BIRD IMPACT ASSESSMENT REPORT

Proposed Eskom Double Circuit (132kV) Powerline from Romansrivier Substation to Ceres Substation

August 2017

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Chris van Rooyen

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

DECLARATION OF INDEPENDENCE

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which SRK Consulting was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Basic Assessment for the proposed Eskom Double Circuit (132kV) Powerline from Romansrivier Substation to Ceres Substation .

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Full Name: Chris van Rooyen

Title / Position: Director

EXECUTIVE SUMMARY

The construction of the proposed new 132/66kV double-circuit line between Ceres and Romansrivier Substations is expected to have a range of potential impacts on Red Data avifauna. These can be summarised as follows:

Electrocution: No electrocution risk is envisaged for Red Data avifauna on the proposed pylon structures.

Collisions: The risk of mortality of Red Data species through collisions with the earthwire is assessed to be of Low significance. The species that are most at risk of collisions are the Blue Crane, Secretarybird, Black Stork, Maccoa Duck and Greater Flamingo. Other Red Data species potentially at risk, but to a lesser extent, are Lanner Falcon, Verreaux's Eagle, Black Harrier and African Marsh-harrier. With appropriate mitigation, the collision risk can be reduced to Very Low.

Displacement: The impact of displacement due to disturbance and habitat transformation is assessed to be of Low significance. The most significant potential impact in this regard is the possible disturbance of a pair of Verreaux's Eagles on an active nest situated at 33°23'38.30"S 19°17'45.93"E, which is situated 740m from the proposed powerline at its closest point. There is a risk that the birds may be disturbed by the construction activities associated with the powerline, which may lead to intermittent/ temporary displacement of the birds during the breeding season (May – November), especially if there is blasting involved. Timing of the construction activities for specific poles, to avoid the breeding season, should reduce the impact to Insignificant. Other Red Data species that could potentially be temporarily impacted through disturbance are Black Harrier, Cape Rock-jumper and Protea Seed-eater, but this impact should be of a transient nature and relatively insignificant. The habitat transformation associated with the footprint of the powerlines and access roads should not materially affect the local populations of Red Data species as there are still large areas of undisturbed habitat remaining.

Summary of impacts

Impact	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Impact 1: Collisions of Red Data avifauna with the earthwire of the proposed powerlines.	**Medium**	Possible	**Low**	**Negative**	High
With Mitigation	**Low**	Possible	**Very Low**	**Negative**	High
Impact 2: Displacement due to habitat destruction and disturbance associated with the	**Low**	Probable	**Low**	**Negative**	Medium

construction of the substation, powerlines and access roads					
With Mitigation	**Very Low**	Improbable	**Insignificant**	**Negative**	Medium

In conclusion, it can therefore be stated that the proposed development could proceed from an avifaunal impact assessment perspective, provided the proposed mitigation measures are strictly applied.

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1 INTRODUCTION

The Witzenberg substation is currently supplied by one 132 kV[1] single circuit powerline only. This line runs over the Witzenberg Mountain Range from the Romansrivier substation. Three 66kV feeders out of the Witzenberg substation supply the Ceres, Gydo and Slangboom substations from where Eskom's customers draw their electricity.

A 66kV powerline runs from Romansriver to Witzenberg via Ceres. A portion of this line between Romansriver and Ceres burnt down, cutting this 66 kV supply from Romansriver to Ceres and Witzenberg, and thereby increasing the fragility of the supply to the area (i.e. the only supply to Witzenberg is the 132kV line from Romansriver to Witzenberg, and the only supply to Ceres is from the remaining portion of the 66kV line from Witzenberg to Ceres).

Since the fire on the 66kV line between Romansriver and Ceres, the Ceres substation has been supplied by the 66 kV line from the Witzenberg substation (and consequently, by the 132kV line between the Romansriver and Witzenberg substations) only. Therefore both the Ceres and the Witzenberg substations are solely dependent on the 132kV line between Romansriver and Witzenberg. Eskom would be unable to supply the dependent network (i.e. the towns of Prince Alfred Hamlet and Ceres) for several months should a fault occur on this line (i.e. until the line is repaired[2]).

Eskom Holdings SOC Limited, Western Operating Unit: Distribution Division (Eskom) therefore propose to construct a new double circuit powerline (132kV and 66kV) from the Romansrivier substation to the Ceres substation. This line would provide 132kV supply to Ceres, and replace the partially burnt 66kV line between Romansriver and Ceres and address the fragility of the supply to the Ceres and Witzenburg substations.

Key aspects of the project include:

- Installation of an 80 MVA 132/66/11kV transformer at the Romansrivier substation to supply the new 132kV line to Ceres;
- Installation of a 132 kV and 66kV feeder[1] bays at Romansriver substation and a 66kV feeder bay at Ceres substation to accommodate these lines;
- Construction of a double circuit distribution powerline (132kV and 66kV) between Romansrivier and Ceres substations in the Breede River Valley / Mitchell's Pass (~20km);
- Construction of new access roads, including bridges and other watercourse crossings;
- Upgrading of various existing roads; and
- Decommissioning of the existing 66kV line between the Romansriver and Ceres substations.

In a future phase of work, Eskom proposes to replace the 66kV line running between the Ceres and Witzenberg substations with a single circuit 132kV line.

[1] 1 kilovolt is equal to 1 000 volts
[2] Repairs to this line would take an extensive amount of time as the pylons are old and no designs (or spares) are available for this infrastructure).
[1] A feeder is a powerline transferring power from the substation to the transformers

Two routes have been assessed by Eskom i.e. mountain route and river route. Eskom is applying for the river route as this is the only feasible route. The mountain route was considered during the planning phase but due to feedback from CapeNature and the relevant land owners this option is not being considered or applied for.

Design alternatives can include lattice, monopoles and wood poles. Due to the constructability challenges of the river route, the current engineering design for the line caters for lattice steel and limited steel monopole structures.

SRK has appointed Chris van Rooyen Consulting to compile a specialist avifaunal assessment report detailing the potential bird related impacts associated with the proposed new powerline and substations.

See Figures 1 and 2 below for maps showing the location of the project.

