CONSTRUCTION OF 2 X 400 KV LINES FROM KENDAL POWER STATION TO ZEUS SUBSTATION AND BRAVO POWER STATION TO ZEUS SUBSTATION (Bravo 4)
DEA Ref No - 12/12/20/1095

Specialist Avifaunal Impact Assessment

Prepared for

Limosella Consulting on behalf of Envirolution Consulting

by

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DECLARATION OF PROFESSIONAL STANDING AND INDEPENDENCE

I, Andrew Edward McKechnie (SACNASP # 400205/05) declare that I:

- hold higher degrees in the biological sciences, which allowed registration by the South African Council for Natural Scientific Professions (SACNASP) as a Professional Zoologist that sanctions me to function independently as a specialist scientific consultant;
- declare that as per prerequisites of the Natural Scientific Professions Act No. 27 of 2003 this project was my own work from inception and reflects exclusively my observations and unbiased scientific interpretations, and executed to the best of my abilities;
- abide by the Code of Ethics of SACNASP;
- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate opportunities to learn through constructive criticism and debate, I reserve the right to form and hold my own opinions within the constraints of my training, experience and results and therefore will not submit willingly to the interests of other parties or change my statements to appease or unduly benefit them;
- am subcontracted as a specialist consultant for the project "Specialist Avifaunal Impact Assessment – Bravo 4 Power Line", as described in this report;
- have no financial interest in the proposed development other than remuneration for the work performed;
- do not have, and will not have in the future, any vested or conflicting interests in the proposed development;
- undertake to disclose to the consultant and its client(s) as well as to the competent authority any material information that may have the potential to influence any decisions by the competent authority, as required in terms of the Environmental Impact Assessment Regulations 2006;
- reserve the right to transfer my intellectual property contained in this report only to the client(s), (party or company that commissioned the work) on full payment of the contract fee. Upon transfer of the intellectual property, I recognise that written consent from the client will be required for me to release of any part of this report to third parties.
- In addition, remuneration for services provided by me is not subjected to or based on approval of the proposed project by the relevant authorities responsible for authorising this proposed project.

Andrew Edward McKechnie Pretoria, 12 June 2016

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Even though every care is taken to ensure the accuracy of this report, faunal and environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are made, to some extent, on reasonable and informed assumptions built on *bona fide* information sources, as well as deductive reasoning. A more factual report, based on field collecting and observations, can only be derived over several years and seasons of research, to account for fluctuating environmental conditions and animal migrations. Since environmental impact studies deal with dynamic natural systems, additional information may come to light at a later stage. The specialist can therefore not accept responsibility for conclusions and mitigation measures, made in good faith, based on own databases, and on the information provided at the time of the directive. Although the author exercised due care and diligence in rendering services and preparing documents, he accepts no liability and the client, by accepting this document, indemnifies the author against all actions, claims, demands, losses, liabilities, costs, damages and expenses that arise from or in connection with services rendered, directly or indirectly, by the author and use of this document. This report should therefore be viewed and acted upon with these limitations in mind.

Executive Summary

The proposed Bravo 4 project consists of 2 x 400 kV lines from Kendal power station to Zeus substation and Bravo power station to Zeus substation. These two lines will run parallel to each other in Mpumalanga Province, along a route approximately 70 km in length. The need for this line is related to the construction of the new Bravo power station between Bronkhorstspruit and Witbank, with the Kendal-Zeus line representing Phase 4 of the Bravo Integration Project. Alternative routes for these lines were evaluated previously by van Rooyen (2008).

The proposed line traverses two natural vegetation types, Eastern Highveld Grassland and Soweto Highveld Grassland, both of which are listed as Endangered based on their current conservation status. However, much of the area of area has been highly transformed by human activities such as agriculture, grazing, and coal mining.

Birds and avian habitats occurring at the site were surveyed through a desktop study (based in part on data from the South African Bird Atlas Project), and field surveys conducted on 4 June 2016. In addition, previous assessments of the impacts of this project on birds were consulted during the preparation of this report.

Avian habitats along the proposed power line route can be broadly divided into the following categories: grasslands, wetlands, water bodies and drainage lines, agricultural fields and urban areas. The grasslands along the route have generally been subjected to heavy grazing pressure, although some are still in good condition.

In broad terms, the impacts of the proposed power lines and required mitigation measures are as follows:

- Habitat loss – avian habitats will be lost in the areas cleared for the ~350 towers involved in this project. Additional habitat loss may occur during the construction phase, because of areas cleared for the construction of the towers and lines, new access roads, and clearing vegetation from the servitude. Construction activities should be confined to the area directly under the new lines, and as far as possible existing access roads should be used. No towers should be positioned in habitat suitable for African Grass-owls.

- Disturbance – construction activities, and to a lesser extent maintenance activities, will cause disturbance to birds along the route of the proposed power line. This impact will be most severe if it affects breeding birds, particularly threatened species. Construction should take place in winter, in order to minimise disturbance of breeding birds.

- Collisions – power lines can cause signficant avian mortality through collisions, and in South Africa species such as Ludwig's Bustard and Blue Cranes provide sobering examples of the severity of this impact for populations of threatened birds. Eskom already has a partnership with the Endangered Wildlife Trust focused on mitigating these impacts, and the current lines will require the installation of bird flight diverters in areas where species vulnerable to collisions are likely to move though. Areas of particular concern in this regard are where the proposed lines cross water bodies and/or drainage lines along which large-bodied species, particularly flamingoes, fly regularly. In addition, sections of the lines traversing habitat potentially suitable for Secretarybirds, African Grass-owls, White-bellied Korhaans and other threatened grassland species must be fitted with these devices. **It is strongly recommended that before construction commences, an ornithologist be engaged to examine the entire route with Eskom staff and identify spans requiring the installation of flight diverters.**

- Electrocution risk – the risk of birds being electrocuted is lower for the large 400 kV towers involved in this project compared to smaller 11 – 132 kV sub-transmission and reticulation lines. No specific mitigation requirements are needed beyond the installation of standard Eskom Bird Guards on all towers near water in order to prevent shorting caused by avian excreta.

- Electromagnetic fields – no specific mitigation measures are needed.

On the basis of the present desktop study, the author's opinion is that the negative avifaunal impacts associated with the proposed Bravo 4 lines can to a large extent be mitigated, and that the project should therefore go ahead. Once operational, the Bravo 4 lines should be regularly monitored for avian fatalities, and any additional spans subsequently identified as posing a collision risk will need to be retrofitted with bird flight diverters.

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1. INTRODUCTION

Eskom plans to construct 2 x 400 kV lines from Kendal power station to Zeus substation and Bravo power station to Zeus substation. These two lines will run parallel to each other in Mpumalanga Province, along a route approximately 90 km in length (Figure 1), and involving 186 towers, of which several in the vicinity of Zeus already exist. The need for this line is related to the construction of the new Bravo power station between Bronkhorstspruit and Witbank, with the Kendal-Zeus line representing Phase 4 of the Bravo Integration Project.

The route for these lines was selected on the basis of an evaluation of alternative routes by van Rooyen (2008). For this reason, the present report does not include impact assessments for any routes other than that shown in Figure 1.

The author was appointed by Limosella Consulting to undertake a specialist avifaunal impact assessment study of the proposed power lines. This investigation is in accordance with the EIA Regulations No. R982-985, Department of Environmental Affairs and Tourism, 4 December 2014 emanating from Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and other relevant legislation.

1.1 SCOPE AND OBJECTIVES OF THE STUDY

- To qualitatively and quantitatively assess the significance of the habitat components and current general conservation status of the study site;
- Identify and comment on ecologically sensitive areas or ecological services;
- Comment on connectivity with natural vegetation and habitats on adjacent terrain;
- To provide a list of species that occur or might occur, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the avifauna and habitats of the study site;
- To investigate the possibility of knock-on effects within the district as a result of the development, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.
- Calculate a significance rating for the proposed development.

1.2 DESKTOP ANALYSIS OF POTENTIAL IMPACTS

The major potential avifaunal impacts associated with power lines in general include the following:

- habitat loss
- disturbance, particularly during construction phase
- collisions
- electrocution
- electromagnetic fields

Below, each category of impact is discussed.

1.2.1 DISPLACEMENT THROUGH HABITAT LOSS AND HUMAN ACTIVITY

Worldwide, habitat loss through human activities represents a major cause for declining bird populations. Many species, particularly those restricted to scarce and/or fragmented habitat types, have experienced significant population decreases through the loss of habitat for mining, agriculture

etc. The central Highveld regions of South Africa are home to several such species, such as the *Vulnerable* African Grass-owl and *Vulnerable* White-bellied Korhaan. In the case of both these species, as well as many others, habitat losses and subsequent reliance on increasingly fragmented patches of natural habitat have been identified as key causes of recent population declines (Taylor et al. 2015). Any development that involves clearing and/or construction in natural vegetation risks placing additional pressure on already threatened species, and the presence of such species must be thoroughly investigated during the EIA process.

Human activities during the construction, operational and decommissioning phases of a project can also generate significant negative impacts. Many bird species are highly sensitive to disturbance, particularly when breeding. Human activities in the vicinity of breeding birds can cause significant problems for reproductive success, even when those activities are comparatively benign (e.g., avitourism, e.g., (Müllner et al. 2004).

1.2.2 DISTURBANCE DURING CONSTRUCTION PHASE

The construction phase of a project often involves much higher levels of activity than the subsequent operational phase, and disturbance of birds and other animals is often greatest during this phase. In addition to large numbers of vehicles and personnel being present on site, the construction phase often involves clearing of additional areas surrounding the development itself for purposes of temporary housing, vehicle maintenance, fuel depots, storage of construction materials, rubble dumping, etc. Many of these activities increase the probability of impacts such as fuel spills, as well as activities such as illegal hunting of birds by construction workers. For these reasons, the impacts of the construction phase need to feature prominently in the environmental management plan, and due care must be taken to avoid excessive impacts.

1.2.3 COLLISIONS

Bird deaths from collisions with power lines have been documented in many parts of the world. Some groups of birds are more susceptible to collisions with power lines than others, with the orders Galliformes (gamebirds), Gruiformes (cranes), and Ciconiiformes (storks and allies) being most vulnerable (Bevanger 1995). Variation among groups of birds in their likelihood of colliding with power lines appears to reflect variation in flight patterns and aerodynamics. Birds with high wing loading (i.e., higher body mass per unit wing area) collide more frequently with power lines than species with lower wing loading (Bevanger 1998, Janss 2000). In several studies, the most common collision victims were “poor fliers”, species with rapid flight and high wing loading resulting in a limited ability to rapidly change direction in mid-air and avoid collisions (Bevanger 1998, Janss 2000). In addition to characteristics of the birds themselves, an important determinant of collision risk is the structure of power lines. (Bevanger and Brøseth 2001) found that power lines with fewer wire levels in the vertical plane resulted in fewer avian collisions, a finding consistent with those of earlier studies (e.g., (Renssen et al. 1975). In the former study, significantly more birds collided with a power line before the removal of the lower earth wire than after removal.

