red-faced	*Urocolius indicus*			44.12
Mousebird, Speckled	*Colius striatus*			0.33
Mousebird, White-backed	*Colius colius*			1.96
Myna, Common	*Acridotheres tristis*			13.73
Neddicky, Neddicky	*Cisticola fulvicapilla*			21.57
Night-Heron, Black-crowned	*Nycticorax nycticorax*			1.63
Nightjar, European	*Caprimulgus europaeus*			1.96
Nightjar, Fiery-necked	*Caprimulgus pectoralis*			9.15
Nightjar, Freckled	*Caprimulgus tristigma*			5.88
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*			14.38
Nightjar, Square-tailed	*Caprimulgus fossii*			1.63
Openbill, African	*Anastomus lamelligerus*			0.33
Oriole, Black-headed	*Oriolus larvatus*			13.73
Oriole, Eurasian Golden	*Oriolus oriolus*			0
Osprey, Osprey	*Pandion haliaetus*			0.33
Ostrich, Common	*Struthio camelus*			26.14
Owl, Barn	*Tyto alba*			11.76
Owl, Marsh	*Asio capensis*			9.8
Owlet, Pearl-spotted	*Glaucidium perlatum*			27.12
Oxpecker, Red-billed	*Buphagus erythrorhynchus*			57.84
Painted-snipe, Greater	*Rostratula benghalensis*			0.65
Palm-swift, African	*Cypsiurus parvus*			15.36
Paradise-flycatcher, African	*Terpsiphone viridis*			4.58
Paradise-whydah, Long-tailed	*Vidua paradisaea*			34.97
Penduline-tit, Cape	*Anthoscopus minutus*			5.88
Petronia, Yellow-throated	*Petronia superciliaris*			7.19
Pigeon, Speckled	*Columba guinea*			44.12
Pipit, African	*Anthus cinnamomeus*			15.69
Pipit, Buffy	*Anthus vaalensis*			7.19
Pipit, Bushveld	*Anthus caffer*			0.33
Pipit, Plain-backed	*Anthus leucophrys*			2.29
Pipit, Striped	*Anthus lineiventris*			0.33
Plover, Common Ringed	*Charadrius hiaticula*			0
Plover, Grey	*Pluvialis squatarola*			0.33
Plover, Kittlitz's	*Charadrius pecuarius*			3.92
Plover, Three-banded	*Charadrius tricollaris*			48.37
Plover, White-fronted	*Charadrius marginatus*			0.65
Pochard, Southern	*Netta erythrophthalma*			4.9
Prinia, Black-chested	*Prinia flavicans*			36.6
Prinia, Tawny-flanked	*Prinia subflava*			9.15
Puffback, Black-backed	*Dryoscopus cubla*			13.4
Pytilia, Green-winged	*Pytilia melba*			50