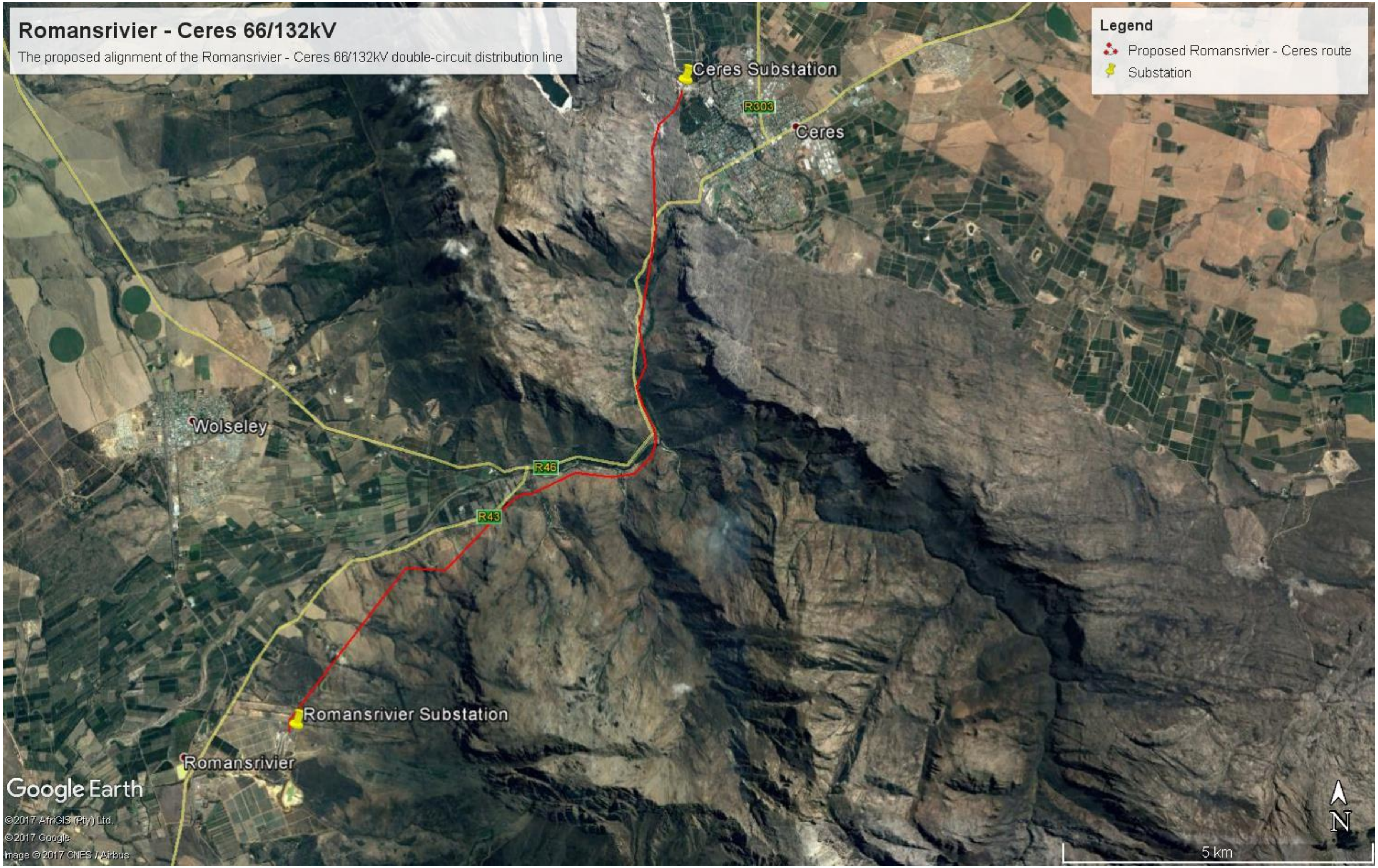

Figure 1: Close-up view of the study area and proposed alignment

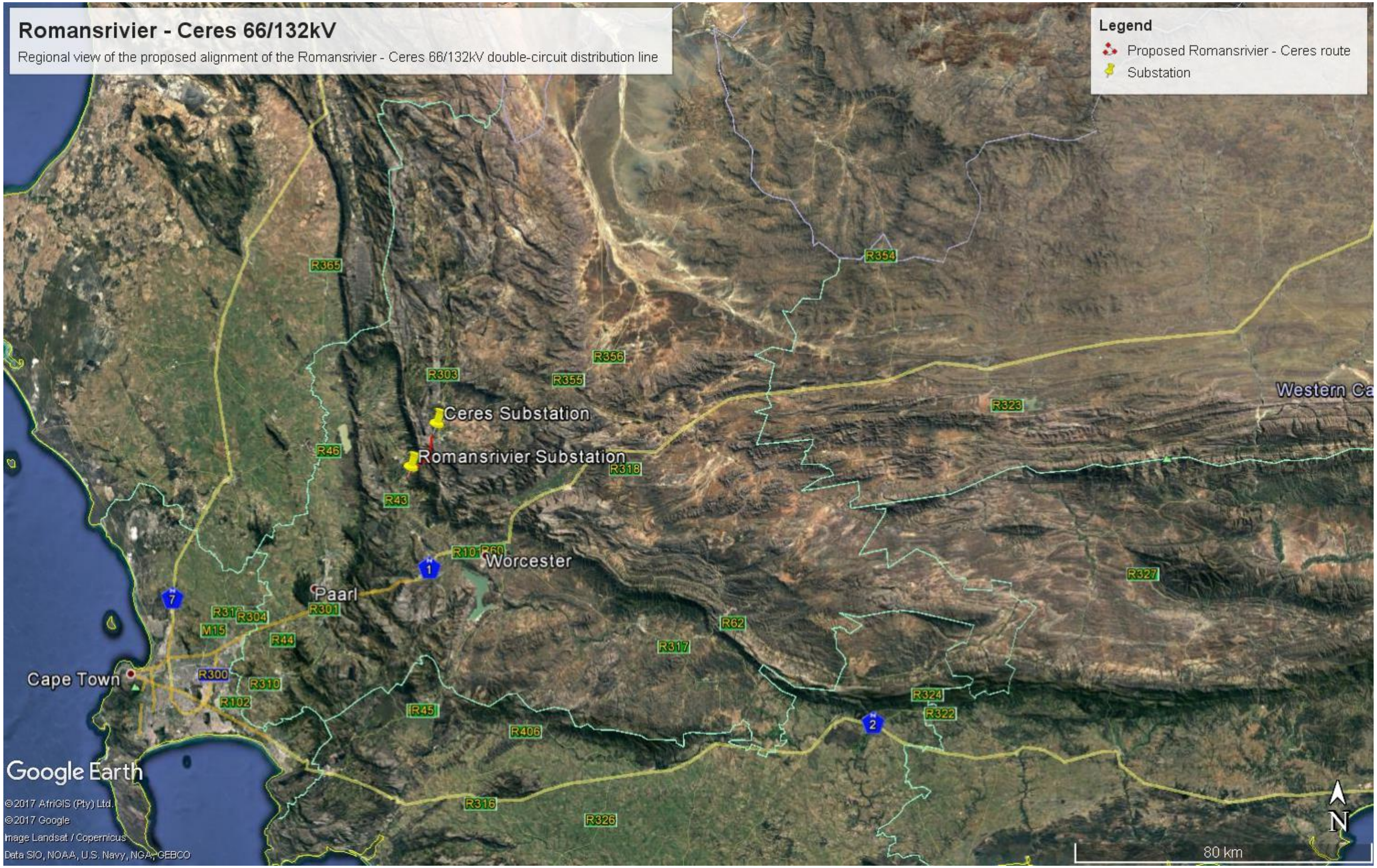

Figure 2: Regional map showing the approximate location of the study area

2 BACKGROUND AND BRIEF

The terms of reference for this bird impact assessment study are as follows:

- Describe the affected environment;
- Indicate how birdlife will be affected by the proposed development;
- List gaps in baseline data;
- List and assess the expected impacts; and
- Provide recommendations for mitigating measures.

3 STUDY APPROACH

3.1 Sources of information

The study made use of the following data sources:

- Bird distribution data of the South African Bird Atlas 2 (SABAP2) was obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occur within the broader area i.e. within a block consisting of 4 pentad grid cells within which the study area is situated. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. Between 2008 and 2017, a total of 49 full protocol cards (i.e. 49 bird surveys lasting a minimum of two hours each) have been completed for this area (see Figure 3 below).

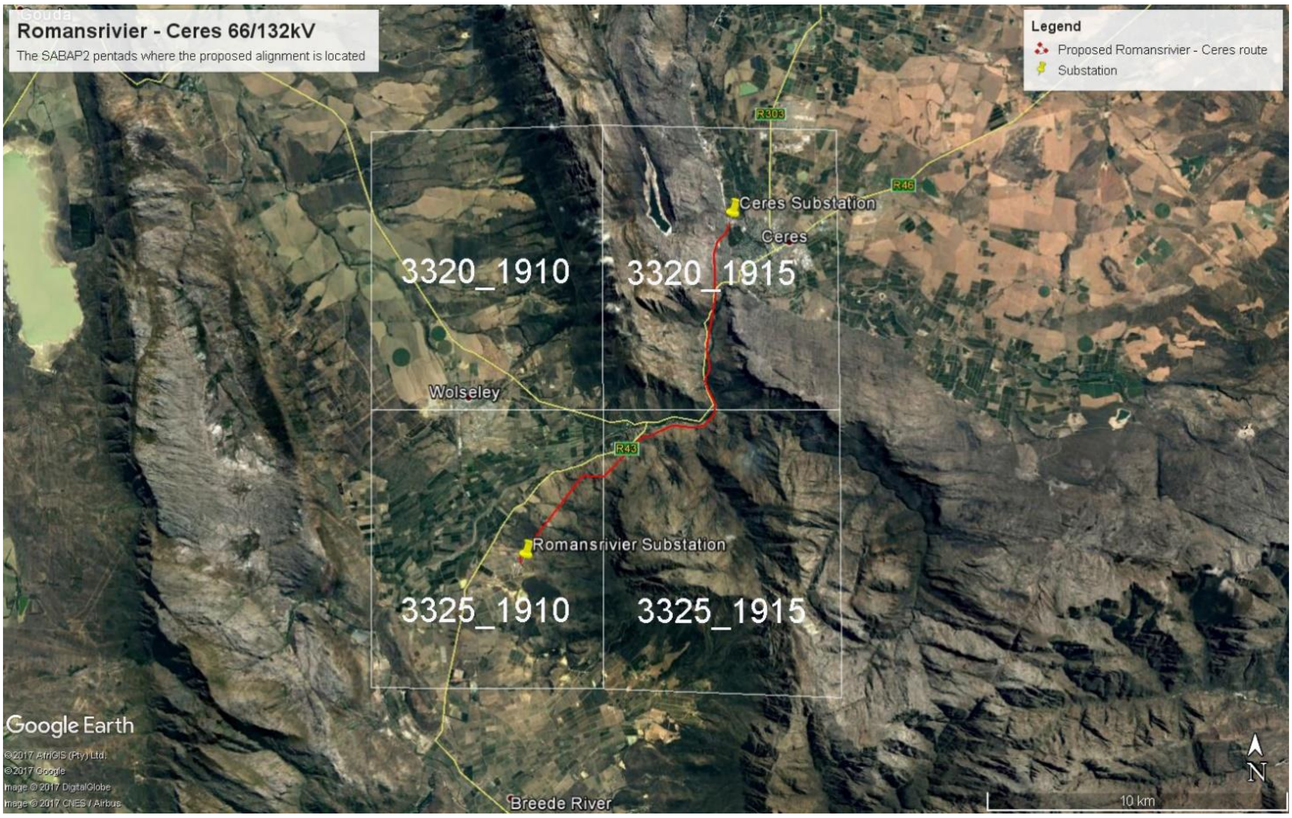

Figure 3: The 4 SABAP2 pentads within which the study area is located.

- The Important Bird Areas project data was consulted to get an overview of important bird areas (IBAs) and species diversity in the study area (Marnewick *et al*. 2015).

- The power line bird mortality incident database of the Endangered Wildlife Trust (1996 to 2007) was consulted to determine which of the species occurring in the study area are typically impacted upon by power lines (Jenkins *et al.* 2010).
- Data on vegetation types in the study area was obtained from the Vegetation Map of South Africa, (Mucina & Rutherford 2006).
- The conservation status of all species considered likely to occur in the area was determined as per the most recent iteration of the South African Red Data list for birds (Taylor *et al.* (eds) 2016), the 2016.3 IUCN Red List of Threatened Species and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Personal observations, especially experience from other projects which the author worked on in the Western Cape Province since 1996, have also been used to supplement the data that is available from SABAP2, and has been used extensively in forming a professional opinion of likely bird/habitat associations.
- Field visits to the study area were conducted on 24 – 25 April and 23 - 24 May 2017 to gain a first-hand impression of the micro-habitat and avifauna in the study area.
- The database of Coordinated Waterbird Counts (CWAC) project of the ADU was consulted to establish if there are any waterbodies in the study area with known significant populations of waterbirds.
- The Coordinated Avifaunal Roadcounts (CAR) project data was consulted to establish if there are any CAR routes in the study area which are utilised for large terrestrial bird surveys.
- A list of protected areas which overlap with the study area was sourced from the South African National Biodiversity Institute (SANBI) website (http://bgis.sanbi.org).