In South Africa, collisions with power lines have been implicated in population declines of several threatened birds, with two key species being Ludwigs’ Bustard and Blue Crane. A recent study documented very high mortality rates for Ludwig’s Bustard in the Nama and Succulent Karoo, with an average of 0.63 fatal collisions per km of 400 kV transmission line per year (Jenkins et al. 2011). These authors extrapolated this average collision rate across the bustard’s range, and estimated that collisions kill 4,000 – 11,900 individuals per year. Given that the total population of this southern African near-endemic is thought to number no more than 81,000 birds, the current power-line-associated mortality rate is extremely alarming (Jenkins et al. 2011). Blue Cranes, South Africa’s national bird, have also been hard-hit. In the Overberg region of the Western Cape, recent data suggest that around 12 % of the local Blue Crane population is killed by collisions each year, a

mortality rate that is completely unsustainable (Shaw et al. 2010). These two studies provide a sobering insight into the potential impacts of power lines on birds, and underscore the extreme caution required when erecting power lines anywhere in southern Africa.

1.2.4 ELECTROCUTIONS

The second major threat posed to birds by power lines is electrocution. In several studies, electrocution victims ranged in size from large species (e.g., vultures, and storks) to medium and small species (e.g., falcons, starlings) (Bevanger 1998, Janss 2000, Mañosa 2001). On pylons constructed of conductive materials (e.g., steel), even small species can create a short circuit between a live wire and the pylon (Janss 2000). Even when pylons are constructed of non-conductive materials (e.g., wood), small species are electrocuted when several perching and/or flying individuals come into contact with each other, creating a short circuit between wires (Bevanger 1998). In general, groups most susceptible to electrocution are the orders Ciconiiformes (storks and allies), Falconiformes (raptors, including vultures), Strigiformes (owls) and Passeriformes (songbirds) (Bevanger 1995). Pylon structure is an important determinant of electrocution risk (Mañosa 2001). In a comparison of five pylon designs, the "crossbow" design was found to be the most dangerous in terms of avian electrocution, whereas the vertically arranged design was safest (Mañosa 2001). Electrocution can have profound impacts on populations of endangered species. A recent study of the population impacts of electrocution in Eagle Owls (*Bubo bubo*) in Europe revealed that population dynamics were severely affected by the presence of power lines (Sergio et al. 2004). Over a 10-year period, the majority of Eagle Owl territories near power lines were abandoned, leading to a significant decline in population size (Sergio et al. 2004). In southern Africa, Cape Vultures (*Gyps coprotheres*) perching on power lines have been severely affected by electrocution (Ledger and Annegarn 1981, Hobbs and Ledger 1986, van Rooyen 2000, 2003).

1.2.5 ELECTROMAGNETIC FIELDS

There is some evidence that electromagnetic fields (EMFs) generated by power lines affect aspects of avian behaviour, reproductive success, growth and development, and physiology and hormone levels (Fernie and Reynolds 2005). However, the results of studies examining the effects of EMFs vary in their findings, and it is not currently possible to draw general conclusions regarding the effects of power line EMFs on avian survival and reproduction (Fernie et al. 2000, Fernie and Reynolds 2005). More recently, experimental evidence has emerged that "electrosmog", electromagnetic noise associated with high densities of electronic devices in urban areas, interferes with the ability of migrant birds to navigate by disrupting their sense of magnetoreception (Engels et al. 2014).

1.3 DESCRIPTION OF STUDY AREA

Eskom propose to construct two new 400 kV power lines, one from Bravo to Zeus and the other one from the Kendal Power Station (near Ogies) to the Zeus substation (near Secunda),Mpumalanga. A section of existing line joins the Bravo substation to the new proposed kV line. These lines will run parallel to each other and will be approximately 90 km in length. The lines run south past the towns of Evander and Leandra for about 72 kilometres to the Zeus substation north of Standerton (Figure 1). The Land-Use is dominated by cultivated fields (maize), grazed grasslands, urban centres, coal mines and power stations.

The Mpumalanga Biodiversity Conservation Plan: Critical Biodiversity Areas (Terrestrial) Map show the lines traversing areas with sensitivity scores ranging from Irreplaceable to No Habitat Remaining. The central section of the line crosses a large area classified as Highly Significant (Figure 2).

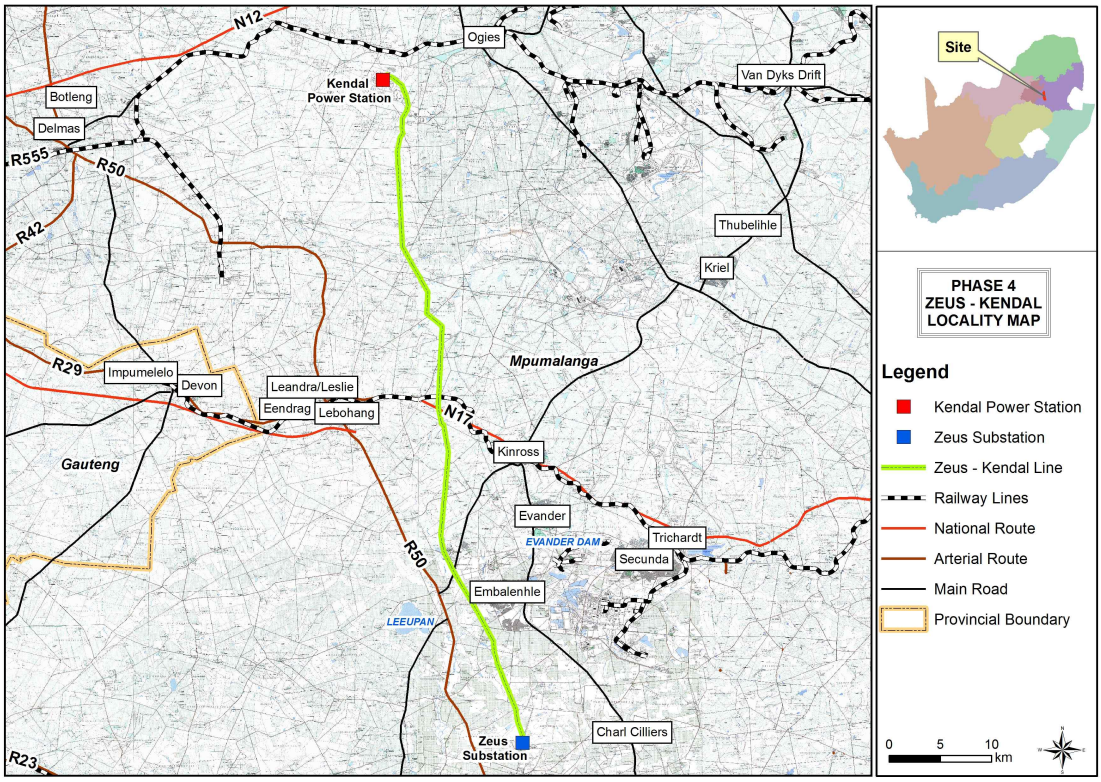

Figure 6: *Location of the Bravo 4 powerline.*

1.3.1 CONSERVATION STATUS

Conservation status as indicated by the National Biodiversity Assessment (SANBI, 2011) shows the entire proposed line crossing land classified as Vulnerable (Figure 3).

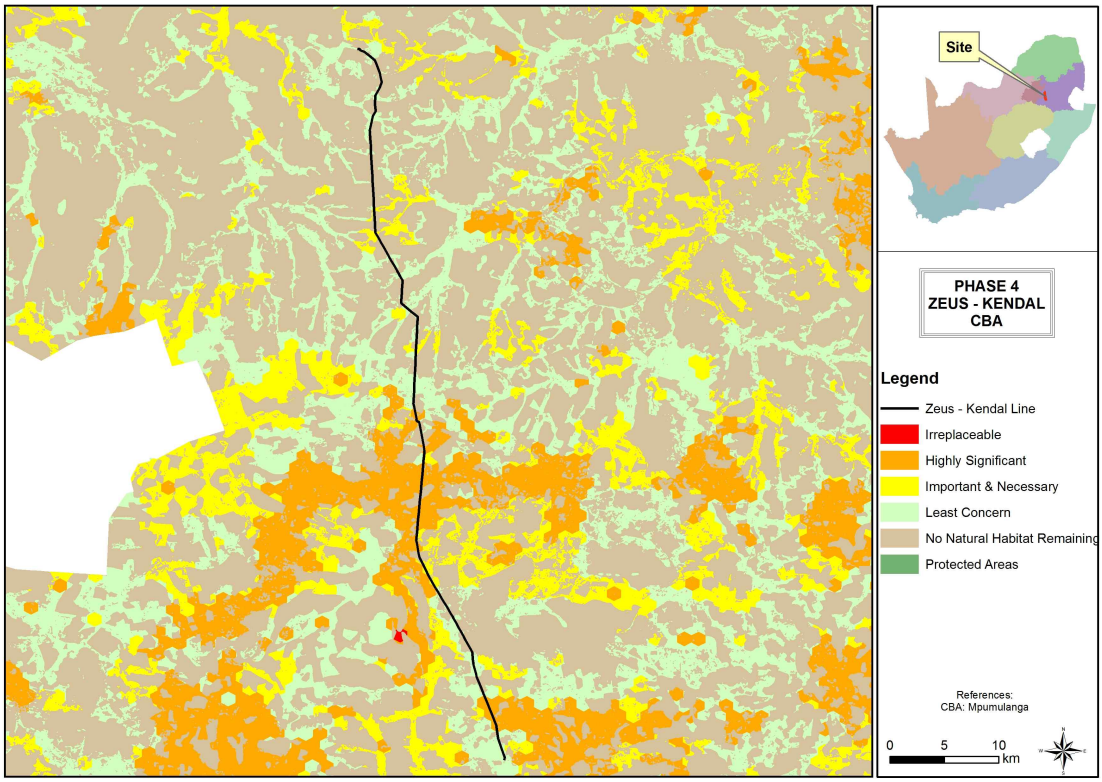

Figure 7: *Conservation status of areas traversed by the proposed powerline as classified in the Mpumalanga regional dataset.*

