ANKERLIG-KOEBERG (ALTERNATIVE 2)
POWER LINE ROUTE

Walk-through survey

Southern section of the Ankerlig power line site

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1 EXECUTIVE SUMMARY

This study contains a brief review of literature on bird-power line impacts, and identifies potential impacts associated with a new 132 kV power routing from Atlantis Power station (Ankerlig) to Koeberg Nuclear Power plant, Western Cape. The possible impacts are: (i) minimal aerial-habitat alteration by the power lines themselves (due to existing lines along most of the planned route), (ii) disturbance by construction and maintenance activities, (iii) possible displacement or disturbance of sensitive species, and most critical, (iv) direct collision of birds with the power line network. Electrocution of avifauna is a lesser problem for all but the largest species on the power line infrastructure.

The impact zone of the power line route lies within the Hopefield Sand Fynbos vegetation zones. Up-to-date bird atlas data from the region indicates that habitat around the 7 km new routing supports up to 171 bird species, including 14 threatened (red-listed) species, and 18 collision-prone species ranked in the top 105 species.

The avian groups of greatest conservation significance likely to be impacted by the power lines include the flocking waterbirds near the main wetland hotspots near the Atlantis water treatment works where collision-prone White Pelicans *Pelecanus onocrotalus,* Fish Eagles *Haliaetus vocifer* and African Marsh Harriers *Circus ranivorus* were previously found at the wetland. Resident raptors such as Black Harriers *Circus maurus*, and African Marsh Harrier are rare (but breeding) collision-prone species within the Koeberg Nature Reserve at the southern end of the line.

Semi-quantitative assessments of the significance of the impacts to birds found before mitigation gave a medium-high score (56) suggesting mitigations are necessary. After mitigation this could drop to medium-low score of 33.

To mitigate the possible problems to sensitive avian species we recommend that: (i) all power lines – *present and future* – particularly near the Atlantis wetland, and in the Koeberg Nature Reserve, are marked with diurnal and nocturnal bird diverters to reduce collision risk, and (ii) post-construction monitoring of bird sensitive areas takes place for the areas highlighted as "sensitive" (refer to Figure 2) as well as the other existing lines in the area.

1.1 Consultant's Declaration of Independence

Dr Rob Simmons and Marlei Martins are independent consultant (of Birds & Bats Unlimited Environmental Consulting) hired by Savannah Environmental. We have no business, financial, personal or other interest in the activity, application or appeal in respect of which we were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work.

Dr R E Simmons **Marlei Martins**

June 2016

1.2 Background and Qualifications of Specialist Consultants

Dr Rob Simmons was approached by Savannah Environmental to undertake the specialist avifaunal walk through for the new (Alt 2) 132 kV power line route from Atlantis Power Station (Ankerlig) to Koeberg, in the Western Cape.

He is an experienced ornithologist, with over 30 years' experience and 100 papers on avian research and impact assessment work. More than thirty avian impact assessments have been undertaken throughout Namibia and South Africa. He independently undertakes research on threatened species (raptors, flamingos, waders and terns) at the FitzPatrick Institute, UCT (see www.fitzpatrick.uct.ac.za/docs/robert.html).

Marlei Martins has 20 years' experience in animal rehabilitation and 5 years' experience in environmental impact assessment work as both a specialist and an assistant. She has worked in the Western Cape, Eastern Cape and Northern Cape and has experience in the Succulent Karoo, Nama Karoo and Fynbos biomes.

2 INTRODUCTION

Eskom obtained environmental authorisation for the re-routing of the power line between Atlantis and Koeberg power stations in August 2015. In terms of the requirements of the EMP and Eskom's standard practices, a walk-through survey had to be undertaken for the approved route (Alternative 2). The purpose of this walk through would be to inform them of any areas of sensitivity where mitigation may be required, or which should be avoided by the towers.

Savannah Environmental appointed Birds & Bats Unlimited to conduct the specialist avifaunal walk through. This report reviews the bird species present from bird atlas records, and reports on those species most at risk from collision, avoidance and electrocution of the power lines and substations. A brief, 1 day, site visit allowed us to record numbers of birds along sensitive sections of the (Alt 2) proposed power line, particularly those associated with wetlands and possible flyways. We were also asked to investigate the possible impacts and suggest ways to mitigate them wherever feasible. This allows us to reduce impacts to the avian community to a minimum.