3.2 Limitations & assumptions

This study made the following assumptions:

- The coverage by SABAP2 has been extensive, with a total of 49 full protocol checklists (i.e. 49 surveys lasting between 4 hours and 5 days) completed since 2008 for the twelve pentads where the study area is located, which give an updated snapshot of the birds currently occurring there. In view of this, the reporting rates for the species in the study area are regarded as an accurate guideline, reflecting actual densities on the ground.
- The author has travelled and worked extensively on avifaunal impact assessments for a variety of projects in the Western Cape Province since 1996. Personal observations and past experience have therefore also been used to interpret the data that is available from SABAP2, and has been used extensively in identifying likely bird/habitat associations.
- Assessments in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will hold true under all circumstances; therefore, professional judgment played an important role in this assessment. It should also be noted that the impact of power lines on birds has been well researched with a robust body of published research stretching over thirty years.
- The report focused on the potential impact of the proposed infrastructure on nationally and/or globally threatened (Red Data) avifauna. These species serve as surrogates for a wide range of non-threatened avifauna which could also potentially be impacted by the powerline. The proposed mitigation measures will also effectively mitigate for the non-threatened avifauna.
- The study area was defined as a 2km radius around the proposed infrastructure.

4. STUDY AREA

4.1 Important Bird Areas (IBAs)

The study area does not overlap with any Important Bird Areas (IBAs). It is situated mid-way between two IBA's namely the Cedarberg - Koue Bokkeveld Complex (IBA SA101), and the Boland Mountains (IBA SA107). The proposed development should not have any direct impact on avifauna occurring in the two IBAs.

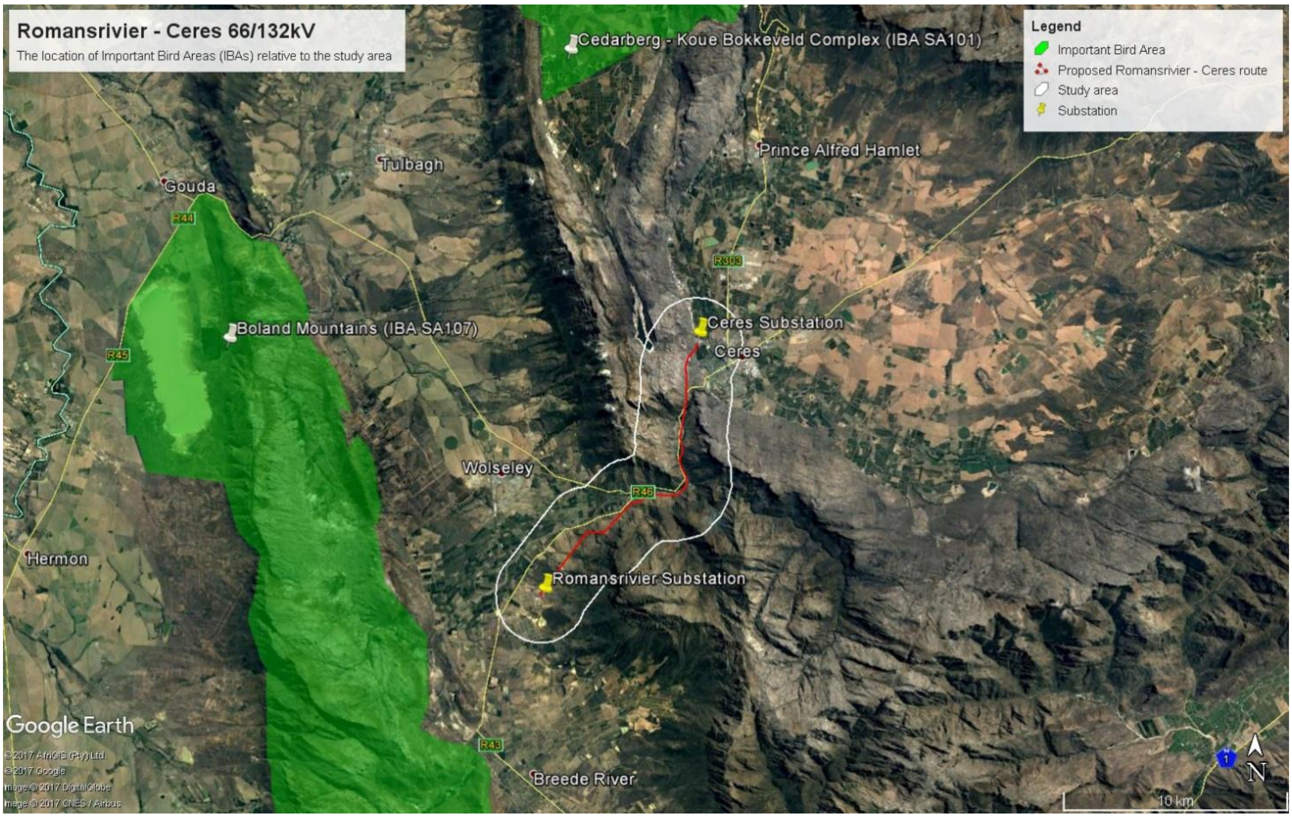

Figure 4: The Cederberg – Koue Bokkeveld Compex IBA relative to the study area

4.2 Primary vegetation divisions (biomes)

The study area extends over a single primary vegetation division, namely fynbos (Harrison *et.al* 1997; Mucina & Rutherford 2006). It is generally accepted that vegetation structure, rather than the actual plant species, influences bird species distribution and abundance (Harrison *et al.* 1997). In other words, while avifaunal distribution is influenced by primary vegetation divisions, avifaunal diversity is less dependent on vegetation units within these primary vegetation types. From an avifaunal perspective, the Atlas of southern African Birds (SABAP1) recognises six primary vegetation divisions or biomes within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). These vegetation descriptions do not focus on lists of plant species, but rather on factors which are relevant to bird distribution. The criteria used by the SABAP1 authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations.