Quail, Common	*Coturnix coturnix*			8.82
Quail, Harlequin	*Coturnix delegorguei*			5.88
Quailfinch, African	*Ortygospiza atricollis*			33.33
Quelea, Red-billed	*Quelea quelea*			42.81
Reed-warbler, African	*Acrocephalus baeticatus*			0
Robin-chat, White-throated	*Cossypha humeralis*			20.59
Rock-thrush, Short-toed	*Monticola brevipes*			25.16
Roller, Lilac-breasted	*Coracias caudatus*			45.75
Roller, Purple	*Coracias naevius*			35.62
Ruff, Ruff	*Philomachus pugnax*			7.84
Sandgrouse, Burchell's	*Pterocles burchelli*			0.98
Sandgrouse, Double-banded	*Pterocles bicinctus*			29.41
Sandgrouse, Yellow-throated	*Pterocles gutturalis*			26.14
Sandpiper, Common	*Actitis hypoleucos*			5.23
Sandpiper, Curlew	*Calidris ferruginea*			0.65
Sandpiper, Green	*Tringa ochropus*			0.33
Sandpiper, Marsh	*Tringa stagnatilis*			2.61
Sandpiper, Wood	*Tringa glareola*			29.74
Scimitarbill, Common	*Rhinopomastus cyanomelas*			11.44
Scops-owl, African	*Otus senegalensis*			3.92
Scops-owl, Southern White-faced	*Ptilopsus granti*			7.19
Scrub-robin, Kalahari	*Cercotrichas paena*			49.02
Scrub-robin, White-browed	*Cercotrichas leucophrys*			35.29
Shelduck, South African	*Tadorna cana*			24.84
Shikra, Shikra	*Accipiter badius*			2.94
Shoveler, Cape	*Anas smithii*			0.65
Shrike, Crimson-breasted	*Laniarius atrococcineus*			78.76
Shrike, Lesser Grey	*Lanius minor*			37.58
Shrike, Magpie	*Corvinella melanoleuca*			59.48
Shrike, Red-backed	*Lanius collurio*			42.48
Shrike, Southern White-crowned	*Eurocephalus anguitimens*			31.7
Snake-eagle, Black-chested	*Circaetus pectoralis*			35.62
Snake-eagle, Brown	*Circaetus cinereus*			14.71
Sparrow, Cape	*Passer melanurus*			6.54
Sparrow, Great	*Passer motitensis*			12.09
Sparrow, House	*Passer domesticus*			20.59
Sparrow, Southern Grey-headed	*Passer diffusus*			76.47
Sparrowhawk, Black	*Accipiter melanoleucus*			0.33
Sparrowhawk, Little	*Accipiter minullus*			0.65
Sparrowhawk, Ovambo	*Accipiter ovampensis*			0.98
Sparrowlark, Chestnut-backed	*Eremopterix leucotis*			16.01
Sparrowlark, Grey-backed	*Eremopterix verticalis*			1.63
Sparrow-weaver, White-browed	*Plocepasser mahali*			38.89
Spoonbill, African	*Platalea alba*			19.28
Spurfowl, Natal	*Pternistis natalensis*			47.06
Spurfowl, Swainson's	*Pternistis swainsonii*			75.82
Starling, Burchell's	*Lamprotornis australis*			16.99
Starling, Cape Glossy	*Lamprotornis nitens*			83.01
Starling, Red-winged	*Onychognathus morio*			1.63
Starling, Violet-backed	*Cinnyricinclus leucogaster*			14.38
Starling, Wattled	*Creatophora cinerea*			26.14

Stilt, Black-winged	*Himantopus himantopus*			25.82
Stint, Little	*Calidris minuta*			8.17
Stonechat, African	*Saxicola torquatus*			7.52
Stork, Abdim's	*Ciconia abdimii*			2.61
Stork, Black	*Ciconia nigra*			1.31
Stork, Marabou	*Leptoptilos crumeniferus*			9.15
Stork, White	*Ciconia ciconia*			7.84
Stork, Yellow-billed	*Mycteria ibis*			1.96
Sunbird, Amethyst	*Chalcomitra amethystina*			0.65
Sunbird, Marico	*Cinnyris mariquensis*			33.01
Sunbird, White-bellied	*Cinnyris talatala*			22.22
Swallow, Barn	*Hirundo rustica*			32.68
Swallow, Greater Striped	*Hirundo cucullata*			9.8
Swallow, Lesser Striped	*Hirundo abyssinica*			28.1
Swallow, Pearl-breasted	*Hirundo dimidiata*			1.31
Swallow, Red-breasted	*Hirundo semirufa*			35.95
Swallow, White-throated	*Hirundo albigularis*			0.65
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*			0.65
Swift, African Black	*Apus barbatus*			4.9
Swift, Alpine	*Tachymarptis melba*			0
Swift, Common	*Apus apus*			4.58
Swift, Horus	*Apus horus*			0.98
Swift, Little	*Apus affinis*			17.97
Swift, White-rumped	*Apus caffer*			22.22
Tchagra, Black-crowned	*Tchagra senegalus*			0.98
Tchagra, Brown-crowned	*Tchagra australis*			44.12
Teal, Cape	*Anas capensis*			2.29
Teal, Hottentot	*Anas hottentota*			0.65
Teal, Red-billed	*Anas erythrorhyncha*			40.85
Tern, Caspian	*Sterna caspia*			0
Tern, Whiskered	*Chlidonias hybrida*			0.65
Tern, White-winged	*Chlidonias leucopterus*			1.31
Thick-knee, Spotted	*Burhinus capensis*			39.22
Thick-knee, Water	*Burhinus vermiculatus*			0
Thrush, Groundscraper	*Psophocichla litsipsirupa*			17.97
Thrush, Karoo	*Turdus smithi*			0.33
Thrush, Kurrichane	*Turdus libonyanus*			6.86
Tinkerbird, Yellow-fronted	*Pogoniulus chrysoconus*			0.65
Tit, Ashy	*Parus cinerascens*			34.64
Tit, Southern Black	*Parus niger*			8.82
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*			44.77
Tit-flycatcher, Grey	*Myioparus plumbeus*			5.56
Turtle-dove, Cape	*Streptopelia capicola*			90.85
Wagtail, African Pied	*Motacilla aguimp*			0.65
Wagtail, Cape	*Motacilla capensis*			3.27
Warbler, Garden	*Sylvia borin*			0.65
Warbler, Icterine	*Hippolais icterina*			0.98
Warbler, Marsh	*Acrocephalus palustris*			0.33
Warbler, Olive-tree	*Hippolais olivetorum*			3.59
Warbler, Willow	*Phylloscopus trochilus*			5.23
Waxbill, Black-faced	*Estrilda erythronotos*			33.33
Waxbill, Blue	*Uraeginthus angolensis*			80.72