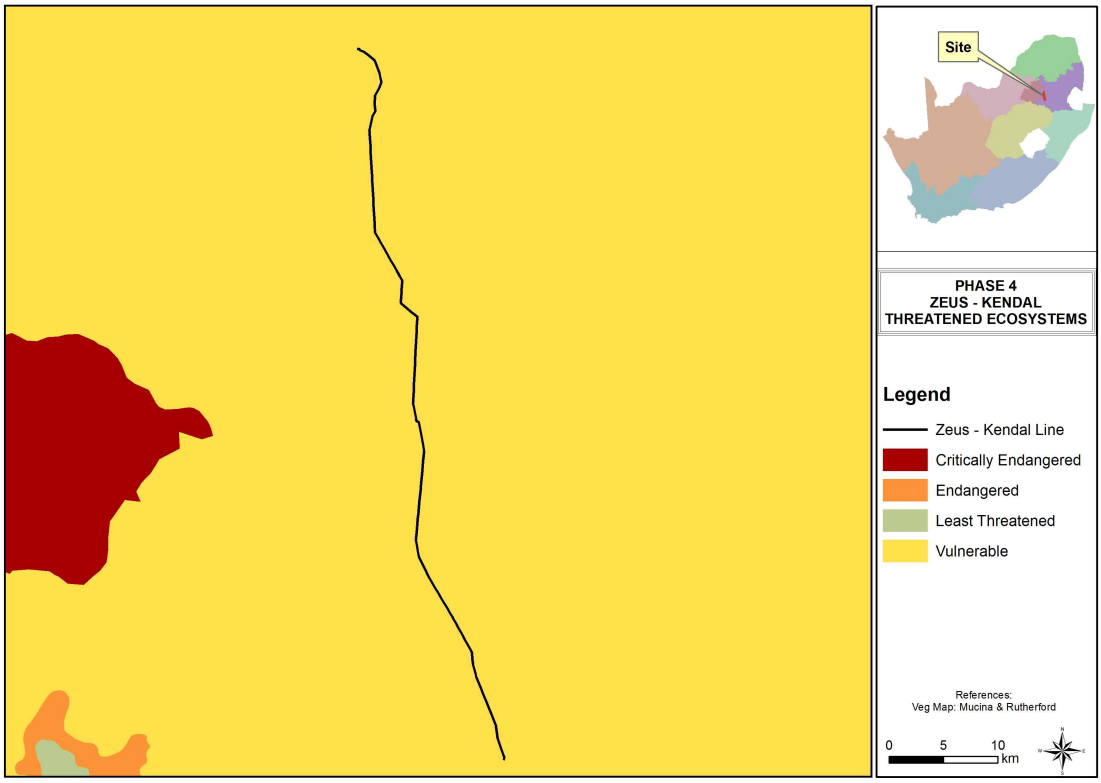

Figure 8: *Threatened ecosystems as classified by the 2011 SANBI National Biodiversity Assessment.*

1.3.2 VEGETATION TYPES

The vegetation classification of South Africa (Mucina & Rutherford, 2006) classifies vegetation types crossed by the proposed lines as Eastern Highveld Grassland and Soweto Highveld Grassland. Both these vegetation types are listed as Endangered based on their current conservation status (Mucina & Rutherford, 2006).

The accompanying floral report presents a more comprehensive overview of the site, incorporating all the elements underpinning the above-mentioned vegetation units.

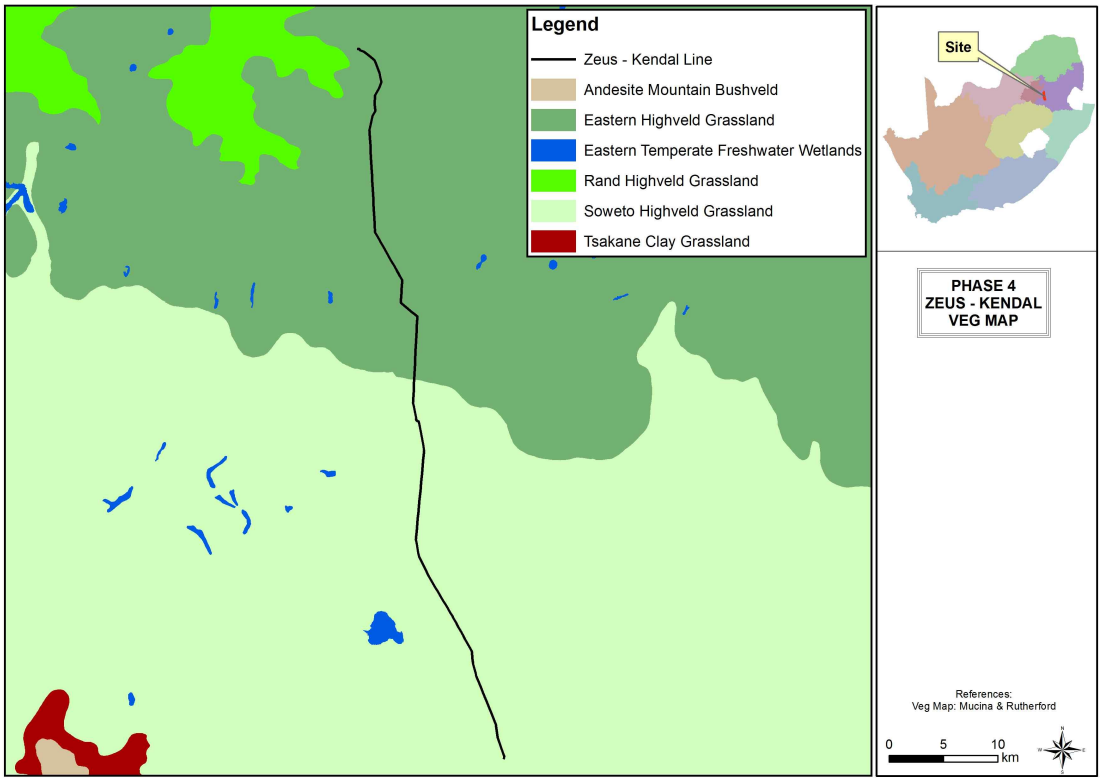

***Figure 9**: Vegetation classification for the proposed powerlines.*

1.3.3 REGIONAL HYDROLOGY

The study area falls within the Olifants River (Catchment B) and Vaal River (Catchment C). Quaternary Catchments relevant to the proposed lines are B20F, B20E, B11E, C12D and C12F. The main river in the northern section of the site is the Wilge River along with the Kromdraai Spruit and the Riet Spruit. All these watercourses drain primarily northwards towards the Olifants River. The southern section of the lines drains into the Rolspruit and the Kaapspruit and eventually into the Vaal River. Several non-perennial streams and drainage lines also occur throughout the area, draining towards the main rivers (Figure 5).

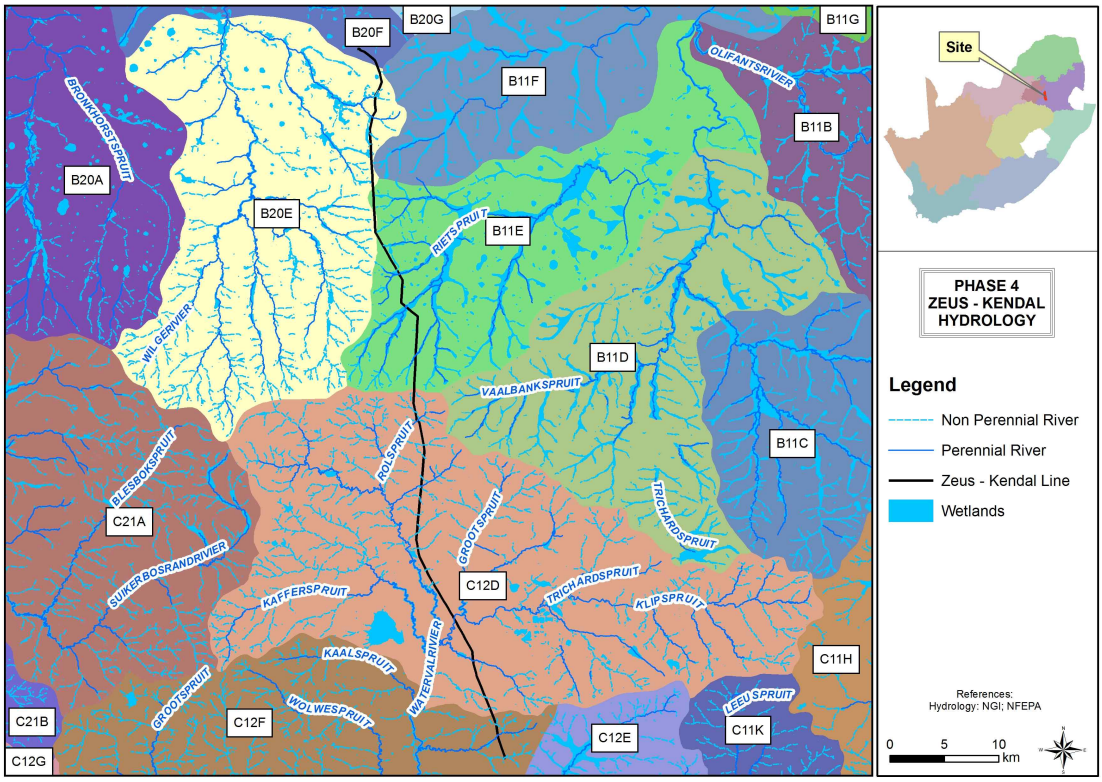

Figure 10: *Hydrology map of the site and water features in the proximity of the powerline route.*

2. METHODS

Birds occurring along the route of the proposed development were assessed in several steps, as detailed below. Red-listed species were identified using the most recent (2015) Red Data Book for South Africa, Lesotho and Swaziland (Taylor et al. 2015).

2.1 DESKTOP STUDY

Prior to the site visit, a desktop study was undertaken in which bird species that potentially occur at the site and in the surrounding areas were identified using data from the first and second South African Bird Atlas Projects (SABAP 1 and 2). SABAP 2 data are based on records for pentads (i.e., 5' X 5'), whereas SABAP 1 data were based on quarter-degree grid cells (i.e., 15' X 15'). A list of species potentially occurring along the route of the proposed power line was developed using data for all the SABAP 2 pentads within which the project is located, plus surrounding pentads (Figure 6). The pentads at the four corners of this region are: northwest: 2600_2850; northeast: 2600_2900; southeast: 2645_2905; southwest: 2645_2850. The area considered during the desktop study is thus much larger than the area likely to be affected by the project (Figure 6). This approach is adopted to ensure that all species potentially occurring at the site, whether resident, nomadic, or migratory, are identified.

2.2 FIELD SURVEYS

A site visit took place on 4 June 2016, with a total of approximately 8 hours spent along the power line route.

