

**CONSTRUCTION OF A 400 KV BYPASS LINE ON THE BRAVO –  
VULCAN (WITBANK) LINE TO BYPASS DUVHA  
(Bravo 5)  
DEA Ref No - 12/12/20/1097**

**Specialist Avifaunal Impact Assessment**

Prepared for

Limosella Consulting on behalf of Envirolution Consulting

by

*Professor Andrew McKechnie*

*Pr. Sci. Nat.*

*aemckechnie@gmail.com*

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Andrew Edward McKechnie

Pretoria, 12 June 2016

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## Executive Summary

Eskom plans to Construction of a 400 kV bypass line, approximately 10 km in length, on the Bravo – Vulcan (Witbank) line to bypass Duvha substation (Figure 1). The need for this line is related to the construction of the new Bravo power station between Bronkhorstspuit and Witbank, with the Duvha bypass line representing Phase 5 of the Bravo Integration Project.

The proposed line traverses two natural vegetation types, Rand Highveld Grassland and Eastern Highveld Grassland. In terms of current conservation status, the line traverses primarily areas with no natural habitat remaining and a small section classified as Important and Necessary and Highly Significant on the southern extent.

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 a site visit on 4 June 2016. In addition, previous assessments of the impacts of this project on birds were consulted during the preparation of this report.

In terms of avian habitats, the entire site of the Bravo 5 Duvha bypass power line consists of heavily transformed and mowed Highveld grassland located between the Bravo power station, a small residential area, a mine dump, and various artificial water bodies associated with the power station..

In broad terms, the impacts of the proposed power line are as follow:

- Habitat loss – avian habitats will be lost in the areas cleared for the towers involved in this project. In the case of the Bravo 5 line, this impact will be minimal on account of the small area involved and highly transformed nature of this site. Additional habitat loss may occur during the construction phase.
- Disturbance – construction activities, and to a lesser extent maintenance activities, will cause disturbance to birds at the site of the proposed power line. This impact will be most severe if it affects breeding birds, although this is unlikely given the small area involved.
- Collisions – power lines can cause significant 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. The Bravo 5 power line will not present a significant collision hazard, because of the low likelihood of large-bodied species flying through this area. The water bodies in the immediate area are all small and artificial, and unlikely to attract threatened species. Although many power lines require bird flight diverters to be fitted, the minor collision risk posed by the Bravo 5 line does not warrant this mitigation measure.
- Electrocutation risk – 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 on all towers near water in order to prevent shorting caused by avian excreta.
- Electromagnetic fields – no specific mitigation measures are needed.

The 400 kV power line of the proposed Bravo 5 project is restricted to a small area of highly transformed Highveld grassland immediately adjacent to the Bravo power station. The area is highly

unlikely to hold any threatened bird species, and the proposed line is unlikely to affect avian habitats in a significant way. The author's opinion is that the negative avifaunal impacts associated with the proposed Bravo 5 line will be minor, and that the project should therefore go ahead.

**TABLE OF CONTENTS**

|   |    |
|---|----|
| 1. Introduction.....  | 8  |
| 1.1 Scope and objectives of the study.....                                      | 8  |
| 1.2 Desktop analysis of potential impacts.....                                  | 8  |
| 1.2.1 Displacement through habitat loss and human activity.....                 | 8  |
| 1.2.2 Disturbance during construction phase.....                                | 9  |
| 1.2.3 Collisions.....   | 9  |
| 1.2.4 Electrocutions.....   | 10 |
| 1.2.5 Electromagnetic fields.....   | 10 |
| 1.3 Description of study area.....  | 10 |
| 1.3.1 Vegetation types.....   | 12 |
| 1.3.3 Regional hydrology.....   | 12 |
| 2. Methods.....   | 13 |
| 2.1 Desktop study.....  | 13 |
| 2.2 Field surveys.....  | 13 |
| 2.2.1 Intensive searching and habitat assessment.....                           | 14 |
| 2.2.2 Road surveys and habitat assessment.....                                  | 14 |
| 2.2.3 Consultation of previous reports.....                                     | 14 |
| 2.2.4 Limitations of baseline data.....   | 15 |
| 3. Results.....   | 15 |
| 3.1 Desktop survey: avian habitats along the power line route.....              | 15 |
| 3.2 Baseline data: birds occurring along the power line route.....              | 15 |
| 3.3 Baseline data: threatened species occurring along the power line route..... | 22 |
| 4. Discussion: impact assessment and mitigation recommendations.....            | 23 |
| 4.1 General impacts.....  | 23 |
| 4.2 Specific impacts and mitigation recommendations.....                        | 23 |
| 4.3 Conclusions and recommendations.....  | 28 |
| 5. References.....  | 29 |
| 6. Author's abridged Curriculum Vitae.....                                      | 30 |

## LIST OF FIGURES

**Figure 1:** Location of the Bravo 5 powerline.

**Figure 2:** Conservation status of areas traversed by the proposed powerline as classified in the Mpumalanga regional dataset.

**Figure 3:** Threatened ecosystems as classified by the 2011 SANBI National Biodiversity Assessment.

**Figure 4:** Vegetation classification for the proposed powerlines.

**Figure 5:** Hydrology map of the site and water features in the proximity of the powerline 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.

**Figure 7:** Site of the proposed Bravo 5 power line.

## LIST OF TABLES

**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.

**Table 2.** Red-listed species whose possible presence along the route of the proposed Bravo 5 power lines was evaluated during the assessment process.

**Table 3:** Impact assessment - Habitat loss

**Table 4:** Impact assessment - Disturbance

**Table 5:** Impact assessment – Collisions

**Table 5b.** Sections of the Bravo 5 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.

**Table 6:** Impact assessment - Electrocutions

**Table 7:** Impact assessment – Electromagnetic fields

## 1. INTRODUCTION

Eskom plans to Construction of a 400 kV bypass line, approximately 10 km in length, on the Bravo – Vulcan (Witbank) line to bypass Duvha substation (Figure 1). The need for this line is related to the construction of the new Bravo power station between Bronkhorstspuit and Witbank, with the Duvha bypass line representing Phase 5 of the Bravo Integration Project.

The route for this line 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 line. 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 Ludwig's 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 (Ferne 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 (Ferne et al. 2000, Ferne 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

The Bravo 5 site is located east of Emahlahleni, Mpumalanga, in the vicinity of the Duvha Power Station (Figure 1). The studied area includes a powerline that bypasses the Duvha Power Station and connects the line to the existing grid. The site lies immediately south of large slimes dams. The Olifants River lies to the west and the R575 lies to the east.

The Mpumalanga Biodiversity Conservation plan: Critical Biodiversity Areas (Terrestrial) Map show the line traversing primarily areas with no natural habitat remaining and a small section classified as Important and Necessary and Highly Significant on the southern extent (Figure 2).

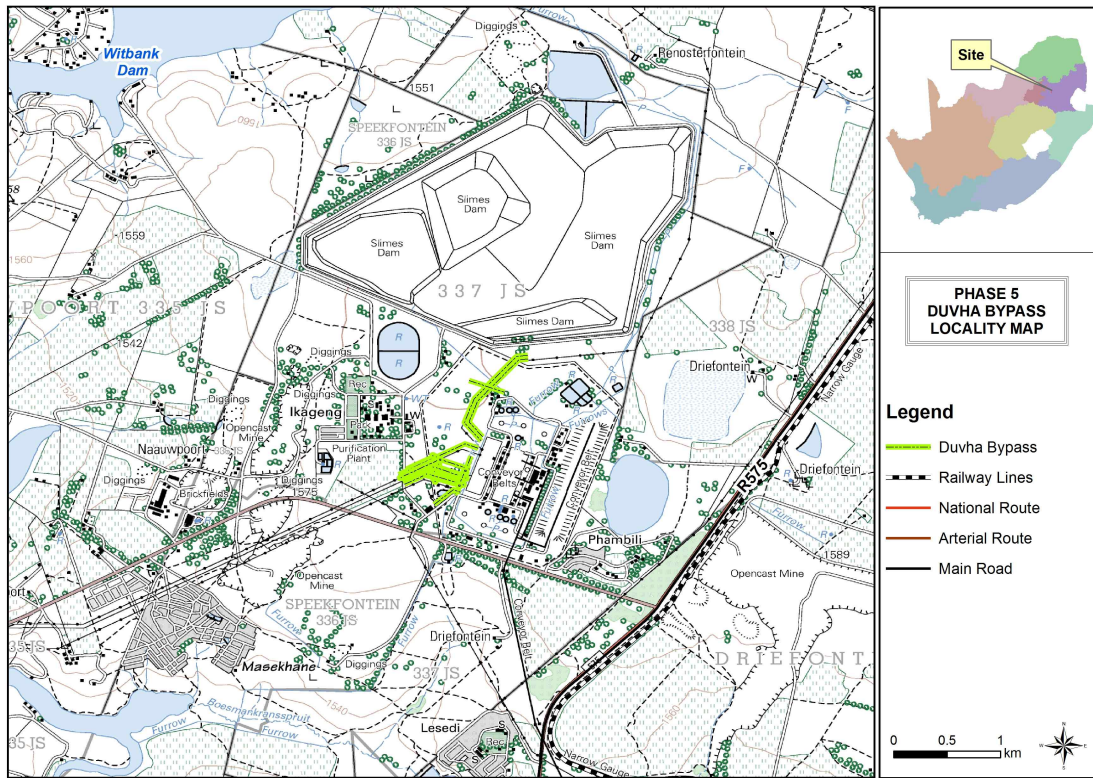


Figure 1: The location of the Bravo 5 powerline.