4.3 Description of bird habitat classes in the study area

The following bird habitat classes were recorded in the study area (vegetation descriptions based largely on Harrison *et al.* 1997 and Mucina & Rutherford 2006) (see also Appendix 1 for photographs of the various habitat classes):

4.3.1 Fynbos

The natural vegetation types in the study area are a variety of fynbos types, consisting of a mixture of Winterhoek Sandstone Fynbos, Breede Shale Fynbos, Ceres Shale Renosterveld, and North Hex Sandstone Fynbos (Mucina & Rutherford 2006). Fynbos is dominated by low shrubs characterised by restioid, erioid and proteoid components (Harrison *et al.* 1997). Fynbos represents the majority of the natural vegetation in the study area and it is the dominant vegetation type along the proposed alignment. The fynbos biome is characterised by a high level of diversity and endemism in its botanical composition, which is not paralleled in its terrestrial avifauna, which is depauperate relative to other southern African biomes. The natural fynbos vegetation in the study area has been heavily disturbed in places through alien infestation and burning which resulted in large grassy clearings, but substantial areas of good quality fynbos habitat remains. Red Data species that may be attracted to areas of natural fynbos vegetation in the study area are Black Harrier *Circus maurus*, Secretarybird *Sagittarius serpentarius*, Verreaux's Eagle *Aquila verreauxii*, African Marsh-harrier *Circus ranivorus*, Protea Seed-eater *Crithagra leucopterus*. Blue Crane *Anthropoides paradiseus* may occasionally visit clearings in the natural fynbos.

4.3.2 Drainage lines and rivers

The study area contains the perennial Breërivier and several smaller, ephemeral drainage lines. The rivers and drainage lines have generally been heavily infested with Port Jackson *Acacia saligna* and Black Wattle *Acacia mearnsii*. Due to the degraded state of the rivers, few Red Data species are likely to frequent the river systems in the study area. African Black Duck *Anas sparsa* was observed in some of the drainage channels during one of the site visits, and Red Data Black Stork *Ciconia nigra* could be present on occasion.

4.3.3 Dams

The study area contains several man-made dams of various sizes. The dams could attract several Red Data species, which may include Black Stork, Greater Flamingo *Phoenicopterus ruber*, Maccoa Duck *Oxyura maccoa* and Blue Crane. Movement between the dams is possible, with birds following the natural contours of the landscape.

4.3.4 Mountains

Study area contains some of the most impressive mountains in the Western Cape, namely the Witzenberge, Skurweberge and Waaihoekberge. Red Data species which could be attracted to the towering cliffs and buttresses are Black Stork, Verreaux's Eagle, Lanner Falcon *Falco biarmicus* and Cape Rock-jumper *Chaetops frenatus*. Several non-Red Data powerline sensitive species could also frequent this habitat, e.g. Jackal Buzzard *Buteo rufofuscus*, Booted Eagle *Hieraaetus pennatus* and Peregrine Falcon *Falco peregrinus*. A Verreaux's Eagle nest was recorded during the site visit just south of the town of Ceres on a cliff of the Skurweberge (see Figure 5 below).

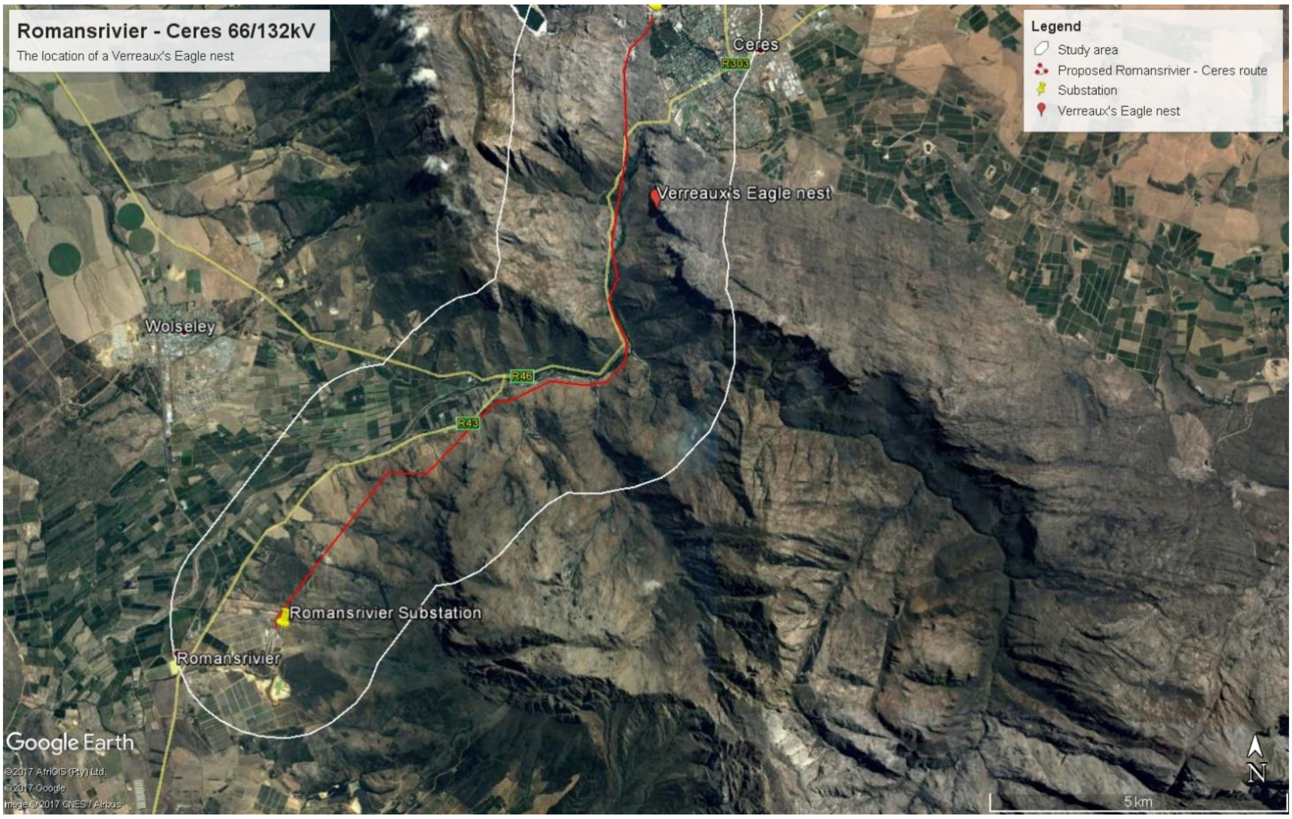

Figure 5: A Verreaux's Eagle nest situated just outside the town of Ceres

4.3.5 Alien trees

The study area contains a variety of alien trees, mostly Port Jackson, Black Wattle, *Pinus* spp and *Eucalyptus* spp. In some instances, these trees form dense stands. Red Data species which could utilise this habitat are Verreaux's Eagle, Lanner Falcon and a variety of powerline sensitive non-Red Data raptors, e.g. Jackal Buzzard, Steppe Buzzard *Buteo vulpinus*, Booted Eagle and Peregrine Falcon.