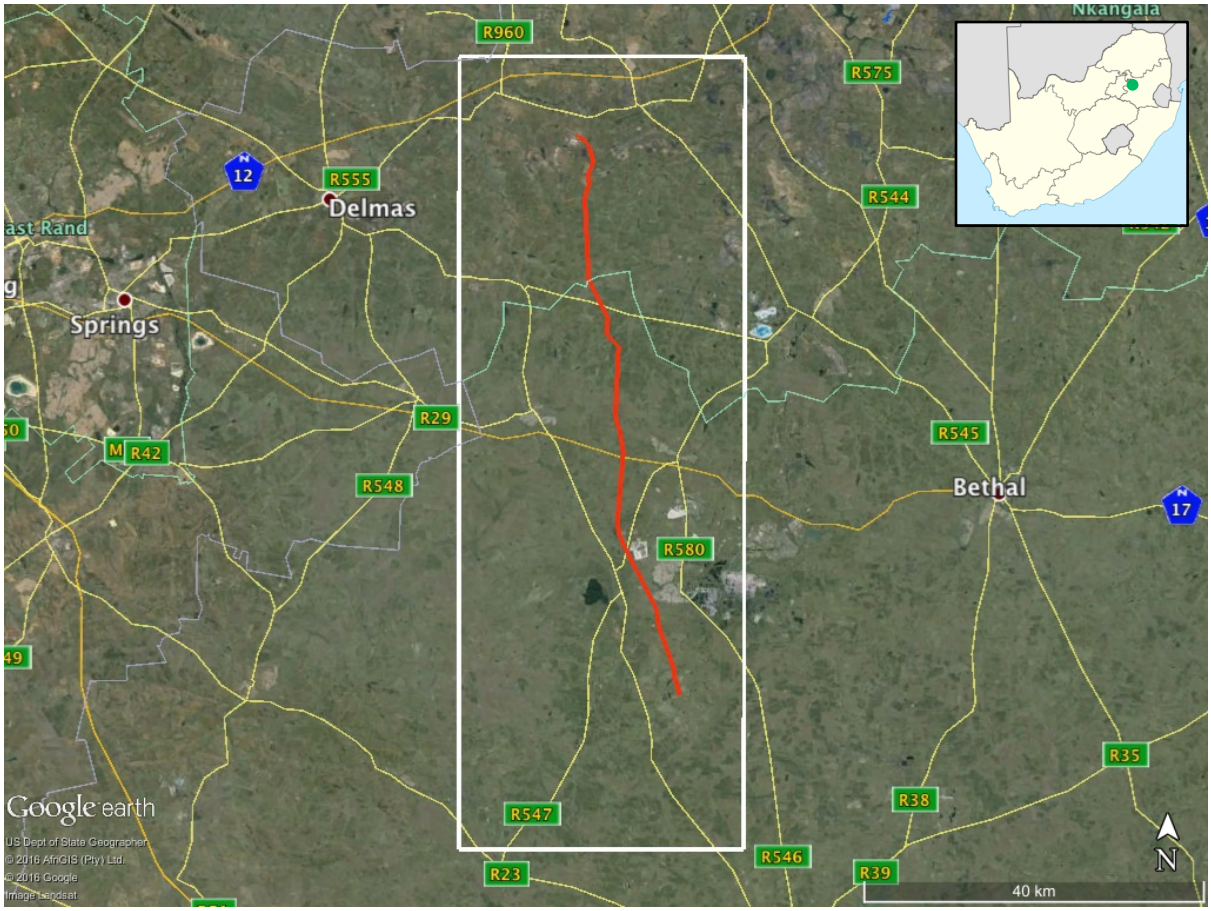

Figure 6. *Approximate extent of area included (white rectangle) when generating the list of birds potentially occurring along the route of the proposed power lines (red line). Image courtesy of Google Earth, and inset outline map showing national context courtesy of Wikipedia.*

2.2.1 INTENSIVE SEARCHING AND HABITAT ASSESSMENT

During the field survey, birds occurring along the route and adjacent areas were identified during transects. During these transects, an observer with binoculars walked slowly through the site, identifying all birds encountered (seen or heard), identifying nests observed, and assessing the avian habitats present. This methodology is loosely based on the point count method of (Ralph et al. 1993). One key issue with avian censuses concerns the relationship between detectability and distance from an observer; several authors have proposed methods to correct census data for this problem. However, the open nature of the habitat along the Bravo 4 route means that detectability remains relatively constant with distance from an observer, unlike the case in dense forests, for instance.

2.2.2 ROAD SURVEYS AND HABITAT ASSESSMENT

Because of the high mobility of birds, during the field survey habitats occurring within approximately 10 km of the power line route were surveyed by means of road transects, driving at a maximum of 60 km/h and noting all available habitats and birds detected. This survey method is particularly effective for detecting birds that habitually perch on power lines, including many raptors.

2.2.3 CONSULTATION OF PREVIOUS REPORTS

The Bravo 4 Kendall – Zeus power line has been the subject of several previous avifaunal impact assessments. Van Rooyen (van Rooyen 2008) conducted an Bird Impact Assessment Study, in which three alternate routes were evaluated and one selected based on minimising impacts on avifauna. More recently, Smallie (Smallie 2012) conducted an avifaunal walk through, and provided

recommendations as to specific sections of the power lines that should be fitted with bird flight diverters. Both these studies were extensively consulted during the process of compiling the present report, and their recommendations have been incorporated here.

2.2.4 LIMITATIONS OF BASELINE DATA

- Bird species occurring at the site of the proposed project were intensively assessed during one day, and the possibility exists that rarer species in the area were not encountered due to the short time spent on site. This constraint is partly offset by the incorporation of data in from SABAP 1 and SABAP 2.
- The field surveys took place in winter, a time of year when migrants are absent and bird activity is reduced compared to summer. This constraint is partly offset by the incorporation of data in from SABAP 1 and SABAP 2. Moreover, the area of the proposed power lines is relatively well-covered in terms of atlasing effort, meaning that bird lists compiled from SABAP data are more reliable than would be the case for remote areas in which little atlassing has taken place.
- The behaviour and ecology of birds, like that of other organisms, is not completely predictable. The overall impacts of the proposed project can reliably be predicted on the basis of impacts observed elsewhere, but it is important to appreciate that specific, and sometimes subtle, local factors can modify interactions between birds and human activities

3. RESULTS

The proposed Bravo 4 power line does not fall within a recognized Important Bird and Biodiversity Area (Marnewick et al. 2015).

3.1 AVIAN HABITATS ALONG THE POWER LINE ROUTE

Based on examination of satellite imagery and the site visit, the avian habitats along the proposed power line route can be broadly divided into the following categories:

- Grasslands – much of the route, particularly in the southern section, traverses natural grassland, much of which is heavily grazed and distrubed. Some of the grasslands are considered suitable for threatened species such as African Grass-owl and Secretarybird, with White-bellied Korhaan possible but less likely.

- Wetlands – a number of wetlands occur along the route of the proposed power lines. Many ave been transformed by human activities, but some nevertheless represent habitat for wetland-associated species.

- Water bodies and drainage lines – the proposed route traverses a number of water bodies (primarily small farm dams) and drainage lines. These provide habitat for a number of aquatic and riparian species. The largest of these water bodies is Leeupan, located ~5km west of the power line route, and which holds large numbers of waterbirds. Another dam, located near Brendan village, had large numbers of Greater Flamingos present during the field survey.

- Agricultural fields – large areas along the route are made up of transformed agricultural landscapes, with irrigated maize and sunflower fields predominating.

- Urban areas – in some places the power lines route runs near urban áreas, including mine villages.

Figure 7. *Heavily grazed grasslands typical of much of the southern section of the proposed Bravo 4 power line route.*

Figure 8. *Heavily grazed grasslands typical of much of the southern section of the proposed Bravo 4 power line route. Photo taken along route near Brendan Village*

Figure 9. *Dam at 26°30'7.8"S 29° 1'3.2"E near Brendan Village. Note the number of flamingos present.*

Figure 10. *Grasslands and small dams; this is scenery typical of areas along the route in the Kinross area.*

Figure 11. *Agricultural fields in the area around Kendall power station.*

3.2 BASELINE DATA: BIRDS OCCURRING ALONG THE POWER LINE ROUTE

A total of 295 species have been recorded during SABAP 1 and SABAP 2 in the area considered for the desktop survey. Of these, the presence of 41 was confirmed during surveys and 61 are considered highly likely to occur along the route, with an additional 86 species whose likelihood of occurrence is considered medium (Table 1). These species include grassland specialists, water birds, as well as species characteristic of agricultural and urban areas.

Table 1. *Bird species recorded in the area considered for the desktop survey (see Figure 6). The current (2015) regional red data status ("RD" column) of each red-listed species is provided (NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered), and the likelihood of each species occurring along the power line route is rated as high, medium or low.*

English name	Scientific name	RD	Likelihood	English name	Scientific name	RD	Likelihood
Apalis, Bar-throated	*Apalis thoracica*		Low	Avocet, Pied	*Recurvirostra avosetta*		Medium
Babbler, Arrow-marked	*Turdoides jardineii*		Low	Barbet, Acacia Pied	*Tricholaema leucomelas*		Low
Barbet, Black-collared	*Lybius torquatus*		Medium	Barbet, Crested	*Trachyphonus vaillantii*		Medium
Bee-eater, European	*Merops apiaster*		High	Bee-eater, White-fronted	*Merops bullockoides*		Low
Bishop, Southern Red	*Euplectes orix*		Confirmed	Bishop, Yellow	*Euplectes capensis*		Low
Bishop, Yellow-crowned	*Euplectes afer*		High	Bittern, Little	*Ixobrychus minutus*		Low
Bokmakierie	*Telophorus zeylonus*		Confirmed	Bulbul, African Red-eyed	*Pycnonotus nigricans*		Low
Bulbul, Dark-capped	*Pycnonotus tricolor*		Medium	Bunting, Cape	*Emberiza capensis*		Low
Bunting, Cinnamon-breasted	*Emberiza tahapisi*		Low	Bustard, Denham's	*Neotis denhami*	VU	Low
Buttonquail, Kurrichane	*Turnix sylvaticus*		Low	Buzzard, Jackal	*Buteo rufofuscus*		Confirmed
Buzzard, Steppe	*Buteo vulpinus*		High	Canary, Black-throated	*Crithagra atrogularis*		High
Canary, Cape	*Serinus canicollis*		Low	Canary, Yellow	*Crithagra flaviventris*		Medium
Canary, Yellow-fronted	*Crithagra mozambicus*		Medium	Chat, Anteating	*Myrmecocichla formicivora*		High
Chat, Familiar	*Cercomela familiaris*		Low	Chat, Sickle-winged	*Cercomela sinuata*		Low
Cisticola, Cloud	*Cisticola textrix*		High	Cisticola, Desert	*Cisticola aridulus*		Low
Cisticola, Levaillant's	*Cisticola tinniens*		High	Cisticola, Pale-crowned	*Cisticola cinnamomeus*		Low
Cisticola, Wailing	*Cisticola lais*		Medium	Cisticola, Wing-snapping	*Cisticola ayresii*		High
Cisticola, Zitting	*Cisticola juncidis*		Confirmed	Cliff-swallow, South African	*Hirundo spilodera*		High
Coot, Red-knobbed	*Fulica cristata*		Confirmed	Cormorant, Reed	*Phalacrocorax africanus*		Confirmed
Cormorant, White-breasted	*Phalacrocorax carbo*		High	Coucal, Burchell's	*Centropus burchellii*		Low
Coucal, White-browed	*Centropus superciliosus*		Low	Courser, Double-banded	*Rhinoptilus africanus*		Low
Crake, Baillon's	*Porzana pusilla*		Low	Crake, Black	*Amaurornis flavirostris*		Medium
Crane, Blue	*Anthropoides paradiseus*	NT	High	Crane, Grey Crowned	*Balearica regulorum*	EN	Low
Crane, Wattled	*Bugeranus*	CR	Low	Crombec, Long-billed	*Sylvietta rufescens*		Low