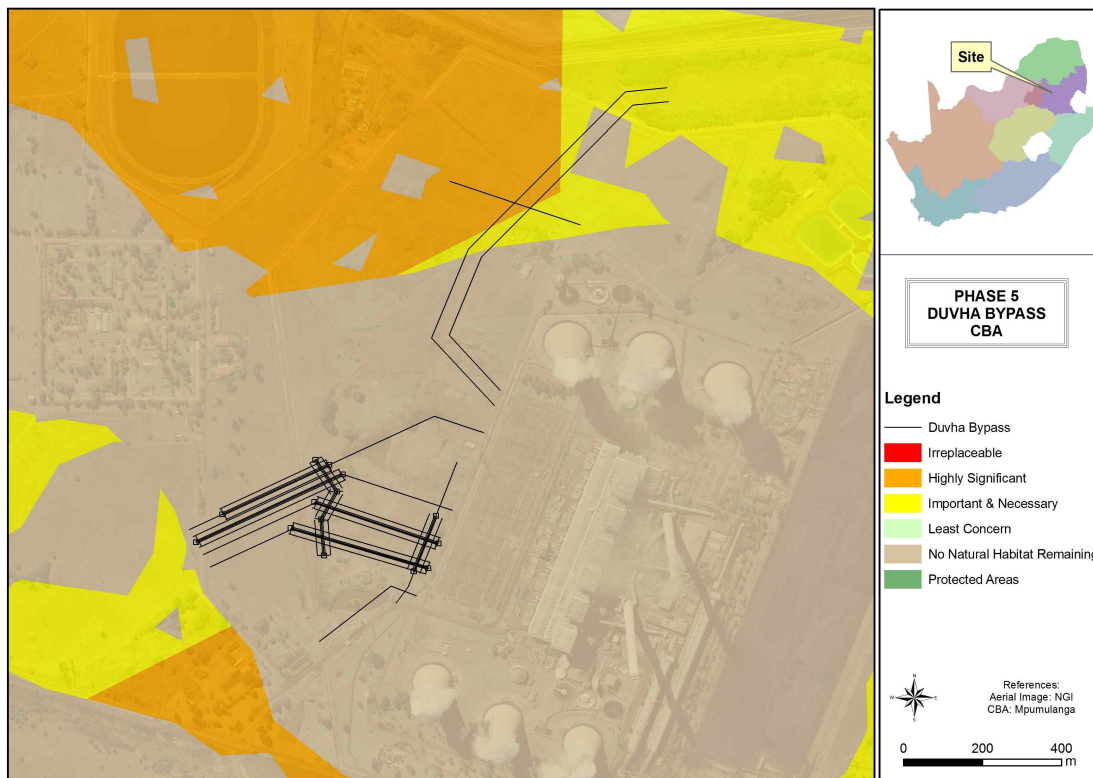
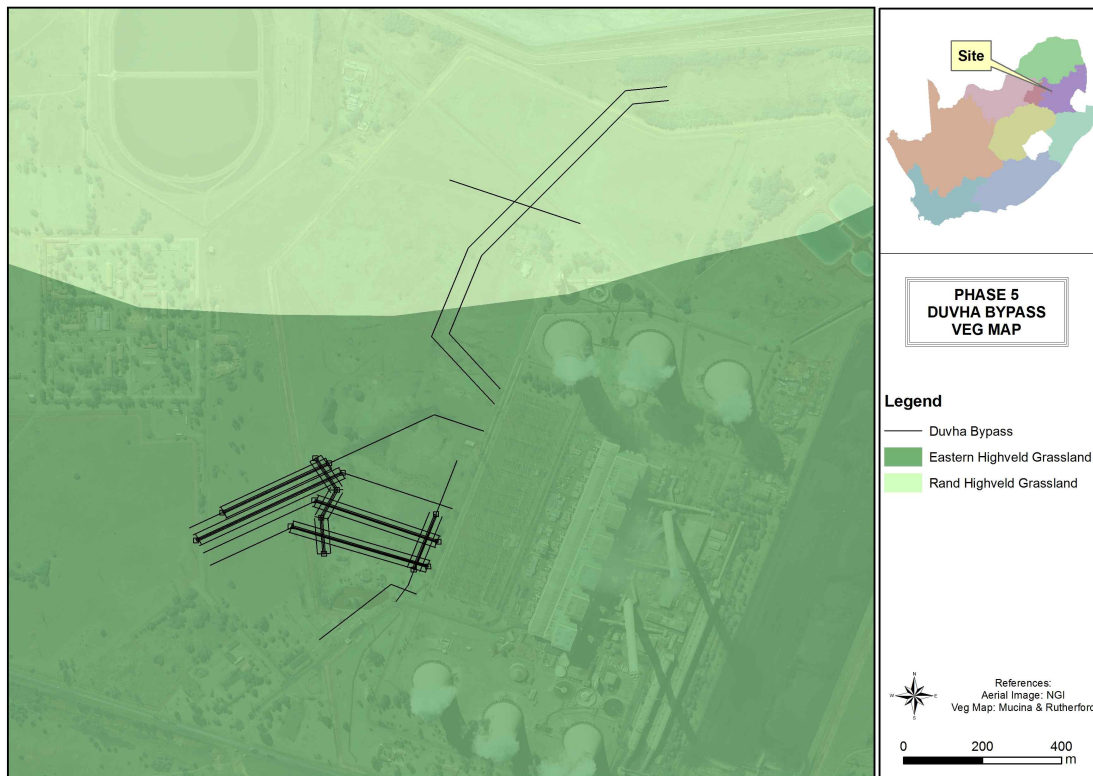


Figure 2: Conservation status of areas traversed by the proposed powerline as classified in the Mpumalanga regional datasets.

### 1.3.1 VEGETATION TYPES

The study area falls within the grassland Biome and at a smaller scale, the Rand Highveld Grassland to the south and Eastern Highveld Grassland to the north as classified in Mucina and Rutherford (2006) (Figure 3).

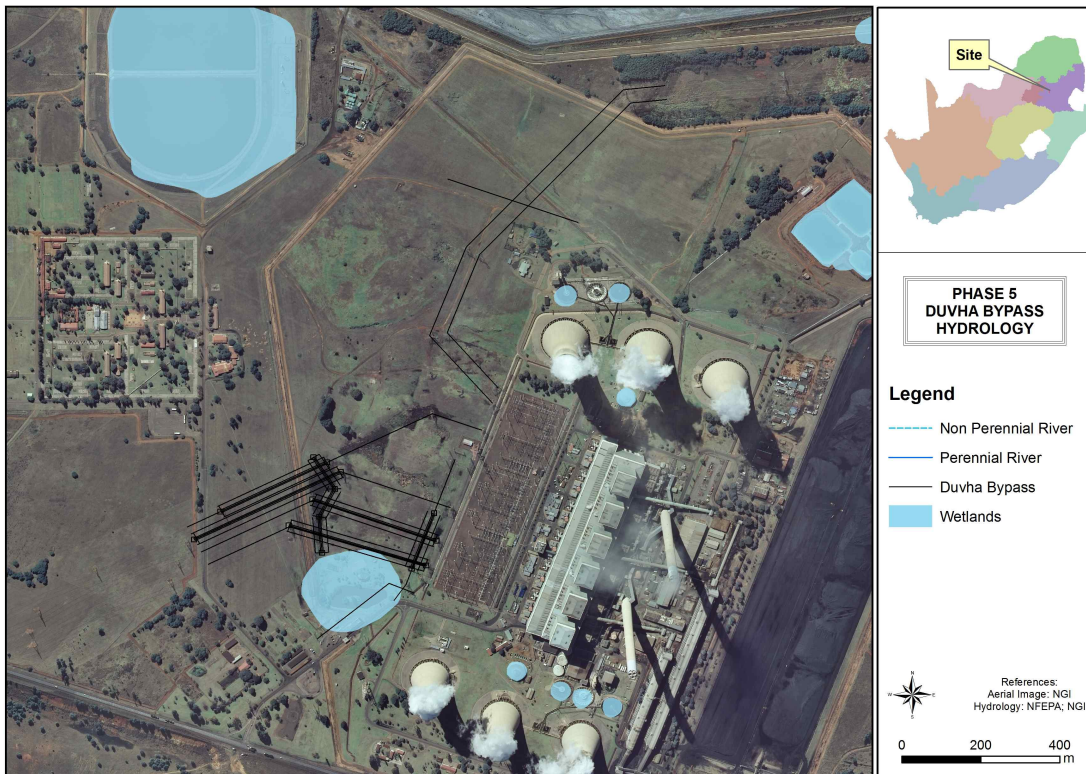
The accompanying floral report presents a more comprehensive overview of the site, incorporating all the elements underpinning the above-mentioned vegetation units as well as their conservation status.