3 TERMS OF REFERENCE

The terms of reference for the walk through as provided by Savannah Environmental are as follows:

- To undertake a walk-through of the recently authorised 132 kV power line (Alt 2) route, from the Atlantis substation to Koeberg
- To inform any areas of sensitivity where mitigation may be required, or which should be avoided by the towers.

4 STUDY METHODOLOGY

4.1 Approach

This Report includes the following steps:

- A review of available published and unpublished literature pertaining to bird interactions with power lines; this summarises the issues involved and the current level of knowledge in

this field. Various data sources were examined including details of the avifauna of the area and previous studies of bird interactions with electrical infrastructures associated with them.

- A list of the avifauna likely to occur along the length of the power lines was compiled using a combination of the most recent (2007-2015) distributional data from bird atlas data, and a 1-day visit in March 2014 and June 2016, for critical sections of the proposed line.
- A semi-quantified assessment of the significance of the impacts to birds.

Table 1. A compilation of the bird atlas cards that the new line option crosses from Atlantis to Koeberg. A pentad refers to 5 x 5' square area that the Southern African bird atlas covers.

Locality and bird atlas cards		
Pentad	**Cards**	**Area**
3335_1825	24	Atlantis
3340-1825	51	Koeberg
Total 2 pentads; 75 cards		

- A short-list of priority bird species (defined in terms of conservation status and collision-prone ranking) which may be impacted by the power lines was extracted from the bird list. These species are considered the most important and their likelihood of occurrence (reporting rate) is given.

- The power line option to be put in context of the BAWESG (Birds and Wind Energy Specialist Group) sensitivity map of the western Cape taken from (http://www.birdlife.org.za/conservation/birds-and-wind-energy/windmap/325-windmap documentation).

4.2 Assessment of Impacts

Direct, indirect and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase are assessed in terms of the following criteria:

» The **nature** - a description of what causes the effect, what will be affected and how it will be affected.
» The **extent (E)**, - whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
» The **duration (D)**, - an indication of the expected length of impact:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;

- the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
- medium-term (5–15 years) – assigned a score of 3;
- long term (> 15 years) - assigned a score of 4; or
- permanent - assigned a score of 5;

» The **magnitude (M)**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

» The **probability (P)** *of occurrence*, is the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very unlikely (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).

» the **status**, which will be described as either positive, negative or neutral.

» the degree to which the impact can be reversed.

» the degree to which the impact may cause irreplaceable loss of resources.

» the *degree* to which the impact can be *mitigated.*

» the **significance (S)**, is a synthesis of the quantified characteristics above and can be assessed as low, medium or high; and is calculated as follows:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

» < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),

» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),

» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Assessment of impacts is summarised in table format.

4.3 Data sources used

The following data sources and reports were used in the compilation of this report:

- Information on the biology (Hockey et al 2005), distribution (Harrison et al. 1997) and conservation status (Barnes 2000) of southern African birds was consulted. Up to date data were extracted from the Southern African Bird Atlas Projects (SABAP), which were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the relevant "pentads" of 5' x 5' from (SABAP 2: Table 1 above). From these data we compiled a list of the avifauna known to occur within the impact zone of the proposed power lines. These data were combined, with our own 1-day visits to the area on 6 March 2014 and 2 June 2016.
- Conservation status and collision-prone ranking of all species considered likely to occur in the area was determined from the South African Red-list for birds (Barnes 2000, Taylor et al. 2015), and the ranking of collision-prone birds drawn from the BAWESG tabulation.
- Data on breeding Black Harriers *Circus maurus* (R.E. Simmons unpubl. data).

4.4 Limitations & assumptions

Inaccuracies in the above sources of information can limit this study. The SABAP1 data for this area is over 20 years old (Harrison *et al.* 1997), so we have used only the new SABAP 2 data set. This has a higher spatial resolution specific to the power lines and is up to date (2007 to 2015). 1-day "walk-throughs" are insufficient to cover all areas, so we sub-sampled at sensitive spots along the line. These sampling bouts may miss certain areas of importance or rarer birds that a longer visit, in a different season, with longer sampling intervals would cover better.