	carunculatus		
Crow, Cape	*Corvus capensis*		Medium
Cuckoo, African	*Cuculus gularis*		Low
Cuckoo, Klaas's	*Chrysococcyx klaas*		Low
Darter, African	*Anhinga rufa*		High
Dove, Namaqua	*Oena capensis*		Medium
Dove, Rock	*Columba livia*		High
Duck, African Black	*Anas sparsa*		Medium
Duck, Fulvous	*Dendrocygna bicolor*		Medium
Duck, White-backed	*Thalassornis leuconotus*		Medium
Duck, Yellow-billed	*Anas undulata*		High
Eagle, Long-crested	*Lophaetus occipitalis*		Low
Egret, Great	*Egretta alba*		Medium
Egret, Yellow-billed	*Egretta intermedia*		High
Falcon, Lanner	*Falco biarmicus*	VU	Medium
Falcon, Red-footed	*Falco vespertinus*	NT	High
Finch, Red-headed	*Amadina erythrocephala*		Confirmed
Fiscal, Common (Southern)	*Lanius collaris*		Confirmed
Flamingo, Greater	*Phoenicopterus ruber*	NT	Confirmed
Flufftail, Red-chested	*Sarothrura rufa*		Medium
Flycatcher, Fiscal	*Sigelus silens*		Low
Francolin, Grey-winged	*Scleroptila africanus*		Low
Francolin, Red-winged	*Scleroptila levaillantii*		Low
Go-away-bird, Grey	*Corythaixoides concolor*		Low
Goose, Egyptian	*Alopochen aegyptiacus*		Confirmed
Grass-owl, African	*Tyto capensis*	VU	Confirmed
Grebe, Black-necked	*Podiceps nigricollis*		Medium

Crow, Pied	*Corvus albus*		Confirmed
Cuckoo, Diderick	*Chrysococcyx caprius*		High
Cuckoo, Red-chested	*Cuculus solitarius*		Low
Dove, Laughing	*Streptopelia senegalensis*		Confirmed
Dove, Red-eyed	*Streptopelia semitorquata*		Confirmed
Drongo, Fork-tailed	*Dicrurus adsimilis*		Low
Duck, Comb	*Sarkidiornis melanotos*		Medium
Duck, Maccoa	*Oxyura maccoa*	NT	Medium
Duck, White-faced	*Dendrocygna viduata*		High
Eagle-owl, Spotted	*Bubo africanus*		Medium
Egret, Cattle	*Bubulcus ibis*		High
Egret, Little	*Egretta garzetta*		High
Falcon, Amur	*Falco amurensis*		High
Falcon, Peregrine	*Falco peregrinus*		Low
Finch, Cuckoo	*Anomalospiza imberbis*		Low
Finch, Scaly-feathered	*Sporopipes squamifrons*		Low
Fish-eagle, African	*Haliaeetus vocifer*		Medium
Flamingo, Lesser	*Phoenicopterus minor*	NT	High
Flycatcher, Fairy	*Stenostira scita*		Low
Flycatcher, Spotted	*Muscicapa striata*		Low
Francolin, Orange River	*Scleroptila levaillantoides*		Confirmed
Francolin, Shelley's	*Scleroptila shelleyi*		Low
Godwit, Black-tailed	*Limosa limosa*		Low
Goose, Spur-winged	*Plectropterus gambensis*		High
Grassbird, Cape	*Sphenoeacus afer*		Medium
Grebe, Great Crested	*Podiceps cristatus*		Medium

Grebe, Little	*Tachybaptus ruficollis*		Confirmed
Guineafowl, Helmeted	*Numida meleagris*		Confirmed
Gull, Lesser Black-backed	*Larus fuscus*		Low
Harrier-Hawk, African	*Polyboroides typus*		Low
Harrier, Montagu's	*Circus pygargus*		Medium
Heron, Black	*Egretta ardesiaca*		Low
Heron, Goliath	*Ardea goliath*		Medium
Heron, Grey	*Ardea cinerea*		Confirmed
Heron, Squacco	*Ardeola ralloides*		Medium
Honeyguide, Greater	*Indicator indicator*		Low
House-martin, Common	*Delichon urbicum*		Low
Ibis, Glossy	*Plegadis falcinellus*		Confirmed
Ibis, Southern Bald	*Geronticus calvus*	VU	Medium
Kestrel, Greater	*Falco rupicoloides*		High
Kestrel, Rock	*Falco rupicolus*		Medium
Kingfisher, Malachite	*Alcedo cristata*		Medium
Kite, Black-shouldered	*Elanus caeruleus*		Confirmed
Korhaan, Blue	*Eupodotis caerulescens*		High
Korhaan, White-bellied	*Eupodotis senegalensis*	VU	Medium
Lapwing, Blacksmith	*Vanellus armatus*		High
Lark, Botha's	*Spizocorys fringillaris*	EN	Low
Lark, Eastern Long-billed	*Certhilauda semitorquata*		Low
Lark, Pink-billed	*Spizocorys conirostris*		Medium
Lark, Rufous-naped	*Mirafra africana*		High
Lark, Spike-heeled	*Chersomanes albofasciata*		Medium
Marsh-harrier, African	*Circus ranivorus*	EN	High
Martin, Brown-throated	*Riparia paludicola*		High
Martin, Sand	*Riparia riparia*		Medium

Greenshank, Common	*Tringa nebularia*		Medium
Gull, Grey-headed	*Larus cirrocephalus*		High
Hamerkop	*Scopus umbretta*		Medium
Harrier, Black	*Circus maurus*	EN	Medium
Harrier, Pallid	*Circus macrourus*		Low
Heron, Black-headed	*Ardea melanocephala*		Confirmed
Heron, Green-backed	*Butorides striata*		Low
Heron, Purple	*Ardea purpurea*		Medium
Hobby, Eurasian	*Falco subbuteo*		Low
Hoopoe, African	*Upupa africana*		Medium
Ibis, African Sacred	*Threskiornis aethiopicus*		Confirmed
Ibis, Hadeda	*Bostrychia hagedash*		Confirmed
Jacana, African	*Actophilornis africanus*		Low
Kestrel, Lesser	*Falco naumanni*		Medium
Kingfisher, Giant	*Megaceryle maximus*		Medium
Kingfisher, Pied	*Ceryle rudis*		High
Kite, Yellow-billed	*Milvus aegyptius*		Low
Korhaan, Northern Black	*Afrotis afraoides*		Medium
Lapwing, African Wattled	*Vanellus senegallus*		High
Lapwing, Crowned	*Vanellus coronatus*		High
Lark, Eastern Clapper	*Mirafra fasciolata*		Low
Lark, Melodious	*Mirafra cheniana*		Low
Lark, Red-capped	*Calandrella cinerea*		Confirmed
Lark, Sabota	*Calendulauda sabota*		Low
Longclaw, Cape	*Macronyx capensis*		Confirmed
Martin, Banded	*Riparia cincta*		Medium
Martin, Rock	*Hirundo fuligula*		Medium
Masked-weaver, Southern	*Ploceus velatus*		Confirmed

Moorhen, Common	*Gallinula chloropus*		High
Mousebird, Speckled	*Colius striatus*		Medium
Neddicky	*Cisticola fulvicapilla*		High
Nightjar, European	*Caprimulgus europaeus*		Low
Oriole, Black-headed	*Oriolus larvatus*		Low
Ostrich, Common (domestic)	*Struthio camelus*		Confirmed
Owl, Marsh	*Asio capensis*		High
Palm-swift, African	*Cypsiurus parvus*		Medium
Paradise-whydah, Long-tailed	*Vidua paradisaea*		Low
Pigeon, Speckled	*Columba guinea*		Confirmed
Pipit, Buffy	*Anthus vaalensis*		Low
Pipit, Plain-backed	*Anthus leucophrys*		Medium
Plover, Common Ringed	*Charadrius hiaticula*		Medium
Plover, Kittlitz's	*Charadrius pecuarius*		Medium
Plover, White-fronted	*Charadrius marginatus*		Low
Pratincole, Black-winged	*Glareola nordmanni*	NT	Medium
Prinia, Tawny-flanked	*Prinia subflava*		Medium
Quail, Common	*Coturnix coturnix*		High
Quailfinch, African	*Ortygospiza atricollis*		Confirmed
Rail, African	*Rallus caerulescens*		Low
Reed-warbler, Great	*Acrocephalus arundinaceus*		Low
Rock-thrush, Cape	*Monticola rupestris*		Low
Roller, European	*Coracias garrulus*	NT	Low
Ruff	*Philomachus pugnax*		Medium
Sandpiper, Common	*Actitis hypoleucos*		Medium
Sandpiper, Marsh	*Tringa stagnatilis*		Medium
Scimitarbill, Common	*Rhinopomastus cyanomelas*		Low
Seedeater, Streaky-headed	*Crithagra gularis*		Low

Mousebird, Red-faced	*Urocolius indicus*		Medium
Myna, Common	*Acridotheres tristis*		Confirmed
Night-Heron, Black-crowned	*Nycticorax nycticorax*		Medium
Openbill, African	*Anastomus lamelligerus*		Low
Oriole, Eurasian Golden	*Oriolus oriolus*		Low
Owl, Barn	*Tyto alba*		Low
Painted-snipe, Greater	*Rostratula benghalensis*	NT	High
Paradise-flycatcher, African	*Terpsiphone viridis*		Low
Pelican, Pink-backed	*Pelecanus rufescens*	VU	Medium
Pipit, African	*Anthus cinnamomeus*		Confirmed
Pipit, Long-billed	*Anthus similis*		Low
Plover, Chestnut-banded	*Charadrius pallidus*	NT	Medium
Plover, Grey	*Pluvialis squatarola*		Low
Plover, Three-banded	*Charadrius tricollaris*		High
Pochard, Southern	*Netta erythrophthalma*		High
Prinia, Black-chested	*Prinia flavicans*		Confirmed
Pytilia, Green-winged	*Pytilia melba*		Low
Quail, Harlequin	*Coturnix delegorguei*		Medium
Quelea, Red-billed	*Quelea quelea*		Confirmed
Reed-warbler, African	*Acrocephalus baeticatus*		Medium
Robin-chat, Cape	*Cossypha caffra*		Medium
Rock-thrush, Sentinel	*Monticola explorator*		Low
Roller, Lilac-breasted	*Coracias caudatus*		Low
Rush-warbler, Little	*Bradypterus baboecala*		Medium
Sandpiper, Curlew	*Calidris ferruginea*		Medium
Sandpiper, Wood	*Tringa glareola*		Medium
Secretarybird	*Sagittarius serpentarius*		High
Shelduck, South African	*Tadorna cana*		Medium