**Figure 3:** The vegetation classification for the proposed powerline.

### 1.3.2 REGIONAL HYDROLOGY

Wetland and river systems affected by the proposed powerline are discussed in detail in the accompanying wetland assessment report. In general, the study site falls within Quaternary Catchment B11G and drains towards the Olifants River. This site further falls within the DWS Olifants Water Management Area, nr 4. The NFEPA wetland layer shows several water bodies close to the proposed infrastructure, although they are not natural (Figure 4).



**Figure 4:** A hydrology map of the site and water features in the proximity of the powerline route.

## 2. METHODS

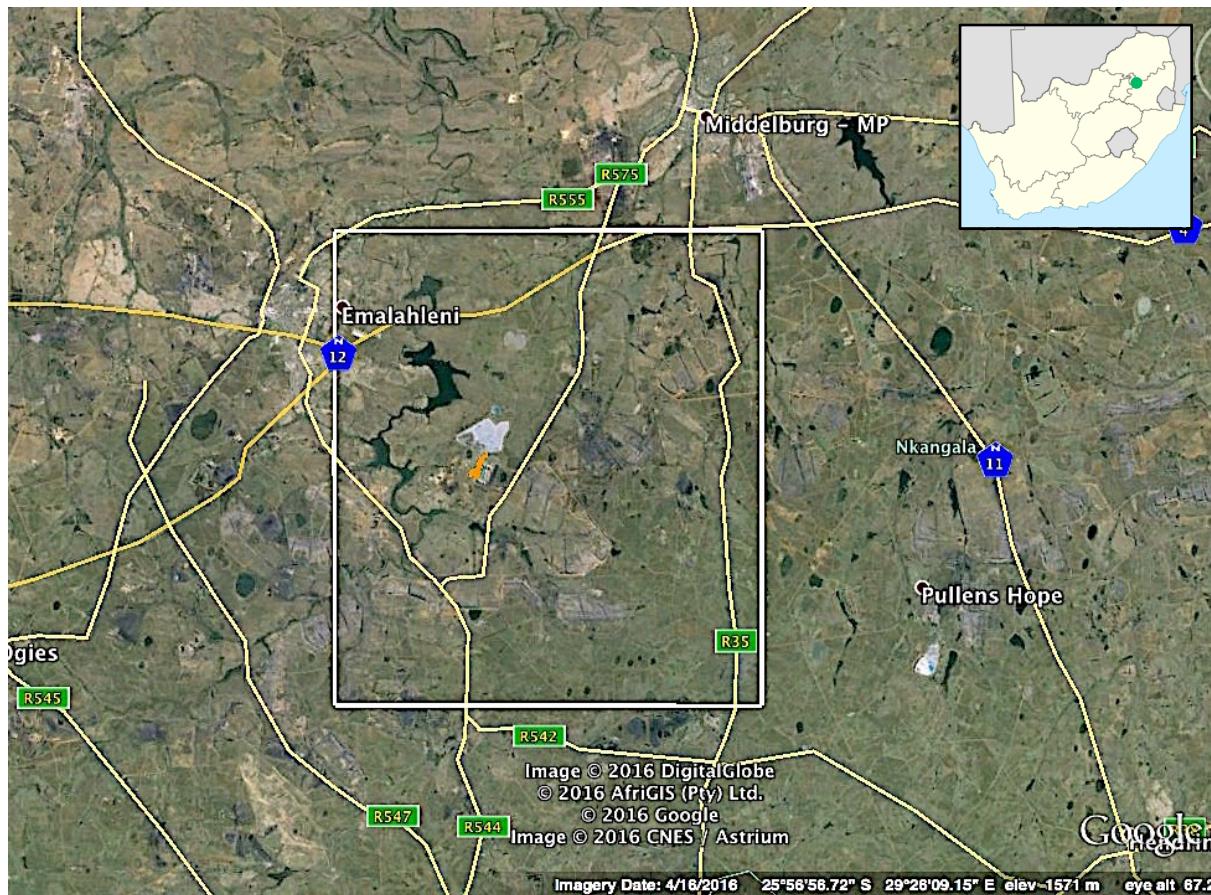
Birds occurring at the site of the proposed power line were assessed in several steps, as detailed below. Red-listed species were identified using the most recent (2015) Red Data Book for South Africa, Lesotho and Swaziland (Taylor et al. 2015).

### 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: 2545\_2755; northeast: 2545\_2855; southeast: 2605\_2855; southwest: 2605\_2755. 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 approximately one hour spent at the site. The weather during the visit was warm and clear, with little wind.



**Figure 6.** Approximate extent of area included (white square) when generating the list of birds potentially occurring at the site of the proposed power line (orange 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 were identified during transects and adjacent areas (Figure 3). During these transects, an observer with binoculars walks 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, highly transformed nature of the habitat at the Bravo 5 site 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 in a radius of approximately 10 km of the power line route will be 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 5 Duvha bypass power line has been the subject of a previous avifaunal impact assessment. 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.

This study was extensively consulted during the process of compiling the present report, and relevant 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 a brief visit, and the possibility exists that rarer species in the area are 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 line 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 atlasing 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 5 power line does not fall within a recognized Important Bird and Biodiversity Area (Marnewick et al. 2015).

#### **3.1 DESKTOP SURVEY: AVIAN HABITATS ALONG THE POWER LINE ROUTE**

The entire site of the Bravo 5 Duvha bypass power line (Figure 7) consists of heavily transformed Highveld grassland that has been mowed (presumably for purposes of fire suppression) located between the Bravo power station, a small residential area, a mine dump, and various artificial water bodies associated with the power station. The conservation status of most of the site is “No Natural Habitat Remaining” (Figure 2).

#### **3.2 BASELINE DATA: BIRDS OCCURRING ALONG THE POWER LINE ROUTE**

A total of 289 species have been recorded during SABAP 1 and SABAP 2 in the area considered for the desktop survey. Of these, eight were seen during the site visit, 31 are considered highly likely to occur at the site, with an additional 38 species whose likelihood of occurrence is considered medium (Table 1). The low expected density reflects the small area involved and highly transformed nature of the site.

#### **3.3 BASELINE DATA: THREATENED SPECIES OCCURRING ALONG THE POWER LINE ROUTE**

A total of 17 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 that are known to be vulnerable to collisions with power lines and/or electrocution (e.g., cranes, bustards, storks, large raptors). However, in light of the very small area involved, and the highly transformed nature of habitats at the site, none of these species are considered significant in terms of mitigating impacts related to collisions and electrocutions along the Bravo 5 power line.