4.3.6 Agriculture and urban areas

The study area contains several areas of intensive agriculture, mostly fruit orchards and partially encompasses the town of Ceres. These urban and agricultural environments are generally less attractive to Red Data avifauna. Lanner Falcon and Blue Crane could be attracted to fallow crop fields in the south of the study area near the Romansrivier Substation.

See Appendix 1 for a photographic record of the bird habitats in the study area.

4.4 Red Data species potentially occurring in the study area

The 13 Red Data species which could potentially occur in the study area are listed in Table 4-1 below. For each species, the potential for occurring in a specific habitat class is indicated, as well as the type of impact (if any) that could potentially affect the species in the study area.

Table 4-1: Red Data species that could potentially occur in the study area.

EN = Endangered VU = Vulnerable NT = Near-threatened

Name	Taxonomic name	Global conservation status (IUCN 2016)	Regional Conservation status (Taylor *et al.* (eds) 2016)	Consolidated SABAP2 reporting rate in the 12 pentads %	Habitat type						Potential threats	
					Fynbos	Mountains	Rivers	Alien trees	Dams	Agric	Collisions	Displacement through disturbance and habitat transformation
Falcon, Lanner	*Falco biarmicus*	LC	VU	0	x	x		x		x	x	
Crane, Blue	*Anthropoides paradiseus*	VU	NT	12.24	x				x	x (fallow fields	x	
Flamingo, Greater	*Phoenicopterus ruber*	LC	NT	0					x		x	
Harrier, Black	*Circus maurus*	VU	EN	0	x						x	x
Marsh-harrier, African	*Circus ranivorus*	LC	EN	2.04	x						x	
Secretarybird	*Sagittarius serpentarius*	VU	VU	0	x					x (fallow fields)	x	
Verreaux's Eagle	*Aquila verreauxii*	LC	VU	6.12	x	x		x			x	x
Rock-jumper, Cape	*Chaetops frenatus*	LC	NT	0	x	x						x
Seedeater, Protea	*Crithagra leucopterus*	LC	NT	8.16	x							x

Name	Taxonomic name	Global conservation status (IUCN 2016)	Regional Conservation status (Taylor *et al.* (eds) 2016)	Consolidated SABAP2 reporting rate in the 12 pentads %	Habitat type						Potential threats	
					Fynbos	Mountains	Rivers	Alien trees	Dams	Agric	Collisions	Displacement through disturbance and habitat transformation
Duck, Maccoa	*Oxyura maccoa*	NT	NT	6.12					x		x	
Stork, Black	*Ciconia nigra*	LC	VU	0		x	x		x		x	

5 DESCRIPTION OF EXPECTED IMPACTS

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

5.1 Electrocutions on the proposed powerlines

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk is largely determined by the pole/tower design. The tower design that has been proposed for this project is mostly lattice structures, with limited use of steel monopoles.

The clearances on the proposed lattice structures are too large to put any of the Red Data species which could potentially occur in the study at risk of electrocution.

In the case of the steel monopole, clearances between phase conductors on the same side of the 132kV monopole in-line and strain structures is 2m. This clearance should be sufficient to reduce the risk of phase to phase electrocutions of birds on the towers to negligible levels, because none of the Red Data species that are likely to occur in the study area are large enough to bridge the air gap between the phase conductors. Electrocution only occurs when the air gap between the phase conductors is bridged by the bird, thereby causing the current to flow through the bird.

The length of the stand-off insulators is approximately 1.6m. If very large species attempts to perch on the stand-off insulators, they are potentially able to touch both the conductor and the earthed pole simultaneously, potentially resulting in a phase – earth electrocution. However, electrocutions on this pole design have only been recorded for Cape Vultures (which do not occur in the study area), and only where several birds have attempted to perch on the same pole, e.g. at a food source (C. Hoogstad 2017 pers. comm.) Electrocution can therefore be ruled out as a potential impact of the Project, and need not be further assessed.

5.2 Collisions with the earthwire of the proposed powerlines

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

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

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups

– biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).

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

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

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

As mentioned by Shaw (2013) in the extract above, several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e. whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin & Shaw 2010). Visual fields were determined in three bird species representative of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards *Ardeotis kori*, Blue Cranes and White Storks *Ciconia ciconia.* In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35° respectively are sufficient to render the birds blind in the direction of travel; in storks head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families, especially raptors (*Accipitridae*), which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to power line collisions.