Shoveler, Cape	*Anas smithii*		High
Shrike, Red-backed	*Lanius collurio*		Medium
Snipe, African	*Gallinago nigripennis*		High
Sparrow, Cape	*Passer melanurus*		High
Sparrow, Southern Grey-headed	*Passer diffusus*		High
Sparrowlark, Chestnut-backed	*Eremopterix leucotis*		Medium
Spurfowl, Natal	*Pternistis natalensis*		Low
Starling, Cape Glossy	*Lamprotornis nitens*		High
Starling, Red-winged	*Onychognathus morio*		Low
Stilt, Black-winged	*Himantopus himantopus*		Confirmed
Stonechat, African	*Saxicola torquatus*		Confirmed
Stork, Black	*Ciconia nigra*	VU	Low
Stork, Yellow-billed	*Mycteria ibis*	EN	High
Sunbird, Malachite	*Nectarinia famosa*		Low
Swallow, Greater Striped	*Hirundo cucullata*		High
Swallow, Red-breasted	*Hirundo semirufa*		Low
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*		Medium
Swift, African Black	*Apus barbatus*		Low
Swift, Common	*Apus apus*		Low
Swift, Little	*Apus affinis*		High
Teal, Cape	*Anas capensis*		Medium
Teal, Red-billed	*Anas erythrorhyncha*		High
Tern, Whiskered	*Chlidonias hybrida*		Medium
Thick-knee, Spotted	*Burhinus capensis*		High
Thrush, Karoo	*Turdus smithi*		Medium
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*		Low
Turnstone, Ruddy	*Arenaria interpres*		Low

Shrike, Lesser Grey	*Lanius minor*		Medium
Snake-eagle, Black-chested	*Circaetus pectoralis*		Low
Sparrow-weaver, White-browed	*Plocepasser mahali*		Medium
Sparrow, House	*Passer domesticus*		High
Sparrowhawk, Black	*Accipiter melanoleucus*		Low
Spoonbill, African	*Platalea alba*		High
Spurfowl, Swainson's	*Pternistis swainsonii*		Confirmed
Starling, Pied	*Spreo bicolor*		High
Starling, Wattled	*Creatophora cinerea*		Medium
Stint, Little	*Calidris minuta*		Medium
Stork, Abdim's	*Ciconia abdimii*	NT	Low
Stork, White	*Ciconia ciconia*		Medium
Sunbird, Amethyst	*Chalcomitra amethystina*		Low
Swallow, Barn	*Hirundo rustica*		High
Swallow, Lesser Striped	*Hirundo abyssinica*		Medium
Swallow, White-throated	*Hirundo albigularis*		High
Swamphen, African Purple	*Porphyrio madagascariensis*		Medium
Swift, Alpine	*Tachymarptis melba*		Low
Swift, Horus	*Apus horus*		Low
Swift, White-rumped	*Apus caffer*		High
Teal, Hottentot	*Anas hottentota*		Low
Tern, Caspian	*Sterna caspia*		Low
Tern, White-winged	*Chlidonias leucopterus*		Medium
Thrush, Groundscraper	*Psophocichla litsipsirupa*		Low
Thrush, Olive	*Turdus olivaceus*		Low
Tit, Ashy	*Parus cinerascens*		Low
Turtle-dove, Cape	*Streptopelia capicola*		Confirmed

Vulture, Cape	*Gyps coprotheres*	EN	Low
Wagtail, Yellow	*Motacilla flava*		Low
Warbler, Icterine	*Hippolais icterina*		Low
Warbler, Sedge	*Acrocephalus schoenobaenus*		Low
Waxbill, Common	*Estrilda astrild*		High
Weaver, Cape	*Ploceus capensis*		Confirmed
Wheatear, Capped	*Oenanthe pileata*		High
White-eye, Cape	*Zosterops virens*		Medium
Whydah, Pin-tailed	*Vidua macroura*		Confirmed
Widowbird, Long-tailed	*Euplectes progne*		Confirmed
Widowbird, White-winged	*Euplectes albonotatus*		Confirmed
Woodpecker, Cardinal	*Dendropicos fuscescens*		Medium
Wryneck, Red-throated	*Jynx ruficollis*		Medium
Wagtail, Cape	*Motacilla capensis*		High
Warbler, Garden	*Sylvia borin*		Low
Warbler, Marsh	*Acrocephalus palustris*		Low
Warbler, Willow	*Phylloscopus trochilus*		Medium
Waxbill, Orange-breasted	*Amandava subflava*		Medium
Weaver, Village	*Ploceus cucullatus*		Low
Wheatear, Mountain	*Oenanthe monticola*		Medium
Whitethroat, Common	*Sylvia communis*		Low
Widowbird, Fan-tailed	*Euplectes axillaris*		High
Widowbird, Red-collared	*Euplectes ardens*		Medium
Wood-hoopoe, Green	*Phoeniculus purpureus*		Medium
Woodpecker, Ground	*Geocolaptes olivaceus*		Low

3.2 BASELINE DATA: THREATENED SPECIES OCCURRING ALONG THE POWER LINE ROUTE

A total of 24 threatened or near-threatened species have been recorded during SABAP 1 and SABAP 2 in the area considered for the desktop survey (Table 2). These include members of several groups known to be vulnerable to collisions with power lines and/or electrocution (e.g., cranes, bustards, storks, large raptors). Based on the initial desktop habitat assessment and subsequent site visit, the following species are considered significant in terms of requirements to mitigate impacts related to collisions and electrocutions:

- Yellow-billed Stork
- Abdim's Stork
- Southern Bald Ibis
- Secretarybird
- Great Flamingo
- Lesser Flamingo
- Grey Crowned Crane
- Wattled Crane
- Blue Crane
- White-bellied Korhaan
- African Grass-owl

Many of these species have slow life-histories, with long intervals between breeding and low rates of reproduction. For this reason, power line related mortality is a much more severe impact for these birds than it would be for smaller, more rapidly-reproducing species. For this reason, a strongly precautionary approach is required in terms of mitigating the risk of collisions with power lines. Moreover, during a previous assessment of the impacts of this line, van Rooyen (2008) found evidence that Lesser Flamingos and Secretarybirds were being killed through collision with the existing lines in the area.

During the site visit a large number of Greater Flamingos were found in a dam near Brendan Village (Figure 9). This dam is in the vicinity of Leeupan, and this entire area is likely to have flamingos regularly flying through.

In addition, African Grass-owl is a species that deserves special consideration in terms of mitigating habitat loss. Grass-owls are present in the area; several road-kills of this species were obesrved on the R50 between the N17 and the Zeus substation. The entire route should be carefully checked before construction commences to ensure that no towers are positioned in habitat that is potentially suitable for this species. Grass-owls inhabitat areas of tall, rank grassland in marshes and vleis, but may also roost and forage in drier grasslands.

Table 2. *Red-listed species whose possible presence along the route of the proposed Bravo 4 power lines was evaluated during the assessment process.*

Species	Scientific name	Red Data Status[1]	NEMBA[2]	Assessment of likelihood of presence along route
Pelican, Pink-backed	*Pelecanus rufescens*	VU	EN	Very low likelihood of occurrence. No SABAP 2 records from area. Considered vulnerable to collisions.
Stork, Yellow-billed	*Mycteria ibis*	EN		Occurs in inland water bodies, and sites such as Leeuwpan are known to hold this species. Reporting rates for area are low, but it is likely that individuals pass through area from time to time. Considered vulnerable to collisions.
Stork, Abdim's	*Ciconia abdimii*	NT		Occurs in grasslands, woodlands and cultivated fields in rural areas. Very few records from area, but occasional occurrence cannot be ruled out. Considered vulnerable to collisions.
Stork, Black	*Ciconia nigra*	VU	VU	Usually associated with mountainous regions. Very few records from area, but occasional occurrence cannot be ruled out. Considered vulnerable to collisions.
Ibis, Southern Bald	*Geronticus calvus*	VU	VU	Power line route is located along western edge of species' distribution. Unlikely to occur regularly along route, but possible presence must be taken into account. Considered vulnerable to collisions.
Flamingo, Greater	*Phoenicopterus ruber*	NT		Presence in area confirmed. Considered highly vulnerable to collisions.
Flamingo, Lesser	*Phoenicopterus minor*	NT		Known to occur in area. Considered highly vulnerable to collisions.
Duck, Maccoa	*Oxyura maccoa*	NT		Occurs in permanent standing water bodies such as dams. Relatively high reporting rates for area. May be vulnerable to collisions.
Secretarybird	*Sagittarius serpentarius*	VU		Occurs in undisturbed grasslands and savannas. High reporting rates in several pentads in area, and there are large areas of suitable habitat. Considered vulnerable to collisions, and should be viewed as priority species in terms of mitigating impacts of Bravo 4 power line.
Vulture, Cape	*Gyps coprotheres*	EN	EN	Very few records from area, and well outside core distribution. Nevertheless, possible occurrence should be factored into mitigation strategy, as this is a species known to be negatively affected by power lines.
Falcon, Lanner	*Falco biarmicus*	VU		Occurs in area, and is known to sometime breeds on electricity pylons. Not likely to be affected by collisions or electrocution.
Falcon, Red-footed	*Falco vespertinus*	NT		Occurs in area, although reporting rates generally low. Likely to use lines for

				perching, but not very likely to be affected by collisions or electrocution.
Marsh-harrier, African	*Circus ranivorus*	EN	PR	Recorded in area. Occurs in wetlands and grasslands. This species is considered moderately vulnerable to collision risk, since it generally flies at heights lower than 400 kV power lines, and its slow flight speeds mean that the likelihood of collision is reduced.
Harrier, Black	*Circus maurus*	EN		Recorded in area. Occurs in wetlands and grasslands. This species is considered moderately vulnerable to collision risk, since it generally flies at heights lower than 400 kV power lines, and its slow flight speeds mean that the likelihood of collision is reduced.
Crane, Grey Crowned	*Balearica regulorum*	EN	EN	Small number of records from area, but power line route is well outside of core range. Considered highly vulnerable to collisions.
Crane, Wattled	*Bugeranus carunculatus*	CR	CR	Some records from area, and *Critically Endangered* status means that this species requires special consideration. Considered highly vulnerable to collisions.
Crane, Blue	*Anthropoides paradiseus*	NT	EN	Occurs in area, and considered highly vulnerable to collisions.
Bustard, Denham's	*Neotis denhami*	VU	PR	Some records from extreme northern part of area considered. Unlikely to occur along the line route. Considered vulnerable to collisions.
Korhaan, White-bellied	*Eupodotis senegalensis*	VU		Some records from area, but not common. Considered vulnerable to collisions.
Painted-snipe, Greater	*Rostratula benghalensis*	NT		Likely –records from area south of Secunda. Occurs in thick vegetation along the edges of water bodies.
Plover, Chestnut-banded	*Charadrius pallidus*	NT		Possible – some records from area south of Secunda. No suitable habitat along route.
Pratincole, Black-winged	*Glareola nordmanni*	NT		Power line route falls within core range of this species. Not likely to be susceptible to collisions or electrocution.
Grass Owl, African	*Tyto capensis*	VU	VU	Power line route falls within core range of this species. This species is not known to be particularly susceptible to collisions or electrocution, but caution is required. Placing towers in habitat suitable for this species should be avoided.
Kingfisher, Half-collared	*Alcedo semitorquata*	NT		Unlikely. No suitable habitat – clear, vegetated fast-flowing streams.
Roller, European	Coracias garrulus	NT		Unlikely. No suitable habitat – open woodlands.
Lark, Botha's	*Spizocorys fringillaris*	EN		No SABAP 2 records from this area. Nearest known site is near Volksrust.