**Figure 7:** Site of the proposed Bravo 5 power line



**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         | <i>Apalis thoracica</i>          |    | Low        | Avocet, Pied               | <i>Recurvirostra avosetta</i>       |    | Low        |
| Babbler, Arrow-marked        | <i>Turdoides jardineii</i>       |    | Low        | Barbet, Acacia Pied        | <i>Tricholaema leucomelas</i>       |    | Low        |
| Barbet, Black-collared       | <i>Lybius torquatus</i>          |    | Low        | Barbet, Crested            | <i>Trachyphonus vaillantii</i>      |    | Low        |
| Batis, Chinspot              | <i>Batis molitor</i>             |    | Low        | Bee-eater, European        | <i>Merops apiaster</i>              |    | High       |
| Bee-eater, Little            | <i>Merops pusillus</i>           |    | Low        | Bee-eater, White-fronted   | <i>Merops bullockoides</i>          |    | Medium     |
| Bishop, Southern Red         | <i>Euplectes orix</i>            |    | Confirmed  | Bishop, Yellow             | <i>Euplectes capensis</i>           |    | Low        |
| Bishop, Yellow-crowned       | <i>Euplectes afer</i>            |    | Medium     | Bittern, Little            | <i>Ixobrychus minutus</i>           |    | Low        |
| Bokmakierie, Bokmakierie     | <i>Telophorus zeylonus</i>       |    | Medium     | Boubou, Southern           | <i>Laniarius ferrugineus</i>        |    | Low        |
| Brubru, Brubru               | <i>Nilaus afer</i>               |    | Low        | Bulbul, Dark-capped        | <i>Pycnonotus tricolor</i>          |    | Confirmed  |
| Bunting, Cape                | <i>Emberiza capensis</i>         |    | Low        | Bunting, Cinnamon-breasted | <i>Emberiza tahapisi</i>            |    | Low        |
| Bush-shrike, Grey-headed     | <i>Malaconotus blanchoti</i>     |    | Low        | Bustard, Denham's          | <i>Neotis denhami</i>               | VU | Low        |
| Buttonquail, Kurrichane      | <i>Turnix sylvaticus</i>         |    | Low        | Buzzard, Jackal            | <i>Buteo rufofuscus</i>             |    | Low        |
| Buzzard, Steppe              | <i>Buteo vulpinus</i>            |    | Medium     | Canary, Black-throated     | <i>Crithagra atrogularis</i>        |    | Medium     |
| Canary, Cape                 | <i>Serinus canicollis</i>        |    | Low        | Canary, Yellow-fronted     | <i>Crithagra mozambicus</i>         |    | Low        |
| Chat, Anteating              | <i>Myrmecocichla formicivora</i> |    | Medium     | Chat, Familiar             | <i>Cercomela familiaris</i>         |    | Low        |
| Cisticola, Cloud             | <i>Cisticola textrix</i>         |    | High       | Cisticola, Desert          | <i>Cisticola aridulus</i>           |    | Low        |
| Cisticola, Lazy              | <i>Cisticola aberrans</i>        |    | Low        | Cisticola, Levallant's     | <i>Cisticola tinniens</i>           |    | Medium     |
| Cisticola, Pale-crowned      | <i>Cisticola cinnamomeus</i>     |    | Low        | Cisticola, Rattling        | <i>Cisticola chiniana</i>           |    | Low        |
| Cisticola, Wailing           | <i>Cisticola lais</i>            |    | Low        | Cisticola, Wing-snapping   | <i>Cisticola ayresii</i>            |    | Low        |
| Cisticola, Zitting           | <i>Cisticola juncidis</i>        |    | High       | Cliff-chat, Mocking        | <i>Thamnolaea cinnamomeiventris</i> |    | Low        |
| Cliff-swallow, South African | <i>Hirundo spilodera</i>         |    | Low        | Coot, Red-knobbed          | <i>Fulica cristata</i>              |    | Medium     |
| Cormorant, Reed              | <i>Phalacrocorax africanus</i>   |    | Medium     | Cormorant, White-breasted  | <i>Phalacrocorax carbo</i>          |    | Medium     |
| Coucal, Burchell's           | <i>Centropus burchellii</i>      |    | Low        | Cursor, Temminck's         | <i>Cursorius temminckii</i>         |    | Low        |
| Crake, Black                 | <i>Amaurornis flavirostris</i>   |    | Low        | Crane, Blue                | <i>Anthropoides paradiseus</i>      | NT | Low        |
| Crombec, Long-billed         | <i>Sylvietta rufescens</i>       |    | Low        | Crow, Cape                 | <i>Corvus capensis</i>              |    | Low        |
| Crow, Pied                   | <i>Corvus albus</i>              |    | High       | Cuckoo, Black              | <i>Cuculus clamosus</i>             |    | Low        |
| Cuckoo, Diderick             | <i>Chrysococcyx caprius</i>      |    | Low        | Cuckoo, Red-chested        | <i>Cuculus solitarius</i>           |    | Low        |
| Darter, African              | <i>Anhinga rufa</i>              |    | Medium     | Dove, Laughing             | <i>Streptopelia senegalensis</i>    |    | Confirmed  |
| Dove, Namaqua                | <i>Oena capensis</i>             |    | Low        | Dove, Red-eyed             | <i>Streptopelia semitorquata</i>    |    | Confirmed  |
| Dove, Rock                   | <i>Columba livia</i>             |    | High       | Drongo, Fork-tailed        | <i>Dicrurus adsimilis</i>           |    | Low        |
| Duck, African Black          | <i>Anas sparsa</i>               |    | Low        | Duck, Comb                 | <i>Sarkidiornis melanotos</i>       |    | Low        |
| Duck, Fulvous                | <i>Dendrocygna bicolor</i>       |    | Low        | Duck, Maccoa               | <i>Oxyura maccoa</i>                | NT | Low        |
| Duck, White-backed           | <i>Thalassornis leuconotus</i>   |    | Low        | Duck, White-faced          | <i>Dendrocygna viduata</i>          |    | Low        |
| Duck, Yellow-billed          | <i>Anas undulata</i>             |    | Medium     | Eagle-owl, Spotted         | <i>Bubo africanus</i>               |    | Low        |

|                            |                                    |    |        |
|----------------------------|------------------------------------|----|--------|
| Eagle, Verreaux's          | <i>Aquila verreauxii</i>           | VU | Low    |
| Egret, Great               | <i>Egretta alba</i>                |    | Low    |
| Egret, Yellow-billed       | <i>Egretta intermedia</i>          |    | Low    |
| Falcon, Amur               | <i>Falco amurensis</i>             |    | Medium |
| Finfoot, African           | <i>Podica senegalensis</i>         | VU | Low    |
| Firefinch, Red-billed      | <i>Lagonosticta senegala</i>       |    | Low    |
| Fish-eagle, African        | <i>Haliaeetus vocifer</i>          |    | Low    |
| Flamingo, Lesser           | <i>Phoenicopterus minor</i>        | NT | Low    |
| Flycatcher, Fiscal         | <i>Sigelus silens</i>              |    | Low    |
| Flycatcher, Southern Black | <i>Melaenornis pammelaina</i>      |    | Low    |
| Francolin, Orange River    | <i>Scleroptila levaillantoides</i> |    | Low    |
| Francolin, Shelley's       | <i>Scleroptila shelleyi</i>        |    | Low    |
| Goose, Egyptian            | <i>Alopochen aegyptiacus</i>       |    | Medium |
| Goshawk, Gabar             | <i>Melierax gabar</i>              |    | Low    |
| Grassbird, Cape            | <i>Sphenoeacus afer</i>            |    | Low    |
| Grebe, Great Crested       | <i>Podiceps cristatus</i>          |    | Low    |
| Green-pigeon, African      | <i>Treron calvus</i>               |    | Low    |
| Guineafowl, Helmeted       | <i>Numida meleagris</i>            |    | High   |
| Hamerkop, Hamerkop         | <i>Scopus umbretta</i>             |    | Low    |
| Harrier, Pallid            | <i>Circus macrourus</i>            |    | Low    |
| Heron, Black-headed        | <i>Ardea melanocephala</i>         |    | Medium |
| Heron, Green-backed        | <i>Butorides striata</i>           |    | Low    |
| Heron, Purple              | <i>Ardea purpurea</i>              |    | Low    |
| Honeybird, Brown-backed    | <i>Prodotiscus regulus</i>         |    | Low    |
| Honeyguide, Lesser         | <i>Indicator minor</i>             |    | Low    |
| House-martin, Common       | <i>Delichon urbicum</i>            |    | Low    |
| Ibis, Glossy               | <i>Plegadis falcinellus</i>        |    | Low    |
| Ibis, Southern Bald        | <i>Geronticus calvus</i>           | VU | Low    |
| Jacana, African            | <i>Actophilornis africanus</i>     |    | Low    |
| Kestrel, Lesser            | <i>Falco naumanni</i>              |    | Low    |
| Kingfisher, Brown-hooded   | <i>Halcyon albiventris</i>         |    | Low    |
| Kingfisher, Half-collared  | <i>Alcedo semitorquata</i>         | NT | Low    |
| Kingfisher, Pied           | <i>Ceryle rudis</i>                |    | Low    |
| Kingfisher, Woodland       | <i>Halcyon senegalensis</i>        |    | Low    |
| Kite, Black-shouldered     | <i>Elanus caeruleus</i>            |    | High   |
| Korhaan, White-bellied     | <i>Eupodotis senegalensis</i>      | VU | Low    |
| Lapwing, Blacksmith        | <i>Vanellus armatus</i>            |    | High   |
| Lark, Eastern Clapper      | <i>Mirafra fasciolata</i>          |    | Medium |