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

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

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

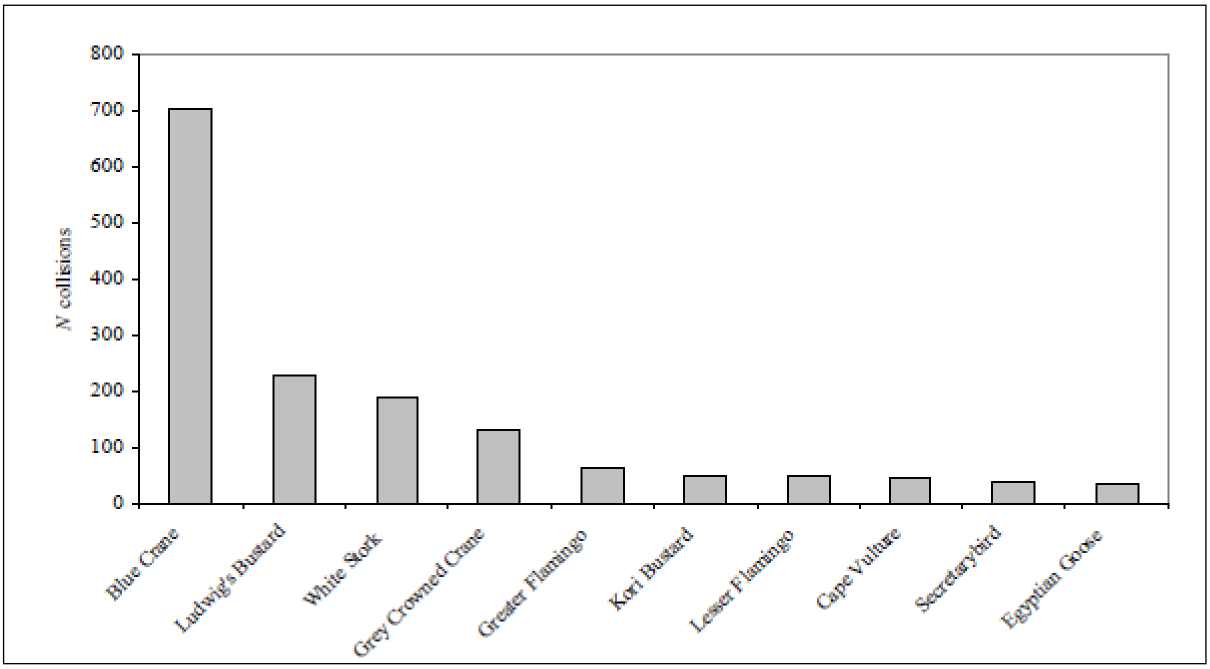

Figure 5: The top ten collision prone bird species in South Africa, in terms of incidentally reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

In the present instance, potential high risk Red Data candidates for collisions are the following:

- Blue Cranes in fallow fields, clearings in the fynbos and at dams, particularly in the southern part of the study area;
- Secretarybirds in clearings in the fynbos and fallow fields;
- Black Storks at dams and river courses;
- Maccoa Duck at dams; and
- Greater Flamingo at dams.

Lower risk candidates for collision are the following:

- Lanner Falcon: Anywhere along the proposed alignment, particularly when pursuing aerial prey;
- Verreaux's Eagle: Could potentially collide with the line when engaging in low altitude slope soaring in rocky fynbos habitat;
- Black Harrier: Could be at risk when flying at low altitude in fynbos habitat;
- African Marsh-harrier: Could be at risk when flying at low altitude in fynbos habitat.

5.3 Displacement due to habitat destruction and disturbance associated with the construction of the substations, power lines and access roads

During the construction phase and maintenance of power lines, substations, roads and other industrial infrastructure, habitat destruction and transformation inevitably takes place. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the development area through transformation of habitat, which could result in temporary or permanent displacement.

5.3.1 Powerlines and Access Roads

Displacement due to disturbance

In the present instance, the following Red Data species are at high risk of displacement due to disturbance, associated with the construction of the powerlines and access roads:

- Verreaux's Eagle. There is an active nest situated at 33°23'38.30"S 19°17'45.93"E, which is situated 740m from the proposed powerline at its closest point. There is a risk that the birds may be disturbed by the construction activities associated with the powerline, which may lead to intermittent/ temporary displacement of the birds during the breeding season (May – November), especially if there is blasting involved.

The following Red Data species are at low risk of temporary displacement due to disturbance during the construction of the powerlines and access roads:

- Black Harrier: It is unlikely that the birds are breeding in the study area due to the general lack of suitable undisturbed fynbos habitat along the alignment, but there is some possibility of birds moving through the study area.
- Cape Rock-jumper and Protea Seed-eater: The species could be temporarily disturbed by construction activities in the study area near Ceres Substation where the alignment is situated in suitable rocky mountain fynbos habitat.

Displacement due to habitat transformation

The Red Data species most likely to be potentially impacted are the fynbos associated species namely Cape Rock-jumper and Protea Seed-eater. However, the total footprint of the powerlines and access roads should not materially affect the local populations of these species as there are still large areas of undisturbed habitat remaining.

6 ASSESSMENT OF EXPECTED IMPACTS

6.1 Assessment criteria

The significance of all potential impacts that would result from the proposed Project is determined in order to assist decision-makers. The significance rating of impacts is considered by decision-makers, as shown below.

- **INSIGNIFICANT**: the potential impact is negligible and **will not** have an influence on the decision regarding the proposed activity.
- **VERY LOW**: the potential impact is very small and **should not** have any meaningful influence on the decision regarding the proposed activity.
- **LOW**: the potential impact **may not** have any meaningful influence on the decision regarding the proposed activity.
- **MEDIUM**: the potential impact **should** influence the decision regarding the proposed activity.
- **HIGH**: the potential impact **will** affect a decision regarding the proposed activity.

- **VERY HIGH**: The proposed activity should only be approved under special circumstances.

Step 1

The **significance** of an impact is defined as a combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The significance of each identified impact was rated according to the methodology set out below:

Rating	Definition of Rating	Score
A. *Extent* *– the area over which the impact will be experienced*		
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. ***Intensity*** *– the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources*		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. ***Duration*** *– the timeframe over which the impact will be experienced and its reversibility*		
Short-term	Up to 2 years (i.e. reversible impact)	1
Medium-term	2 to 15 years (i.e. reversible impact)	2
Long-term	More than 15 years (state whether impact is irreversible)	3

The combined score of these three criteria corresponds to a **Consequence Rating**, as follows:

Combined Score (A+B+C)	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

Step 2

The **probability** of the impact occurring was assessed according to the following definitions:

Probability– the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

Step 3

The overall **significance** of the impact was determined as a combination of the **consequence** and **probability** ratings, as set out below:

		Probability			
		Improbable	Possible	Probable	Definite
Consequenc	Very Low	**INSIGNIFICANT**	**INSIGNIFICANT**	**VERY LOW**	**VERY LOW**
	Low	**VERY LOW**	**VERY LOW**	**LOW**	**LOW**
	Medium	**LOW**	**LOW**	**MEDIUM**	**MEDIUM**
	High	**MEDIUM**	**MEDIUM**	**HIGH**	**HIGH**

	Very High	**HIGH**	**HIGH**	**VERY HIGH**	**VERY HIGH**

Step 4
The **status** of the impact (i.e. will the effect of the impact be negative or positive?) was noted.

Step 5
The level of **confidence** in the assessment of the impact (high, medium or low) was stated.

Step 6
Practical **mitigation** and **optimisation** measures that can be implemented effectively to reduce or enhance the significance of the impact were identified and described. Mitigation and optimisation measures were described as either:

- **Essential**: best practice measures which must be implemented and are non-negotiable; and;
- **Best Practice**: recommended to comply with best practice, with adoption dependent on the proponent's risk profile and commitment to adhere to best practice, and which must be shown to have been considered and sound reasons provided by the proponent if not implemented.

6.2 Impact Assessment Tables

Impact 1: **Collisions of Red Data avifauna with the earthwire of the proposed powerlines**

In the present instance, potential high risk Red Data candidates for collisions are the following:

- Blue Cranes in fallow fields, clearings in the fynbos and at dams, particularly in the southern part of the study area;
- Secretarybird in clearings in the fynbos and fallow fields;
- Black Storks at dams and river courses;
- Maccoa Duck at dams; and
- Greater Flamingo at dams.