[1]Current (2015) IUCN Red List Status for South Africa, Lesotho and Swaziland (Taylor et al. 2015). NT = *Near Threatened*; VU = *Vulnerable*; EN = *Endangered*; CR = *Critically Endangered*

[2]Indicates species listed as Protected (“PR), Vulnerable (“VU”), Endangered (‘EN”) or Critically Endangered (“CR”) in the National Environmental Management: Biodiversity Act, 2004 list of Threatened or Protected Species (2007 version)

4. DISCUSSION: IMPACT ASSESSMENT AND MITIGATION RECOMMENDATIONS

4.1 GENERAL IMPACTS

The area through which the proposed Bravo 4 power line route passes is heavily transformed by agriculture and other activities such as coal mining. As such, the overall ecological sensitivity of this area can be considered medium. Nevertheless, the occurrence or potential occurance of several threatened species along the route, several of which belong to groups known to be sensitive to collisions and/or electrocutions with power lines, means that these impacts need to be carefully mitigated. In addition, the placement of towers needs to be achieved so as to avoid habitat losses for threatened grassland specialists such as African Grass-owl, White-bellied Korhaan, and Secretarybird. In broad terms, the impacts of the proposed power lines are as follow:

- Habitat loss (Table 3) – avian habitats will be lost in the areas cleared for the ~350 towers involved in this project. Whereas the individual footprint of each tower is small, the cumulative impact of the area cleared for power lines can be significant. In the case of the Bravo 4 line, this impact is made less severe by the fact that, for much of the route, lines run immediately adjacent to existing lines, and therefore the area cleared will at worst involve the widening of existing servitudes. Additional habitat loss may occur during the construction phase, because of areas cleared for the construction of the towers and lines, new access roads, and clearing vegetation from the servitude under the lines.

- Disturbance (Table 4) – construction activities, and to a lesser extent maintenance activities, will cause disturbance to birds along the route of the proposed power lines. This impact will be most severe if it affects breeding birds, particularly threatened species.

- Collisions (Table 5) – power lines can cause signficant avian mortality through collisions, and in South Africa species such as Ludwig's Bustard and Blue Cranes provide sobering examples of the severity of this impact for populations of threatened birds. Eskom already has a partnership with the Endangered Wildlife Trust focused on mitigating these impacts, and the current lines will require the installation of bird flight diverters in areas where species vulnerable to collisions are likely to move though. Areas of particular concern in this regard are where the proposed lines cross water bodies and/or drainage lines along which large-bodied species, particularly flamingoes, fly regularly. In addition, sections of the lines traversing habitat potentially suitable for Secretarybirds, African Grass-owls, White-bellied Korhaans and other threatened grassland species must be fitted with these devices. **It is strongly recommended that before construction commences, an ornithologist be engaged to examine the entire route with Eskom staff and identify spans requiring the installation of flight diverters.**

- Electrocution risk (Table 6) – the risk of birds being electrocuted by coming into contact with live wires and towers simultaneously, or through excreta coming into contact with live wires below a perching bird, is lower for the large 400 kV towers involved in this project compared to smaller 11 – 132 kV sub-transmission and reticulation lines. No specific mitigation requirements are needed beyond the installation of standard Eskom Bird Guards at all towers near water in order to prevent shorting caused by avian excreta.

- Electromagnetic fields (Table 7) – no specific mitigation measures are needed.

4.2 SPECIFIC IMPACTS AND MITIGATION RECOMMENDATIONS

Table 3: Impact assessment - Habitat loss

Nature: Avian habitats will be lost in the areas cleared for the construction of the ~350 towers involved in this project. Whereas the individual footprint of each tower is small, the cumulative impact of the area cleared for power lines can be significant. In the case of the Bravo 4 line, this impact is made less severe by the fact that lines run immediately adjacent to existing lines, and therefore the area cleared will at worst involve the widening of existing servitudes. Additional habitat loss may occur during the construction phase, because of areas cleared for the construction of the towers and lines, new access roads, and clearing vegetation from the servitude under the line

	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Highly probable	4	Probable	3
Duration	Short term	2	Short term	2
Extent	Limited to Route	2	Limited to Route	2
Magnitude	Moderate	4	Low	2
Significance	**Moderate**	**32**	**Low**	**18**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Highly probable	4	Probable	3
Duration	Long term	4	Long term	4
Extent	Limited to Route	1	Limited to Route	1
Magnitude	Moderate	2	Low	2
Significance	**Low**	**28**	**Low**	**21**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Low	
Irreplaceable loss of resources?	Low		Low	
Can impacts be mitigated?	Yes			

Mitigation:

- Minimise areas cleared for towers, construction activities and access roads, and as far as possible use existing roads
- Restrict construction activities to area directly below power line
- Minimise width of servitude cleared for power line
- Ensure that no towers are placed in habitat potentially suitable for African Grass-owl
- In areas where the new power lines do not run alongside existing power lines, the area cleared must be kept to an absolute minimum.

Cumulative impacts: Will result in further loss of natural habitat in an area that is already heavily transformed.

Residual Risks: None anticipated provided that the mitigation measures are implemented correctly.

Table 4: Impact assessment - Disturbance

Nature: The presence of vehicles and personnel during construction will create disturbance for birds along the route of the proposed line. This disturbance will be most likely manifested through increased stress levels modulated by the avian stress hormone corticosterone, with consequences for breeding success, immune function and foraging. Further disturbance will occur during the operational phase as a consequence of routine maintenance, but the magnitude of this impact will be lower than during the construction phase.

	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Highly probable	4	Probable	3
Duration	Short term	2	Short term	2
Extent	Limited to Route	2	Limited to Route	2
Magnitude	Moderate	8	Low	4
Significance	**Moderate**	**48**	**Low**	**27**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Highly probable	4	Probable	3
Duration	Long term	4	Long term	4
Extent	Limited to Route	1	Limited to Route	1
Magnitude	Moderate	4	Low	2
Significance	**Moderate**	**36**	**Low**	**21**
Status (positive or negative)	Negative		Negative	
Reversibility	Moderate		Moderate	
Irreplaceable loss of resources?	Low		Low	
Can impacts be mitigated?	Yes			

Mitigation:

- Construction of the proposed power line should take place during winter, outside the breeding season of most birds and when migrants are absent.
- Construction workers must be instructed to minimise disturbance of birds at all times.
- Illegal hunting of birds must be strictly prevented
- During construction, any threatened species breeding along the route should be identified by the Environmental Control Officer, and the author of this report contacted for advice on how to proceed.
- All construction and maintenance should take place as per Eskom Transmission's environmental best practice standards.

Cumulative impacts: Construction activities, and to a lesser extent maintenance activities thereafter, will increase overall levels of human disturbance along the power line route.
Residual Risks: None anticipated provided that the mitigation measures are implemented correctly.

Table 5: Impact assessment - Collisions

Nature: Avian mortalities and injuries as a result of birds colliding with power lines while in flight.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Highly probable	4	Improbable	1
Duration	Short term	2	Short term	2
Extent	Limited to Route	1	Limited to Route	2
Magnitude	High	8	High	8
Significance	**Moderate**	**44**	**Low**	**12**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Highly probable	4	Improbable	1
Duration	Long term	4	Long term	4
Extent	Limited to Route	2	Limited to Route	2
Magnitude	High	9	High	8
Significance	**High**	**60**	**Low**	**14**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Low	
Irreplaceable loss of resources?	High		Low	
Can impacts be mitigated?	Yes			

Mitigation:

- Wherever possible, the new power line should be placed as close to the existing lines as possible, so as to minimise the spatial extent of the collision risk
- Bird flight diverters should be fitted to the line in areas where the risk of collision is considered significant. Specifically, "Bird flappers" or double-loop flight diverters developed by the Eskom / Endangered Wildlife Trust (EWT) Strategic Partnership should be fitted to the line during initial construction. These devices must be attached to the centre 60% of the line between each pair of pylons, with the flappers 5 m apart in a staggered configuration.
- Spans requiring flight diverters should identified at the start of the construction phase by engaging a suitable ornithologist to accompany Eskom staff along the entire route. At this stage, spans that can be identifed as requiring flight diverters on the basis of satellite imagery are listed in Table 5b below.

Cumulative impacts: Collisions caused by power lines have had devastating impacts on the populations of a number of threatened bird species, and it is critical that this impact of the new Bravo 4 line be mitigated to the greatest extent possible.

Residual Risks: The efficacy of bird flight diverters is dependent on their ongoing maintenance; the devices fitted to the Bravo 4 line must be maintained following Eskom Transmission's environmental best practice standards.

Table 5b. Sections of the Bravo 4 line requiring bird flight diverters. Note that tower numbers are provided for only one line, but diverters need to be fitted to both lines at these locations. See Figure 12 for an overview of sensitive areas.