|                           |                                 |    |           |
|---------------------------|---------------------------------|----|-----------|
| Egret, Cattle             | <i>Bubulcus ibis</i>            |    | Medium    |
| Egret, Little             | <i>Egretta garzetta</i>         |    | Low       |
| Eremomela, Yellow-bellied | <i>Eremomela icteropygialis</i> |    | Low       |
| Finch, Red-headed         | <i>Amadina erythrocephala</i>   |    | Medium    |
| Firefinch, African        | <i>Lagonosticta rubricata</i>   |    | Low       |
| Fiscal, Common (Southern) | <i>Lanius collaris</i>          |    | Confirmed |
| Flamingo, Greater         | <i>Phoenicopterus ruber</i>     | NT | Low       |
| Flycatcher, Fairy         | <i>Stenostira scita</i>         |    | Low       |
| Flycatcher, Marico        | <i>Bradornis mariquensis</i>    |    | Low       |
| Flycatcher, Spotted       | <i>Muscicapa striata</i>        |    | Low       |
| Francolin, Red-winged     | <i>Scleroptila levaillantii</i> |    | Low       |
| Go-away-bird, Grey        | <i>Corythaixoides concolor</i>  |    | Low       |
| Goose, Spur-winged        | <i>Plectropterus gambensis</i>  |    | Low       |
| Grass-owl, African        | <i>Tyto capensis</i>            | VU | Low       |
| Grebe, Black-necked       | <i>Podiceps nigricollis</i>     |    | Low       |
| Grebe, Little             | <i>Tachybaptus ruficollis</i>   |    | Low       |
| Greenshank, Common        | <i>Tringa nebularia</i>         |    | Low       |
| Gull, Grey-headed         | <i>Larus cirrocephalus</i>      |    | Low       |
| Harrier-Hawk, African     | <i>Polyboroides typus</i>       |    | Low       |
| Heron, Black              | <i>Egretta ardesiaca</i>        |    | Low       |
| Heron, Goliath            | <i>Ardea goliath</i>            |    | Low       |
| Heron, Grey               | <i>Ardea cinerea</i>            |    | Medium    |
| Heron, Squacco            | <i>Ardeola ralloides</i>        |    | Low       |
| Honeyguide, Greater       | <i>Indicator indicator</i>      |    | Low       |
| Hoopoe, African           | <i>Upupa africana</i>           |    | Medium    |
| Ibis, African Sacred      | <i>Threskiornis aethiopicus</i> |    | Low       |
| Ibis, Hadedra             | <i>Bostrychia hagedash</i>      |    | Medium    |
| Indigobird, Dusky         | <i>Vidua funerea</i>            |    | Low       |
| Kestrel, Greater          | <i>Falco rupicoloides</i>       |    | Low       |
| Kestrel, Rock             | <i>Falco rupicolus</i>          |    | Low       |
| Kingfisher, Giant         | <i>Megaceryle maximus</i>       |    | Low       |
| Kingfisher, Malachite     | <i>Alcedo cristata</i>          |    | Low       |
| Kingfisher, Striped       | <i>Halcyon chelicuti</i>        |    | Low       |
| Kite, Black               | <i>Milvus migrans</i>           |    | Low       |
| Kite, Yellow-billed       | <i>Milvus aegyptius</i>         |    | Low       |
| Lapwing, African Wattled  | <i>Vanellus senegallus</i>      |    | High      |
| Lapwing, Crowned          | <i>Vanellus coronatus</i>       |    | High      |
| Lark, Eastern Long-billed | <i>Certhilauda semitorquata</i> |    | Low       |

|                              |                                  |           |                               |                                 |           |
|------------------------------|----------------------------------|-----------|-------------------------------|---------------------------------|-----------|
| Lark, Pink-billed            | <i>Spizocorys conirostris</i>    | Low       | Lark, Red-capped              | <i>Calandrella cinerea</i>      | Medium    |
| Lark, Rufous-naped           | <i>Mirafrā africana</i>          | High      | Lark, Sabota                  | <i>Calendulauda sabota</i>      | Low       |
| Lark, Spike-heeled           | <i>Chersomanes albofasciata</i>  | Low       | Longclaw, Cape                | <i>Macronyx capensis</i>        | High      |
| Mannikin, Bronze             | <i>Spermestes cucullatus</i>     | Low       | Marsh-harrier, African        | <i>Circus ranivorus</i>         | EN Low    |
| Martin, Banded               | <i>Riparia cincta</i>            | Low       | Martin, Brown-throated        | <i>Riparia paludicola</i>       | High      |
| Martin, Rock                 | <i>Hirundo fuligula</i>          | High      | Martin, Sand                  | <i>Riparia riparia</i>          | Low       |
| Masked-weaver, Southern      | <i>Ploceus velatus</i>           | High      | Moorhen, Common               | <i>Gallinula chloropus</i>      | Low       |
| Mousebird, Red-faced         | <i>Urocolius indicus</i>         | Low       | Mousebird, Speckled           | <i>Colius striatus</i>          | Low       |
| Myna, Common                 | <i>Acridotheres tristis</i>      | Confirmed | Neddicky, Neddicky            | <i>Cisticola fulvicapilla</i>   | Medium    |
| Night-Heron, Black-crowned   | <i>Nycticorax nycticorax</i>     | Low       | Nightjar, Rufous-cheeked      | <i>Caprimulgus rufigena</i>     | Low       |
| Olive-pigeon, African        | <i>Columba arquatrix</i>         | Low       | Openbill, African             | <i>Anastomus lamelligerus</i>   | Low       |
| Oriole, Black-headed         | <i>Oriolus larvatus</i>          | Low       | Osprey, Osprey                | <i>Pandion haliaetus</i>        | Low       |
| Ostrich, Common              | <i>Struthio camelus</i>          | Low       | Owl, Barn                     | <i>Tyto alba</i>                | Medium    |
| Owl, Marsh                   | <i>Asio capensis</i>             | Low       | Oxpecker, Red-billed          | <i>Buphagus erythrorhynchus</i> | Low       |
| Palm-swift, African          | <i>Cypsiurus parvus</i>          | Medium    | Paradise-flycatcher, African  | <i>Terpsiphone viridis</i>      | Low       |
| Paradise-whydah, Long-tailed | <i>Vidua paradisaea</i>          | Low       | Petronia, Yellow-throated     | <i>Petronia superciliaris</i>   | Low       |
| Pigeon, Speckled             | <i>Columba guinea</i>            | High      | Pipit, African                | <i>Anthus cinnamomeus</i>       | High      |
| Pipit, Buffy                 | <i>Anthus vaalensis</i>          | Low       | Pipit, Long-billed            | <i>Anthus similis</i>           | Low       |
| Pipit, Plain-backed          | <i>Anthus leucophrys</i>         | Low       | Pipit, Striped                | <i>Anthus lineiventris</i>      | Low       |
| Plover, Kittlitz's           | <i>Charadrius pecuarius</i>      | Low       | Plover, Three-banded          | <i>Charadrius tricollaris</i>   | Low       |
| Pochard, Southern            | <i>Netta erythrophthalma</i>     | Low       | Prinia, Black-chested         | <i>Prinia flavicans</i>         | Medium    |
| Prinia, Tawny-flanked        | <i>Prinia subflava</i>           | Medium    | Puffback, Black-backed        | <i>Dryoscopus cubla</i>         | Low       |
| Pytilia, Green-winged        | <i>Pytilia melba</i>             | Low       | Quail, Common                 | <i>Coturnix coturnix</i>        | Low       |
| Quailfinch, African          | <i>Ortygospiza atricollis</i>    | Low       | Quelea, Red-billed            | <i>Quelea quelea</i>            | High      |
| Rail, African                | <i>Rallus caerulescens</i>       | Low       | Reed-warbler, African         | <i>Acrocephalus baeticatus</i>  | Low       |
| Reed-warbler, Great          | <i>Acrocephalus arundinaceus</i> | Low       | Robin-chat, Cape              | <i>Cossypha caffra</i>          | Low       |
| Rock-thrush, Cape            | <i>Monticola rupestris</i>       | Low       | Roller, European              | <i>Coracias garrulus</i>        | NT Low    |
| Ruff                         | <i>Philomachus pugnax</i>        | Low       | Rush-warbler, Little          | <i>Bradypterus baboecala</i>    | Low       |
| Sandpiper, Common            | <i>Actitis hypoleucos</i>        | Low       | Sandpiper, Curlew             | <i>Calidris ferruginea</i>      | Low       |
| Sandpiper, Marsh             | <i>Tringa stagnatilis</i>        | Low       | Sandpiper, Wood               | <i>Tringa glareola</i>          | Low       |
| Secretarybird                | <i>Sagittarius serpentarius</i>  | VU Low    | Seedeater, Streaky-headed     | <i>Crithagra gularis</i>        | Medium    |
| Shelduck, South African      | <i>Tadorna cana</i>              | Low       | Shoveler, Cape                | <i>Anas smithii</i>             | Low       |
| Shrike, Lesser Grey          | <i>Lanius minor</i>              | Low       | Shrike, Red-backed            | <i>Lanius collurio</i>          | Medium    |
| Snake-eagle, Black-chested   | <i>Circaetus pectoralis</i>      | Low       | Snipe, African                | <i>Gallinago nigripennis</i>    | Low       |
| Sparrow-weaver, White-browed | <i>Plocepasser mahali</i>        | Low       | Sparrow, Cape                 | <i>Passer melanurus</i>         | Confirmed |
| Sparrow, House               | <i>Passer domesticus</i>         | High      | Sparrow, Southern Grey-headed | <i>Passer diffusus</i>          | Medium    |
| Sparrowhawk, Black           | <i>Accipiter melanoleucus</i>    | Low       | Spoonbill, African            | <i>Platalea alba</i>            | Low       |
| Spurfowl, Natal              | <i>Pternistis natalensis</i>     | Low       | Spurfowl, Swainson's          | <i>Pternistis swainsonii</i>    | High      |