5. BACKGROUND REVIEW

5.1 Interactions between power lines and birds

Collision with power lines

Power lines pose collision risks to birds, affecting collision prone species (Bevanger 1994, 1995, 1998, Janss 2000b, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins *et al.* 2010). Mitigation of this risk involves the careful selection of low impact alignments for new

power lines relative to bird movements, and avoidance of concentrations of high risk species. Where this cannot be avoided, the use of static or dynamic marking devices are needed to make the lines more conspicuous (in particular the narrow earth wires at the top of the cable network – photo 1).

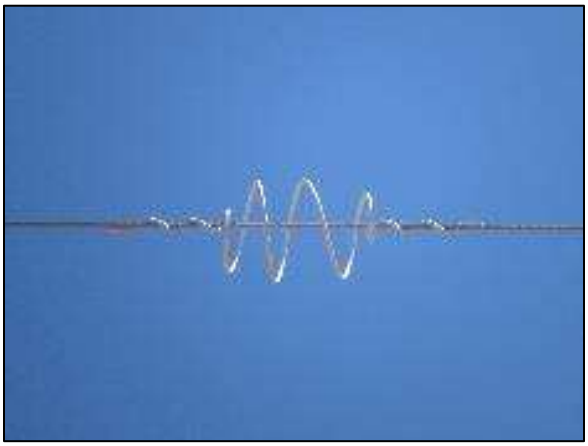

Photo 1 Bird diverter on the earth-wire

Laboratory-based studies of visual acuity in raptors have determined that (i) visual acuity in kestrels appears superior when objects are viewed at a distance, suggesting that the birds may view nearby objects with one visual field and objects further away with another.

Marking overhead lines with bird diverters is one way of reducing impacts for those species that see such devices. While various marking devices have been used globally, many remain untested in terms of reducing collisions. Those that have been tested are only partially effective (Drewitt & Langston 2008, Jenkins *et al.* 2010). However, not all collision-prone species see them, so avoiding areas where these birds occur, congregate, or breed is the best form of mitigation. Night-time fliers (e.g. flamingos) are particularly susceptible and newly developed LED lights powered with tiny solar panels mounted on the earth wire are are currently being field-tested in the Karoo with some success in reducing mortalities of Ludwig's Bustards *Neotis ludwigii and* Blue Cranes *Anthropoides paradiseus* (C Hoogstadt, EWT, unpubl data).

Causes of collision

The identity of the species present in the area is also very important as some birds are more vulnerable to collision with power lines than others, and feature disproportionately in collision

surveys (Drewitt & Langston 2006, 2008, de Lucas *et al.* 2008). Species-specific variation in behaviour, such as foraging, commuting or courting, also affect susceptibility to collision (Barrios & Rodríguez 2004, Smallwood *et al.* 2009). There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk (Simmons 2011).

Landscape features often channel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Ridges and steep slopes are important factors in determining the extent by which an area is used by gliding and soaring birds (Barrios & Rodríguez 2004). High densities of prey will attract raptors, increasing the time spent hunting, and as a result reducing the time spent being vigilant. Poor weather affects visibility. Birds fly lower during strong headwinds (Hanowski & Hawrot 2000, Richardson 2000), so they are more susceptible to power lines - even small reticulation lines (K de Goode, Eskom, pers comm).
Indeed, more large-bodied birds such as bustards are more regularly killed on smaller reticulation lines than larger transmission lines because there are about 58 000 km of such lines crisscrossing South Africa. This amounts to an estimated 47 000 deaths per year for Ludwig's Bustards *Neotis ludwigii (*Shaw 2013).

Collision prone birds
Collision prone birds are generally either (i) large species or those with high ratios of body weight to wing surface area, and low maneuverability (e.g. cranes, bustards, vultures, gamebirds, waterfowl, falcons); (ii) species which fly at high speeds (gamebirds, pigeons and sandgrouse, swifts, falcons); (iii) species which are distracted in flight - predators or species with aerial displays (many raptors, aerial insectivores, some open country passerines); (iv) species which habitually fly in low light conditions (owls, dikkops); and (v) species with narrow fields of forward binocular vision (blue crane, bustard) (Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010).