Span description	Reason for flight diverters being required
Ke-Ze 017 to Ke-Ze 020	Flight path for waterbirds between dams
Ke-Ze 048 to Ke-Ze 051	Proximity to small farm dam
Ke-Ze 051 to Ke-Ze 054	Traverses small farm dam
Ke-Ze 066 to Ke-Ze 070	Stream crossing, likely waterbird flight path. Area with many wetlands.
Ke-Ze 077 to Ke-Ze 081	Stream crossing, likely waterbird flight path
Ke-Ze 082 to Ke-Ze 088	Proximity to small farm dams
Ke-Ze 091 to Ke-Ze 098	Stream crossing, proximity to dams
Ke-Ze 99 to Ke-Ze 104	Stream crossing, likely waterbird flight path
Ke-Ze 108 to Ke-Ze 113	Stream crossing, proximity to dam
Ke-Ze 116 to Ke-Ze 119	Stream crossing, likely waterbird flight path
Ke-Ze 120 to Ke-Ze 123	Stream crossing, likely waterbird flight path
Ke-Ze 124 to Ke-Ze 128	Proximity to dam holding large numbers of flamingos
Ke-Ze 129 to Ke-Ze 132	Stream crossing, likely waterbird flight path
Ke-Ze 137 to Ke-Ze 140	Stream crossing, proximity to dam
Ke-Ze 143 to Ke-Ze 147	Stream crossing, likely waterbird flight path
Ke-Ze 152 to Ke-Ze 156	Stream crossing, likely waterbird flight path
Ke-Ze 162 to Ke-Ze 167	Stream crossing, likely waterbird flight path
Ke-Ze 169 to Ke-Ze 174	Stream crossings, proximity to number of farm dams
Ke-Ze 181 to Ke-Ze 183	Flight path for waterbirds between dams

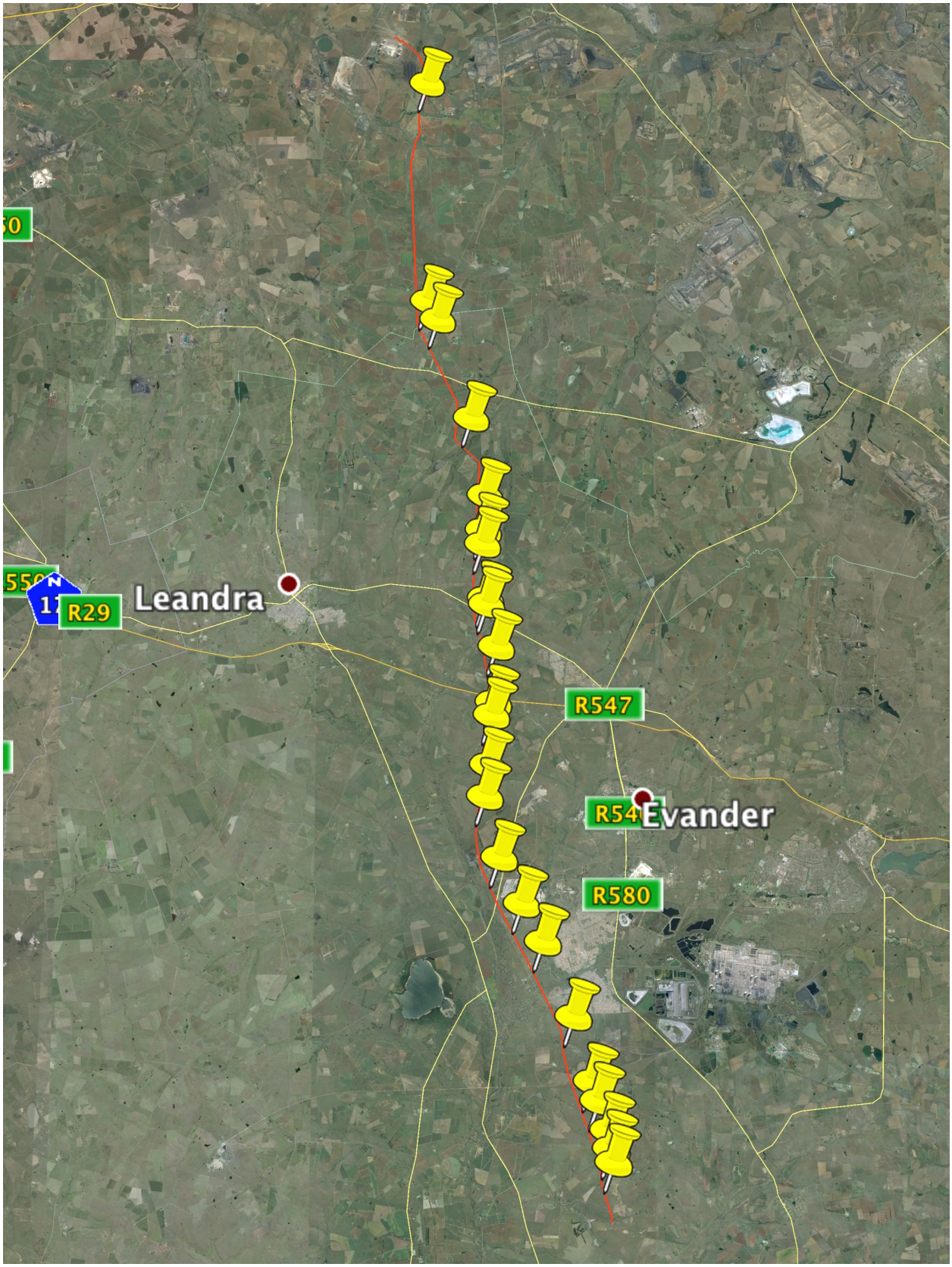

***Figure 12**. Overview of sections of the proposed Bravo 4 power lines route deemed sensitive in terms of collision risk, and requiring the installation of bird flight diverters. Image courtesy of Google Earth.*

Table 6: Impact assessment - Electrocutions

Nature: Avian mortalities and injuries as a result of birds creating short circuits between live wires, or between live wire and tower. Risk generally low for 400 kV lines.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Improbable	1	Improbable	1
Duration	Short term	2	Short term	2
Extent	Limited to Route	1	Limited to Route	2
Magnitude	Low	4	Low	4
Significance	**Low**	**7**	**Low**	**7**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Improbable	1	Improbable	1
Duration	Long term	4	Long term	4
Extent	Limited to Route	1	Limited to Route	1
Magnitude	Low	4	Low	4
Significance	**Low**	**9**	**Low**	**9**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Low	
Irreplaceable loss of resources?	Low		Low	
Can impacts be mitigated?	Yes			
Mitigation: • Electrocutions are extremely unlikely on 400 kV towers. However, in the interests of preventing short circuits caused by excreta, it is recommended that standard Eskom Bird Guards be fitted to all towers in the vicinity of water.				
Cumulative impacts: Electrocutions are unlikely to be a cause of avian mortality				
Residual Risks: None.				

Table 7: Impact assessment – Electromagnetic fields

Nature: There is some evidence that the electromagnetic fields generated by power lines have negative effects on avian breeding, as well as the ability of migrants to navigate

	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Very Improbable	1	Very Improbable	1
Duration	Short term	1	Short term	1
Extent	Limited to Route	1	Limited to Route	1
Magnitude	Low	2	Low	2
Significance	**Low**	**4**	**Low**	**4**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Improbable	2	Improbable	2
Duration	Long term	4	Long term	4
Extent	Limited to Route	1	Limited to Route	1
Magnitude	Low	4	Low	4
Significance	**Low**	**18**	**Low**	**18**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Low	
Irreplaceable loss of resources?	Low		Low	
Can impacts be mitigated?	No			

Mitigation:

- None necessary beyond installation of insulators and shielding following Eskom's standard guidelines for best practise.

Cumulative impacts: Will contribute to widespread EMFs generated by electrical infrastructure. Evidence of negative impacts is limited.

Residual Risks: None.

4.3 CONCLUSIONS AND RECOMMENDATIONS

The two 400 kV power lines of the proposed Bravo 4 project will pass through an area that consists of four broad categories of avian habitats, namely grasslands, wetlands, water bodies and drainage lines, and agricultural landscapes. The area holds a number of threatened bird species, several of which are known to be highly vulnerable to collisions with power lines. This is a source of mortality that has already had devastating effects on a number of southern African species. The new lines will run parallel to exisiting lines for much of their length, a factor that will slighty reduce collision risk along these sections. However, it remains critical that bird flight diverters be installed on the new lines, particularly along sections identified in this report where natural grasslands, stream crossings and/or proximity to water bodies increase the likelihood of large-bodied species flying through the area. The fact that previous surveys produced evidence that species such as flamingos are already colliding with the existing lines underscores the need to carefully mitigate this impact. In contrast to collisions, the risk of electrocutions is very small, on account of the size of the towers used for 400 kV lines. Standard bird guards should nevertheless be fitted to any towers in the proximity of water bodies, to prevent excreta from perching birds creating short circuits. The loss of habitat potentially suitable for African Grass-owls must also be avoided.

In conclusion, on the basis of the present desktop study the author's opinion is that the negative avifaunal impacts associated with the proposed Bravo 4 lines can to a large extent be mitigated, and that the project should therefore go ahead. Once operational, the Bravo 4 lines should be regularly monitored for avian fatalities, and any additional spans subsequently identified as posing a collision risk will need to be retrofitted with bird flight diverters.

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TECHNICAL REPORTS [31 in total, only 10 most recent shown]

McKechnie, A.E. 2013. *Specialist avifaunal assessment: proposed Frankfort Power Station.* Prepared for Rural Maintenance.

McKechnie, A.E. 2013. *Specialist avifaunal assessment: proposed MOGS oil storage facility, Saldanha Bay.* Prepared for Enviro-Insight.

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Pietersen, D.W., Symes, C.T., Woodborne, S.W., **McKechnie, A.E.** and Jansen, R. (in press)

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ARTICLES IN SEMI-POPULAR MAGAZINES [73 in total, only three most recent shown]

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McKechnie, A.E. 2016. Enormous, enigmatic, extinct – the elephant birds of Madagascar. *African Birdlife* press.

Noakes, M.J. and **McKechnie, A.E.** 2015 Hot or not? Physiological variation in white-browed sparrow-weavers. *African Birdlife* September/October 2015: 12-13.

CONFERENCE PRESENTATIONS [110 in total, only plenary lectures shown]

McKechnie. A.E., Smit, B., Hockey, P.A.R. and Wolf, B.O. Taking the heat: climate change and desert *At*: Frontiers in South African Ornithology, 15-16 March 2012, Port Elizabeth, South Africa.

McKechnie, A.E., Smit, B., Cory Toussaint, D., Boyles, J.G. and Wolf, B.O. Hot birds and bats: approaches to predicting climate change impacts in small endotherms. *At:* Joint ZSSA and PARSA Conference, 10-13 July 2011, Stellenbosch, South Africa.

SCIENTIFIC AWARDS AND RECOGNITION [only last five years shown]

2013	Finalist: 2012/2013 NSTF/BHP Billiton Awards
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Associate Editor: *Climate Change Responses*
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INVITED SEMINARS AND LECTURES [23 in total, only 3 most recent shown]

Mitrani Department for Desert Ecology, Ben-Gurion University of the Negev, Israel, August 2015.
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OTHER CONTRIBUTIONS

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