Waxbill, Common	*Estrilda astrild*			7.19
Waxbill, Violet-eared	*Granatina granatina*			49.35
Weaver, Red-headed	*Anaplectes rubriceps*			0.98
Weaver, Village	*Ploceus cucullatus*			19.28
Wheatear, Capped	*Oenanthe pileata*			3.27
White-eye, Cape	*Zosterops virens*			2.94
Whitethroat, Common	*Sylvia communis*			0.98
Whydah, Pin-tailed	*Vidua macroura*			9.15
Whydah, Shaft-tailed	*Vidua regia*			39.22
Widowbird, Long-tailed	*Euplectes progne*			2.94
Widowbird, White-winged	*Euplectes albonotatus*			11.44
Wood-dove, Emerald-spotted	*Turtur chalcospilos*			9.8
Wood-hoopoe, Green	*Phoeniculus purpureus*			20.92
Woodpecker, Bearded	*Dendropicos namaquus*			19.28
Woodpecker, Bennett's	*Campethera bennettii*			3.27
Woodpecker, Cardinal	*Dendropicos fuscescens*			8.5
Woodpecker, Golden-tailed	*Campethera abingoni*			4.58
Wren-warbler, Barred	*Calamonastes fasciolatus*			39.22

APPENDIX 3: IMPACT ASSESSMENT METHODOLOGY

1.1 *Methodology for impact assessment*

The assessment of the significance of impacts for a proposed development is by its nature, a matter of judgement. To deal with the uncertainty associated with judgement and ensure repeatable results, Aurecon rates impacts using a standardised and internationally recognised methodology adhering to ISO 14001 and World Bank/IFC requirements.

1.1.1 Consequence Criteria

For each predicted impact, criteria are applied to establish the significance of the impact based on likelihood and consequence, both without mitigation being applied and with the most effective mitigation measure(s) in place.

The criteria that contribute to the consequence of the impact are **intensity** (the degree to which pre-development conditions are changed), which also includes the **type of impact** (being either a positive or negative impact); the **duration** (length of time that the impact will continue); and the **extent** (spatial scale) of the impact. The sensitivity of the receiving environment and/or sensitive receptors is incorporated into the consideration of consequence by appropriately adjusting the thresholds or scales of the intensity, duration and extent criteria, based on expert knowledge. For each impact, the specialist applies professional judgement to ascribe a numerical rating for each criterion.