|                                  |                                    |    |           |
|----------------------------------|------------------------------------|----|-----------|
| Starling, Cape Glossy            | <i>Lamprotornis nitens</i>         |    | High      |
| Starling, Red-winged             | <i>Onychognathus morio</i>         |    | Medium    |
| Stilt, Black-winged              | <i>Himantopus himantopus</i>       |    | Low       |
| Stonechat, African               | <i>Saxicola torquatus</i>          |    | High      |
| Stork, Black                     | <i>Ciconia nigra</i>               | VU | Low       |
| Stork, Yellow-billed             | <i>Mycteria ibis</i>               | EN | Low       |
| Sunbird, Greater Double-collared | <i>Cinnyris afer</i>               |    | Low       |
| Sunbird, Marico                  | <i>Cinnyris mariquensis</i>        |    | Low       |
| Swallow, Barn                    | <i>Hirundo rustica</i>             |    | High      |
| Swallow, Lesser Striped          | <i>Hirundo abyssinica</i>          |    | Medium    |
| Swallow, Red-breasted            | <i>Hirundo semirufa</i>            |    | Low       |
| Swamp-warbler, Lesser            | <i>Acrocephalus gracilirostris</i> |    | Low       |
| Swift, African Black             | <i>Apus barbatus</i>               |    | Low       |
| Swift, Common                    | <i>Apus apus</i>                   |    | Low       |
| Swift, Little                    | <i>Apus affinis</i>                |    | High      |
| Tchagra, Black-crowned           | <i>Tchagra senegalus</i>           |    | Low       |
| Teal, Hottentot                  | <i>Anas hottentota</i>             |    | Low       |
| Tern, Caspian                    | <i>Sterna caspia</i>               |    | Low       |
| Tern, White-winged               | <i>Chlidonias leucopterus</i>      |    | Low       |
| Thrush, Groundscraper            | <i>Psophocichla litsipsirupa</i>   |    | Low       |
| Thrush, Kurrichane               | <i>Turdus libonyanus</i>           |    | Low       |
| Tinkerbird, Yellow-fronted       | <i>Pogoniulus chrysoconus</i>      |    | Low       |
| Turtle-dove, Cape                | <i>Streptopelia capicola</i>       |    | High      |
| Wagtail, Cape                    | <i>Motacilla capensis</i>          |    | Confirmed |
| Warbler, Marsh                   | <i>Acrocephalus palustris</i>      |    | Low       |
| Waxbill, Blue                    | <i>Uraeginthus angolensis</i>      |    | Low       |
| Waxbill, Orange-breasted         | <i>Amandava subflava</i>           |    | Low       |
| Weaver, Thick-billed             | <i>Amblyospiza albifrons</i>       |    | Low       |
| Wheatear, Capped                 | <i>Oenanthe pileata</i>            |    | Low       |
| White-eye, Cape                  | <i>Zosterops virens</i>            |    | Medium    |
| Widowbird, Fan-tailed            | <i>Euplectes axillaris</i>         |    | Medium    |
| Widowbird, Red-collared          | <i>Euplectes ardens</i>            |    | Low       |
| Wood-dove, Emerald-spotted       | <i>Turtur chalcospilus</i>         |    | Low       |
| Woodpecker, Cardinal             | <i>Dendropicos fuscescens</i>      |    | Low       |
| Wryneck, Red-throated            | <i>Jynx ruficollis</i>             |    | Low       |
| Starling, Pied                   | <i>Spreo bicolor</i>               |    | High      |
| Starling, Violet-backed          | <i>Cinnyricinclus leucogaster</i>  |    | Low       |
| Stint, Little                    | <i>Calidris minuta</i>             |    | Low       |
| Stork, Abdim's                   | <i>Ciconia abdimii</i>             | NT | Low       |
| Stork, White                     | <i>Ciconia ciconia</i>             |    | Low       |
| Sunbird, Amethyst                | <i>Chalcomitra amethystina</i>     |    | Low       |
| Sunbird, Malachite               | <i>Nectarinia famosa</i>           |    | Low       |
| Sunbird, White-bellied           | <i>Cinnyris talatala</i>           |    | Low       |
| Swallow, Greater Striped         | <i>Hirundo cucullata</i>           |    | High      |
| Swallow, Pearl-breasted          | <i>Hirundo dimidiata</i>           |    | Low       |
| Swallow, White-throated          | <i>Hirundo albigularis</i>         |    | High      |
| Swampphen, African Purple        | <i>Porphyrio madagascariensis</i>  |    | Low       |
| Swift, Alpine                    | <i>Tachymarptis melba</i>          |    | Low       |
| Swift, Horus                     | <i>Apus horus</i>                  |    | Low       |
| Swift, White-rumped              | <i>Apus caffer</i>                 |    | High      |
| Teal, Cape                       | <i>Anas capensis</i>               |    | Low       |
| Teal, Red-billed                 | <i>Anas erythrorhyncha</i>         |    | Low       |
| Tern, Whiskered                  | <i>Chlidonias hybrida</i>          |    | Low       |
| Thick-knee, Spotted              | <i>Burhinus capensis</i>           |    | Medium    |
| Thrush, Karoo                    | <i>Turdus smithi</i>               |    | Low       |
| Thrush, Olive                    | <i>Turdus olivaceus</i>            |    | Low       |
| Tit, Southern Black              | <i>Parus niger</i>                 |    | Low       |
| Wagtail, African Pied            | <i>Motacilla aguimp</i>            |    | Low       |
| Wagtail, Yellow                  | <i>Motacilla flava</i>             |    | Low       |
| Warbler, Willow                  | <i>Phylloscopus trochilus</i>      |    | Low       |
| Waxbill, Common                  | <i>Estrilda astrild</i>            |    | Medium    |
| Weaver, Cape                     | <i>Ploceus capensis</i>            |    | Medium    |
| Weaver, Village                  | <i>Ploceus cucullatus</i>          |    | Low       |
| Wheatear, Mountain               | <i>Oenanthe monticola</i>          |    | Low       |
| Whydah, Pin-tailed               | <i>Vidua macroura</i>              |    | High      |
| Widowbird, Long-tailed           | <i>Euplectes progne</i>            |    | High      |
| Widowbird, White-winged          | <i>Euplectes albonotatus</i>       |    | Medium    |
| Wood-hoopoe, Green               | <i>Phoeniculus purpureus</i>       |    | Low       |
| Woodpecker, Golden-tailed        | <i>Campethera abingoni</i>         |    | Low       |

**Table 2.** Red-listed species whose possible presence at the site of the proposed Bravo 5 power line was evaluated during the assessment process.

| Species                | Scientific name                 | Red Data Status <sup>1</sup> | NEMBA <sup>2</sup> | Assessment of likelihood of presence at site  |
|------------------------|---------------------------------|------------------------------|--------------------|---|
| Stork, Yellow-billed   | <i>Mycteria ibis</i>            | EN                           |                    | Occurs in inland water bodies. May occasionally occur in area at nearby Witbank Dam, but unlikely to visit power line site. Considered vulnerable to collisions.  |
| Stork, Abdim's         | <i>Ciconia abdimii</i>          | NT                           |                    | Occurs in grasslands, woodlands and cultivated fields in rural areas. Recorded in the area considered for the desktop study, with low reporting rates. Unlikely to visit site. Considered vulnerable to collisions. |
| Stork, Black           | <i>Ciconia nigra</i>            | VU                           | VU                 | Usually associated with mountainous regions, but nevertheless a few records from the area considered for the desktop study. Unlikely to visit site. Considered vulnerable to collisions.                            |
| Ibis, Southern Bald    | <i>Geronticus calvus</i>        | VU                           |                    | Regularly recorded in area considered for desktop survey, but unlikely to visit site. Considered vulnerable to collisions.  |
| Flamingo, Greater      | <i>Phoenicopterus ruber</i>     | NT                           |                    | Occurs in lakes and pans. May occasionally occur in area at nearby Witbank Dam, but unlikely to visit power line site. Considered highly vulnerable to collisions.  |
| Flamingo, Lesser       | <i>Phoenicopterus minor</i>     | NT                           |                    | Occurs in lakes and pans. May occasionally occur in area at nearby Witbank Dam, but unlikely to visit power line site. Considered vulnerable to collisions.   |
| Duck, Maccoa           | <i>Oxyura maccoa</i>            | NT                           |                    | Occurs in permanent standing water bodies such as dams. May occasionally occur in area at nearby Witbank Dam, but unlikely to visit power line site. Considered vulnerable to collisions.                           |
| Secretarybird          | <i>Sagittarius serpentarius</i> | VU                           |                    | Occurs in undisturbed grasslands and savannas, and unlikely to visit site. Considered vulnerable to collisions.   |
| Eagle, Verreaux's      | <i>Aquila verreauxii</i>        | VU                           |                    | Largely restricted to mountainous areas, and highly unlikely to occur at site. Considered vulnerable to collisions.   |
| Marsh-harrier, African | <i>Circus ranivorus</i>         | EN                           |                    | Occurs in wetlands and grasslands. Unlikely to occur at site. This species is considered moderately vulnerable to collision risk.   |
| Finfoot, African       | <i>Podica senegalensis</i>      | VU                           |                    | Occurs in slow-flowing water in large river systems. Virtually zero chance of ever occurring at site.   |
| Crane, Blue            | <i>Anthropoides</i>             | NT                           | EN                 | Occurs in area, and considered highly vulnerable to collisions. However, the  |