Lower risk candidates for collision are the following:

- Lanner Falcon: Anywhere along the proposed alignment, particularly when pursuing aerial prey;
- Verreaux's Eagle: Could potentially collide with the line when engaging in low altitude slope soaring in rocky fynbos habitat;
- Black Harrier: Could be at risk when flying at low altitude in fynbos habitat;
- African Marsh-harrier: Could be at risk when flying at low altitude in fynbos habitat.

This impact is assessed to be of ***Low*** significance and mitigation is required to reduce it to ***Very Low*** significance (see
Table).

Table 6-1: Significance of the potential mortality of Red Data avifauna due to collisions with the earthwire of the powerlines

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	Medium 2	Long term (reversible) 3	**Medium** **6**	Possible	**Low**	**Negative**	High
Essential Mitigation Measures: • Mark spans in high sensitivity areas with Bird Flappers. These are the spans between the following pylons: (1) 9-10-11 (2) 23 – 24 – 25 - 26 (3) 39 - 40 (4) 42 – 43 - 44 • Once finalised, the final pylon locations must be provided to the avifaunal specialist in order to delineate the exact spans to be marked. **Best Practice Mitigation Measures** None								
With mitigation	Local 1	Low 1	Long term 3	**Low** **5**	Possible	**Very Low**	**Negative**	High

<u>Impact 2:</u> Displacement due to habitat destruction and disturbance associated with the construction of the powerlines and access roads

<u>Displacement due to disturbance</u>

In the present instance, the following Red Data species are at high risk of displacement due to disturbance, associated with the construction of the powerlines and access roads:

- Verreaux's Eagle. There is an active nest situated at 33°23'38.30"S 19°17'45.93"E, which is situated 740m from the proposed powerline at its closest point. There is a risk that the birds may be disturbed by the construction activities associated with the powerline, which may lead to intermittent/ temporary displacement of the birds during the breeding season (May – November), especially if there is blasting involved.

The following Red Data species are at low risk of temporary displacement due to disturbance during the construction of the powerlines and access roads:

- Black Harrier: It is unlikely that the birds are breeding in the study area due to the general lack of suitable undisturbed fynbos habitat along the alignment, but there is some possibility of birds moving through the study area.
- Cape Rock-jumper and Protea Seed-eater: The species could be temporarily disturbed by construction activities in the study area around Ceres Substation where the alignment is situated in suitable rocky mountain fynbos habitat.

Displacement due to habitat transformation

The Red Data species most likely to be potentially impacted by this impact are the fynbos associated species namely Cape Rock-jumper and Protea Seed-eater. However, the total footprint of the powerlines and access roads should not materially affect the local populations of these species as there are still large areas of undisturbed habitat remaining.

Table 6-2: Displacement due to habitat destruction and disturbance associated with the construction of the powerline and access roads

	Extent	***Intensity***	***Duration***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Without mitigation	Local 1	High 3	Short term 1	**Low 5**	Probable	**Low**	**Negative**	Medium
Essential Mitigation Measures: • No construction activities to take place at pylons 51 to 55 between May and November (breeding season) to prevent disturbance of the breeding pair of Verreaux's Eagles situated at 33°23'38.30"S 19°17'45.93"E. • Restrict construction footprints to the smallest possible area. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Standard measures to control noise and dust should be applied during construction. **Best Practice Mitigation Measures** • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.								
With mitigation	Local 1	Low 1	Short term 1	**Very Low** 3	Improbable	**Insignificant**	**Negative**	Medium

This impact is assessed to be of ***Low*** significance. The implementation of mitigation should reduce the impact to ***Insignificant*** (see
Table 2).

7 CONCLUSIONS

The construction of the proposed new 132/66kV double-circuit line between Ceres and Romansrivier Substations is expected to have a range of potential impacts on Red Data avifauna. These can be summarised as follows:

Electrocution: No electrocution risk is envisaged for Red Data avifauna on the proposed pylon structures.

Collisions: The risk of mortality of Red Data species through collisions with the earthwire is assessed to be of Low significance. The species that are most at risk of collisions are the Blue Crane, Secretarybird, Black Stork, Maccoa Duck and Greater Flamingo. Other Red Data species potentially at risk, but to a lesser extent, are Lanner Falcon, Verreaux's Eagle, Black Harrier and African Marsh-harrier. With appropriate mitigation, the collision risk can be reduced to Very Low.

Displacement: The impact of displacement due to disturbance and habitat transformation is assessed to be of Low significance. The most significant potential impact in this regard is the possible disturbance of a pair of Verreaux's Eagles on an active nest situated at 33°23'38.30"S 19°17'45.93"E, which is situated 740m from the proposed powerline at its closest point. There is a risk that the birds may be disturbed by the construction activities associated with the powerline, which may lead to intermittent/ temporary displacement of the birds during the breeding season (May – November), especially if there is blasting involved. Timing of the construction activities to avoid the breeding season should reduce the impact to Insignificant. Other Red Data species that could potentially be temporarily impacted through disturbance are Black Harrier, Cape Rock-jumper and Protea Seed-eater, but this impact should be of a transient nature and relatively insignificant. The habitat transformation associated with the footprint of the powerlines and access roads should not materially affect the local populations of Red Data species as there are still large areas of undisturbed habitat remaining.

Table 7-1: Summary of impacts

Impact	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Impact 1: Collisions of Red Data avifauna with the earthwire of the proposed powerlines.	**Medium**	Possible	**Low**	**Negative**	High
With Mitigation	**Low**	Possible	**Very Low**	**Negative**	High
Impact 2: Displacement due to habitat destruction and disturbance associated with the construction of the substation, powerlines and access roads	**Low**	Probable	**Low**	**Negative**	Medium
With Mitigation	**Very Low**	Improbable	**Insignificant**	**Negative**	Medium

In conclusion, it can therefore be stated that the proposed development could proceed from an avifaunal impact assessment perspective, provided the proposed mitigation measures are strictly applied.

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APPENDIX 1: BIRD HABITATS

Figure 1: Industrial infrastructure (Ceres substation)

Figure 2: Rocky mountain fynbos habitat near Ceres

Figure 3: The Skurweberg mountains

Figure 4: The Breede River


Figure 5: Fallow agricultural fields near Romansrivier Substation


Figure 7: Alien trees