Table 1: Definition of Intensity ratings

RATING	CRITERIA Negative impacts (-)	Positive impacts (+)
Very high (-/+ 4)	Very high degree of damage to natural or social systems or resources. These processes or resources may restore to their pre-project condition over very long periods of time (more than a typical human life time).	Great improvement to ecosystem or social processes and services or resources.
High (-/+ 3)	High degree damage to natural or social system components, species or resources.	Intense positive benefits for natural or social systems or resources.
Moderate (-/+ 2)	Moderate damage to natural or social system components, species or resources.	Average, on-going positive benefits for natural or social systems or resources.
Low (-/+ 1)	Minor damage to natural or social system components, species or resources. Likely to recover over time. Ecosystems and valuable social processes not affected.	Low positive impacts on natural or social systems or resources.
Negligible (0)	Negligible damage to individual components of natural or social systems or resources, such that it is hardly noticeable.	Limited low-level benefits to natural or social systems or resources.

Table 2: Definition of Duration ratings

RATING	CRITERIA
2	**Long-term**: The impact will continue for 6-15 years.
1	**Medium-term:** The impact will continue for 2-5 years.
0	**Short-term:** The impact will continue for between 1 month and 2 years.

Table 3: Definition of Extent ratings

RATING	CRITERIA
2	**Regional:** The impact will affect the entire region
1	**Local:** The impact will extend across the site and to nearby properties.
0	**Site specific:** The impact will be limited to the site or immediate area.

The consequence is then established using the formula:

Consequence = type x (intensity + duration + extent)

Depending on the numerical result, the impact's consequence would be defined as either extremely, highly, moderately or slightly detrimental; or neutral; or slightly, moderately, highly or extremely beneficial. These categories are provided in

Table below:

Table 4: Application of Consequence ratings

RATING	SIGNIFICANCE RATING
-8	Extremely detrimental
-7 to -6	Highly detrimental
-5 to -4	Moderately detrimental
-3 to -2	Slightly detrimental
-1 to 1	Negligible
2 to 3	Slightly beneficial
4 to 5	Moderately beneficial
6 to 7	Highly beneficial
8	Extremely beneficial

1.1.2 Significance criteria

To determine the significance of an impact, the **probability** (or likelihood) of that impact occurring is also taken into account. In assigning probability the specialist takes into account the likelihood of occurrence but also takes cognisance of uncertainty and detectability of the impact. The most suitable numerical rating for probability is selected from Table 5 below:

Table 5: Definition of Probability ratings

RATING	CRITERIA
4	**Certain/ Definite:** There are sound scientific reasons to expect that the impact will definitely occur.
3	**Very likely:** It is most likely that the impact will occur.
2	**Fairly likely:** This impact has occurred numerous times here or elsewhere in a similar environment and with a similar type of development and could very conceivably occur.
1	**Unlikely:** This impact has not happened yet but could happen.
0	**Very unlikely:** The impact is expected never to happen or has a very low chance of occurring.

The significance is then established using the following equation:

Significance = consequence[1] x probability

Depending on the numerical result of this calculation, the impact would fall into a significance category of negligible, minor, moderate or major, and the type would be either positive or negative (see Table 6).

Table 6: Application of significance ratings

RATING	SIGNIFICANCE RATING
-4	Very high - negative
-3	High - negative
-2	Moderate - negative
-1	Low - negative
0	Very low
1	Low - positive
2	Moderate - positive
3	High - positive
4	Very high - positive

1.1.3 Confidence rating

Once the significance of an impact occurring without mitigation has been established, the same impacts will be assigned ratings after the proposed mitigation has been implemented.

Although these measures may not totally eliminate subjectivity, they provide an explicit context within which to review the assessment of impacts. The specialists appointed to contribute to this impact assessment have

[1] The term consequence is used in this methodology instead of magnitude (as included in the definition of "significant impact" in GNR 982. Furthermore, the specialists themselves translate their subjective judgements into numerical ratings to determine the significance score. As this "translation" is undertaken by the specialists themselves, it is asserted that outcomes will be accurately interpreted.

empirical knowledge of their respective fields and are thus able to comment on the confidence they have in their findings based on the availability of data and the certainty of their findings. As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard “degree of certainty” scale. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 7: Definition of Confidence ratings

RATING	CRITERIA
Low	Judgement is based on intuition and there some major assumptions used in assessing the impact may prove to be untrue.
Medium	Determination is based on common sense and general knowledge. The assumptions made, whilst having a degree of uncertainty, are fairly robust.
High	Substantive supportive data or evidence exists to verify the assessment.