|                           |                               |    |    |  |
|---------------------------|-------------------------------|----|----|--|
|                           | <i>paradiseus</i>             |    |    | small area involved and highly transformed nature thereof means that occurrence at site is very unlikely.  |
| Bustard, Denham's         | <i>Neotis denhami</i>         | VU |    | Recorded in area, and considered highly vulnerable to collisions. However, the small area involved and highly transformed nature thereof means that occurrence at site is very unlikely. |
| Korhaan, White-bellied    | <i>Eupodotis senegalensis</i> | VU |    | Recorded in area, but unlikely to ever occur at site. Considered vulnerable to collisions.   |
| Grass Owl, African        | <i>Tyto capensis</i>          | VU | VU | Occurs in area considered for desktop survey, but very unlikely to occur at site. Considered moderately vulnerable to collisions.  |
| Kingfisher, Half-collared | <i>Alcedo semitorquata</i>    | NT |    | Unsuitable habitat, and highly unlikely to ever occur at site. Not considered vulnerable to collisions.  |
| Roller, European          | <i>Coracias garrulus</i>      | NT |    | Some records from area, but habitat not suitable. Not considered vulnerable to collisions.   |

<sup>1</sup>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*

<sup>2</sup>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 in which the proposed Bravo 5 power line is located is heavily transformed by human activities, and the overall ecological sensitivity of this area is low. No threatened species are expected to be directly affected by the proposed power line. In broad terms, the impacts of the proposed power line are as follow:

- Habitat loss (Table 3) – avian habitats will be lost in the areas cleared for the towers involved in this project. In the case of the Bravo 5 line, this impact will be minimal on account of the small area involved and highly transformed nature of this site. Additional habitat loss may occur during the construction phase.
- Disturbance (Table 4) – 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, although this is unlikely given the small area involved.
- Collisions (Table 5) – power lines can cause significant 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. The Bravo 5 power line will not present a significant collision hazard, because of the low likelihood of large-bodied species flying through this area. The water bodies in the immediate area are all small and artificial, and unlikely to attract threatened species. Although many power lines require bird flight diverters to be fitted, the minor collision risk posed by the Bravo 5 line does not warrant this mitigation measure.
- 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 on 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**

|  |                           |   |                        |   |
|--|---------------------------|---|------------------------|---|
| <b>Nature:</b> Avian habitats will be lost in the areas cleared for the towers involved in this project. In the case of the Bravo 5 line, this impact will be minimal on account of the small area involved and highly transformed nature of this site. Additional habitat loss may occur during the construction phase. |                           |   |                        |   |
|  | <b>Without mitigation</b> |   | <b>With mitigation</b> |   |
| <b>CONSTRUCTION PHASE</b>  |                           |   |                        |   |
| <b>Probability</b>   | Probable                  | 3 | Improbable             | 2 |
| <b>Duration</b>  | Short term                | 2 | Short term             | 2 |
| <b>Extent</b>  | Limited to Site           | 1 | Limited to Site        | 1 |

|  |                  |           |                  |           |
|--|------------------|-----------|------------------|-----------|
| <b>Magnitude</b>   | Moderate         | 4         | Low              | 2         |
| <b>Significance</b>  | <b>Low</b>       | <b>21</b> | <b>Low</b>       | <b>10</b> |
| <b>Status (positive or negative)</b>   | Negative         |           | Negative         |           |
| <b>OPERATIONAL PHASE</b>   |                  |           |                  |           |
| <b>Probability</b>   | Probable         | 3         | Improbable       | 2         |
| <b>Duration</b>  | Permanent        | 5         | Permanent        | 5         |
| <b>Extent</b>  | Limited to Route | 1         | Limited to Route | 1         |
| <b>Magnitude</b>   | Moderate         | 3         | Low              | 1         |
| <b>Significance</b>  | <b>Low</b>       | <b>27</b> | <b>Low</b>       | <b>14</b> |
| <b>Status (positive or negative)</b>   | Negative         |           | Negative         |           |
| <b>Reversibility</b>   | Low              |           | Low              |           |
| <b>Irreplaceable loss of resources?</b>  | Low              |           | Low              |           |
| <b>Can impacts be mitigated?</b>   | Yes              |           |                  |           |
| <b>Mitigation:</b>   |                  |           |                  |           |
| <ul style="list-style-type: none"> <li>• Minimise areas cleared for towers, construction activities and access roads, and as far as possible use existing roads</li> <li>• Restrict construction activities to area directly below power line</li> </ul> |                  |           |                  |           |
| <b>Cumulative impacts:</b> Will result in minimal loss of natural habitat in an area that is already heavily transformed.  |                  |           |                  |           |
| <b>Residual Risks:</b> None anticipated provided that the mitigation measures are implemented correctly.   |                  |           |                  |           |

**Table 4: Impact assessment - Disturbance**

|   |                           |   |                        |   |
|---|---------------------------|---|------------------------|---|
| <b>Nature:</b> 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, although this is unlikely given the small area involved. |                           |   |                        |   |
|   | <b>Without mitigation</b> |   | <b>With mitigation</b> |   |
| <b>CONSTRUCTION PHASE</b>   |                           |   |                        |   |
| <b>Probability</b>  | Improbable                | 2 | Very improbable        | 1 |
| <b>Duration</b>   | Short term                | 2 | Short term             | 2 |
| <b>Extent</b>   | Limited to Site           | 1 | Limited to Site        | 1 |



|  |                  |           |                  |          |
|--|------------------|-----------|------------------|----------|
| <b>Magnitude</b>   | Low              | 2         | Low              | 1        |
| <b>Significance</b>  | <b>Moderate</b>  | <b>10</b> | <b>Low</b>       | <b>4</b> |
| <b>Status (positive or negative)</b>   | Negative         |           | Negative         |          |
| <b>OPERATIONAL PHASE</b>   |                  |           |                  |          |
| <b>Probability</b>   | Improbable       | 2         | Very improbable  | 1        |
| <b>Duration</b>  | Permanent        | 5         | Permanent        | 5        |
| <b>Extent</b>  | Limited to Route | 1         | Limited to Route | 1        |
| <b>Magnitude</b>   | Low              | 2         | Low              | 1        |
| <b>Significance</b>  | <b>Low</b>       | <b>16</b> | <b>Low</b>       | <b>7</b> |
| <b>Status (positive or negative)</b>   | Negative         |           | Negative         |          |
| <b>Reversibility</b>   | Moderate         |           | Moderate         |          |
| <b>Irreplaceable loss of resources?</b>  | Low              |           | Low              |          |
| <b>Can impacts be mitigated?</b>   | Yes              |           |                  |          |
| <b>Mitigation:</b>   |                  |           |                  |          |
| <ul style="list-style-type: none"> <li>• Construction of the proposed power line should take place during winter, outside the breeding season of most birds and when migrants are absent.</li> <li>• Construction workers must be instructed to minimise disturbance of birds at all times.</li> <li>• Illegal hunting of birds must be strictly prevented</li> <li>• All construction and maintenance should take place as per Eskom Transmission's environmental best practice standards.</li> </ul> |                  |           |                  |          |
| <b>Cumulative impacts:</b> Construction activities, and to a lesser extent maintenance activities thereafter, will increase overall levels of human disturbance along the power line route.  |                  |           |                  |          |
| <b>Residual Risks:</b> None anticipated provided that the mitigation measures are implemented correctly.   |                  |           |                  |          |