APPENDIX 4: ESKOM MITIGATION GUIDELINES

Eskom	Technical Bulletin	Technology

Title: **UTILIZATION OF BIRD FLIGHT DIVERTERS ON ESKOM OVERHEAD LINES**

Unique Identifier:	**240-93563150**
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Compiled by	Functional Responsibility	Authorized by
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Electrical Engineer	**Senior Consultant**	**Line Engineering Manager**
Date: 22/06/2015	Date: 9/7/2015	Date: 9/7/2015

PCM Reference: **240-53458961 Perform Line Engineering**
SCOT Study Committee Number/Name: **Overhead Lines**

Content

Figures

Revision history

This revision cancels and replaces document number 09 TB - 01.

Date	Rev	Compiler	Remarks
June 2015	1	Zane Evan	This TB replaces 09 TB – 01 and is in the new format.

1. Introduction

A bird collision incident happens when a bird physically strikes either the overhead conductor or the overhead ground wire of a power line. In the case of transmission lines, the overhead ground wire is usually involved. It is generally accepted that birds usually avoid the highly visible bundled conductors but often fail to see the thin ground wire. In South Africa, bird collisions with Transmission lines are a major form of unnatural mortality among several threatened species.

Various line marking devices have been developed in the past. The designs of the devices have largely been through the Research and Development of the Manufacturers. This document provides the basic requirements to be adhered to by the bird diverter / flapper manufacturers and outlines products that are acceptable for use on Eskom power lines.

This document is applicable to distribution lines. A transmission guideline to mitigate against bird collisions may be found in document: TRANSMISSION BIRD COLLISION PREVENTION GUIDELINE tgl41-335.

2. Materials to be used

- Steel components must be stainless steel – grade 304
- Plastic components must be UV stable high impacted PVC.
- Connections between moving parts must be re-enforced with stainless steel grommets

2.1 Size, Colour and Weight

Specifications with regards to the size, colour and weight of the supplied bird flight diverter should comply with the criteria set out below:

- The markers should present an effective visual area of not less than 200 cm^2.
- It would be advantageous if the device could extend both above and below the conductor or shield wire
- The markers shall not pose a transverse wind surface area greater than 200 cm^2.
- The colour of the markers must be in contrast with the surrounding area i.e. yellow, white and black and may be manufactured with reflective materials. Reflective stickers will not be permitted.
- The addition of luminescence or fluorescence or solar powered LEDs, for the prevention of night collisions. The glow must be visible throughout the night, especially for early morning bird movements.
- The weight of the device shall not exceed 500g (entire device including the clamping mechanism).
- Movement of the device may be one directional. Multi directional devices must be engineered to be able to cope with the movement and must be prevented from becoming entangled in its own mechanism or resting on top of the conductor.

2.2 Application for use on Eskom Networks

- The device clamping mechanism must not allow any movement at all once installed on the conductor e.g. rotational around conductor, gravitation to another position along the conductor, etc.
- The device may not damage the conductor onto which it is placed.
- The device may not cause corona.
- Devices which make use of a flapper attached to a clamp, the flapper sections must not be able to flip up over the clamp and conductor.
- Connector part mechanisms must be burr free.
- The device must be applied with a live line link stick for MV lines.
- The device must be removable with a live line link stick for MV lines.

3. Testing

The bird flapper should undergo the following type tests before it is used on Eskom networks:

- Pull down test (spirally moving along the conductor) for squirrel and hare conductor.
- Testing for radio interference at 27 kV on fox conductor.
- Testing for corona at 27 kV on fox conductor.
- Salt fog test for 1000 hours.
- Wind simulation test – must pass a 500 hour test.
- Test to confirm UV stability.

Test certificates will be required for tender submissions or LAP evaluation.

4. Bird Flight Diverters to be used on Eskom Lines (Mitigating Devices)

The following two flight diverters (mitigating devices) have been successfully installed on Eskom power lines.

4.1 Flapper Type Diverter

Figure 1: Flapper Type Bird Flight Diverter

Buyers guide number DDT 3053

The flapper was first installed live line on an Eskom line in the North-West region in conjunction with EWT and proved very successful as a mitigating device over the years on MV lines.

From field experience and the testing of the flapper it was decided at the Envirotech work group meeting that this flapper can be used on conductors ranging from 6 mm to 24 mm on ACSR, AAAC conductors and shield wires.

The flapper can be attached with a link stick and a standard attachment or by hand from a bucket live line or under dead conditions. It is best suited for application on MV lines.

4.2 Swan / Spiral Flight Diverter

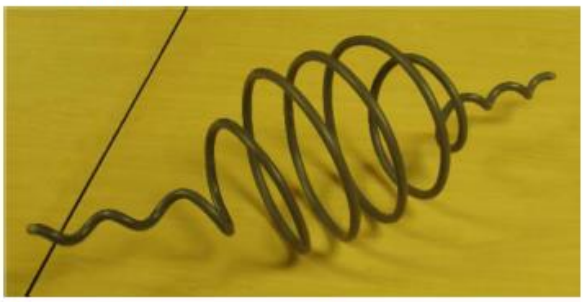

Figure 2: Swan / Spiral Bird Flight Diverter

Buyers guide number DDT 3107

The flight diverter has been used successfully in many places around the world and has been installed on a line in the North- West OU in conjunction with EWT and proved very successful as a mitigating device. The device is supplied in the colours white and grey. This device is best suited for installation on HV lines. Caution to be exercised when installed in areas of high snow loading. Other alternatives are presently being piloted to address installation of bird flight diverters in high snow loading areas.

5. Installing Bird Flight Diverters

5.1 MV Lines

- Spacing of the bird diverters are to be 5m apart alternating on each phase, for single phase lines the colours would alternate 5m apart on the two lines.
- The flight diverters are to be installed with alternating colours.

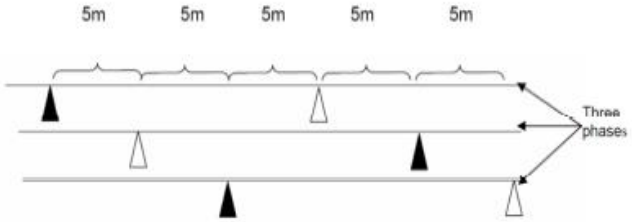

Figure 3: Spacing of Bird Flight Diverters for MV Lines

5.2 HV Lines

- To be installed on both shield wires, staggered (where applicable) or
- To be installed on single shield wire at 10 metre intervals and with alternating colours.
- To be installed only on 60% of the span and in the middle of the span. E.g. A typical 765 kV line span is 450m in length. Bird flight diverters are therefore required to be installed symmetrically from midspan for 270m (as indicated in Figure 4) or as otherwise stipulated in the environmental impact assessment.
- Bird diverters to be installed at 10 metre intervals on each shield wire and with alternating colours on each side (as per sketch below).

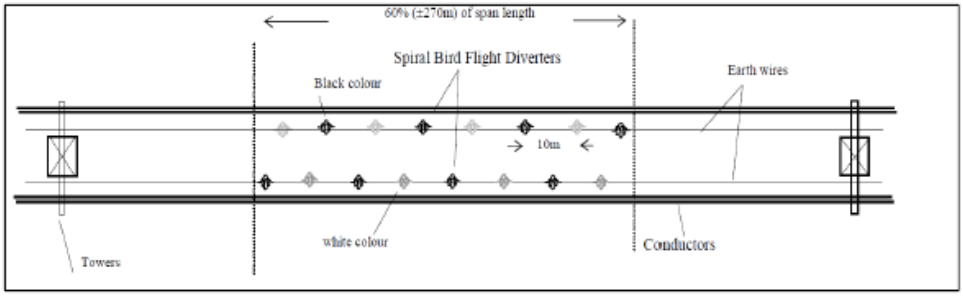

Figure 4: Spacing of Bird Flight Diverters for HV Lines