**Table 5: Impact assessment - Collisions**

|  |                           |   |                        |   |
|--|---------------------------|---|------------------------|---|
| <b>Nature:</b> Avian mortalities and injuries as a result of birds colliding with power lines while in flight. |                           |   |                        |   |
|  | <b>Without mitigation</b> |   | <b>With mitigation</b> |   |
| <b>CONSTRUCTION PHASE</b>  |                           |   |                        |   |
| <b>Probability</b>   | Very improbable           | 1 | Very improbable        | 1 |
| <b>Duration</b>  | Short term                | 2 | Short term             | 2 |
| <b>Extent</b>  | Limited to Route          | 1 | Limited to Route       | 1 |

|   |                 |           |                 |           |
|---|-----------------|-----------|-----------------|-----------|
| <b>Magnitude</b>  | Low             | 1         | Low             | 1         |
| <b>Significance</b>   | <b>Low</b>      | <b>4</b>  | <b>Low</b>      | <b>4</b>  |
| <b>Status (positive or negative)</b>  | Negative        |           | Negative        |           |
| <b>OPERATIONAL PHASE</b>  |                 |           |                 |           |
| <b>Probability</b>  | Improbable      | 2         | Improbable      | 2         |
| <b>Duration</b>   | Permanent       | 4         | Permanent       | 4         |
| <b>Extent</b>   | Limited to Site | 1         | Limited to Site | 1         |
| <b>Magnitude</b>  | Moderate        | 3         | Moderate        | 3         |
| <b>Significance</b>   | <b>High</b>     | <b>16</b> | <b>Low</b>      | <b>16</b> |
| <b>Status (positive or negative)</b>  | Negative        |           | Negative        |           |
| <b>Reversibility</b>  | Low             |           | Low             |           |
| <b>Irreplaceable loss of resources?</b>   | Low             |           | Low             |           |
| <b>Can impacts be mitigated?</b>  | Yes             |           |                 |           |
| <b>Mitigation:</b>  |                 |           |                 |           |
| <ul style="list-style-type: none"> <li>• 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 and maximise the visibility of the lines.</li> </ul> |                 |           |                 |           |
| <b>Cumulative impacts:</b> Collisions caused by power lines have had devastating impacts on the populations of a number of threatened bird species, but the risk posed by the Bravo 5 line in this regard is very low.                                      |                 |           |                 |           |
| <b>Residual Risks:</b> None.  |                 |           |                 |           |

**Table 6: Impact assessment - Electrocutions**

|   |                           |   |                        |   |
|---|---------------------------|---|------------------------|---|
| <b>Nature:</b> 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. |                           |   |                        |   |
|   | <b>Without mitigation</b> |   | <b>With mitigation</b> |   |
| <b>CONSTRUCTION PHASE</b>   |                           |   |                        |   |
| <b>Probability</b>  | Improbable                | 1 | Improbable             | 1 |
| <b>Duration</b>   | Short term                | 2 | Short term             | 2 |
| <b>Extent</b>   | Limited to Route          | 1 | Limited to Route       | 2 |

|   |                  |          |                  |          |
|---|------------------|----------|------------------|----------|
| <b>Magnitude</b>  | Low              | 4        | Low              | 4        |
| <b>Significance</b>   | <b>Low</b>       | <b>7</b> | <b>Low</b>       | <b>7</b> |
| <b>Status (positive or negative)</b>  | Negative         |          | Negative         |          |
| <b>OPERATIONAL PHASE</b>  |                  |          |                  |          |
| <b>Probability</b>  | Improbable       | 1        | Improbable       | 1        |
| <b>Duration</b>   | Long term        | 4        | Long term        | 4        |
| <b>Extent</b>   | Limited to Route | 1        | Limited to Route | 1        |
| <b>Magnitude</b>  | Low              | 4        | Low              | 4        |
| <b>Significance</b>   | <b>Low</b>       | <b>9</b> | <b>Low</b>       | <b>9</b> |
| <b>Status (positive or negative)</b>  | Negative         |          | Negative         |          |
| <b>Reversibility</b>  | Low              |          | Low              |          |
| <b>Irreplaceable loss of resources?</b>   | Low              |          | Low              |          |
| <b>Can impacts be mitigated?</b>  | Yes              |          |                  |          |
| <b>Mitigation:</b>  |                  |          |                  |          |
| <ul style="list-style-type: none"> <li>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.</li> </ul> |                  |          |                  |          |
| <b>Cumulative impacts:</b> Electrocutions are unlikely to be a cause of avian mortality   |                  |          |                  |          |
| <b>Residual Risks:</b> None.  |                  |          |                  |          |

**Table 7: Impact assessment – Electromagnetic fields**

|  |                           |   |                        |   |
|--|---------------------------|---|------------------------|---|
| <b>Nature:</b> 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 |                           |   |                        |   |
|  | <b>Without mitigation</b> |   | <b>With mitigation</b> |   |
| <b>CONSTRUCTION PHASE</b>  |                           |   |                        |   |
| <b>Probability</b>   | Very Improbable           | 1 | Very Improbable        | 1 |
| <b>Duration</b>  | Short term                | 1 | Short term             | 1 |
| <b>Extent</b>  | Limited to Route          | 1 | Limited to Route       | 1 |
| <b>Magnitude</b>   | Low                       | 2 | Low                    | 2 |

|   |                  |           |                  |           |
|---|------------------|-----------|------------------|-----------|
| <b>Significance</b>   | <b>Low</b>       | <b>4</b>  | <b>Low</b>       | <b>4</b>  |
| <b>Status (positive or negative)</b>  | Negative         |           | Negative         |           |
| <b>OPERATIONAL PHASE</b>  |                  |           |                  |           |
| <b>Probability</b>  | Improbable       | 2         | Improbable       | 2         |
| <b>Duration</b>   | Long term        | 4         | Long term        | 4         |
| <b>Extent</b>   | Limited to Route | 1         | Limited to Route | 1         |
| <b>Magnitude</b>  | Low              | 4         | Low              | 4         |
| <b>Significance</b>   | <b>Low</b>       | <b>18</b> | <b>Low</b>       | <b>18</b> |
| <b>Status (positive or negative)</b>  | Negative         |           | Negative         |           |
| <b>Reversibility</b>  | Low              |           | Low              |           |
| <b>Irreplaceable loss of resources?</b>   | Low              |           | Low              |           |
| <b>Can impacts be mitigated?</b>  | No               |           |                  |           |
| <b>Mitigation:</b>  |                  |           |                  |           |
| <ul style="list-style-type: none"> <li>• None necessary beyond installation of insulators and shielding following Eskom's standard guidelines for best practise.</li> </ul> |                  |           |                  |           |
| <b>Cumulative impacts:</b> Will contribute to widespread EMFs generated by electrical infrastructure. Evidence of negative impacts is limited.                              |                  |           |                  |           |
| <b>Residual Risks:</b> None.  |                  |           |                  |           |

#### 4.3 CONCLUSIONS AND RECOMMENDATIONS

The 400 kV power line of the proposed Bravo 5 project is restricted to a very small area of highly transformed Highveld grassland immediately adjacent to the Bravo power station. The area is highly unlikely to hold any threatened bird species, and the proposed line is unlikely to affect avian habitats in a significant way. The author's opinion is that the negative avifaunal impacts associated with the proposed Bravo 5 line will be minor, and that the project should therefore go ahead.

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**ABRIDGED CURRICULUM VITAE****ANDREW E. MCKECHNIE**

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Professor  
Department of Zoology and Entomology  
University of Pretoria

Email: aemckechnie@zoology.up.ac.za  
Tel: +27-(0)12-423232  
Cell: +27-(0)72-7777572

**ACADEMIC QUALIFICATIONS**

Ph.D. (Zoology), University of Natal, April 2002  
M.Sc. *cum laude* (Zoology), University of Natal, April 1999  
B.Sc. (Honours) *cum laude* (Zoology), University of Natal, April 1997  
B.Sc. (Majors: Zoology and Botany), University of Natal, April 1996

**PROFESSIONAL QUALIFICATIONS**

Professional Natural Scientist (*Pr. Sci. Nat.*; Registration number: 400205/05), South African Council for Natural Scientific Professions

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### **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

2013 Exceptional Academic Achiever, University of Pretoria

2011 Founding Member, South Africa Young Academy of Science

2008-2012 Exceptional Young Researcher Award, University of Pretoria

### **STUDENT SUPERVISION**

Current supervision: 4 PhD, 1 BSc(Hons); Current co-supervision: 3 PhD

Past supervision: 1 PhD, 10 MSc, 9 BSc (Hons); Past co-supervision: 1 PhD, 2 MSc, 3 BSc (Hons)

### **EDITORSHIP**

Associate Editor: *Climate Change Responses*

Associate Editor: *Emu – Austral Ornithology*

Editorial Board: *Journal of Comparative Physiology B*

### **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.

School of Biological Sciences, University of Queensland, July 2015

Hawkesbury Institute for the Environment, University of Western Sydney, July 2015.

### **OTHER CONTRIBUTIONS**

Scientific Advisor, *African Birdlife* magazine

Expert reviewer - South African National Standard SANS 10386 Annex C

Member, Research Ethics and Scientific Committee, National Zoological Gardens

Member, Steering Committee, Endangered Wildlife Trust Threatened Grassland Species Program

Council Member, Zoological Society of Southern Africa [2009-2013]

### **SOCIETY MEMBERSHIP**

American Ornithologists' Union

Australia and New Zealand Society for Comparative Physiology and Biochemistry

Cooper Ornithological Society

International Ornithologists' Union

Society for Integrative and Comparative Biology

Zoological Society of Southern Africa