These traits confer high levels of *susceptibility*, which may be compounded by high levels of *exposure* to man-made obstacles such as overhead power lines and wind turbines (Jenkins *et al.* 2010). Exposure is greatest in (i) highly aerial species, (ii) species that make regular or long distance movements (e.g. migrants, any species with widely separated resources: food, water, roost and nest sites), (iii) species that fly in flocks (increasing the chances of incurring multiple fatalities in single collision incidents). Soaring species may be particularly prone to colliding with power lines where these are placed along ridges - vultures, storks, cranes, and most

raptors (Erickson et al. 2001, Kerlinger & Dowdell 2003, Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010).

Analysis of the susceptibility to power line collisions for some species (e.g. bustards and cranes) has been undertaken by Martin and Shaw (2010) and Shaw et al. (2010). From lab experiments they determined that species such as bustards and cranes have **"blind spots**" in their forward vision and simply do not see obstacles in front of them. This is due more to the placement of the eyes in the skull than poor vision by the birds. To see forward, the birds have to turn their heads from side to side. This is why these species head the collision-victim tables of the EWT power-line monitoring. Collisions of bustards are so common that it is difficult to know how the southern African populations of Ludwig's Bustards are maintained (Shaw 2013).

5.1.1 Habitat loss – destruction, disturbance and displacement

The construction and maintenance of substations, power lines, servitudes and roadways causes both temporary and permanent habitat destruction and disturbance. New overhead power lines also pose a collision - and possibly an electrocution threat - to certain species (Van Rooyen 2004a, Lehman *et al.* 2007, Jenkins *et al.* 2010). This may be of lasting significance in cases where power lines and pylons coincide with critical areas or migration corridors for restricted range, endemic and/or threatened species. Similarly, construction, and to a lesser extent ongoing maintenance activities, are likely to cause some disturbance of birds in the general surrounds, and especially of shy or ground-nesting species resident in the area. Mitigation of such effects requires that best-practice principles be rigorously applied – that sites are carefully selected to avoid the destruction of key habitats, and construction and final footprints, as well as sources of disturbance of key species, must be kept to a minimum.

On the other hand, pylons erected in a tree-less landscape can have positive effects for some raptorial species and vultures that have adapted to using the structures for perching-hunting and/or breeding. Red-listed Martial Eagles *Polemaetus bellicosus*, for example, now use extensive areas of the Karoo where they did not occur before, nesting on the top stanchions of the pylons (Machange et al. 2005). All precautions should, though, be taken to ensure that perching raptors are not electrocuted.

Habitat destruction during construction and maintenance of power lines and substations

Some habitat destruction and alteration inevitably takes place during the construction of power lines, the on-site substation (switching yard) and associated roadways. Also, power line servitudes have to be cleared of excess vegetation at regular intervals to allow access to the line for maintenance, and to prevent vegetation from intruding into the gaps between the ground and the conductors. These activities have an impact on birds breeding, foraging and roosting in, or in close proximity of, the servitude, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any given power line (e.g. King & Byers 2002).

Another negative influence can be the introduction of Pied Crows to an otherwise crow-free environment, which allows these cosmopolitan predators to be attracted to an area where they may reduce the survival and success of the small bird community around them (Madden 2013), and potentially reduce success of raptorial species breeding nearby (Simmons & Barnard 2011).

5.2 Description of the proposed alternative power lines

The route for the newly authorised power line is shown in Figure 1 (a). The new route around the power station will then join with the existing power line already in place to the south.

Figure 1: The newly authorized (Alternative 2) power line (black line) from the Atlantis substation and the Koeberg power line (red line) are depicted here. It is ~14 km from Ankerlig Power Station to the Koeberg Power Station.

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

6.1 Vegetation of the study area

The region occurs in the western part of the Fynbos Biome (Mucina and Rutherford 2006) and the line crosses dry Sand Plain Fynbos (Mucina & Rutherford 2006) for the majority of its route south. Near the Atlantis water-treatment works, the line passes through alien vegetation supporting Australian *Acacias* (Port Jackson and Rooikrans). The area experiences winter rainfall with an average of 326 mm. Relatively cool temperatures average just 16.6 – 16.9°C. Coastal fog is common adding to soil moisture levels (Mucina & Rutherford 2006). There is high plant species diversity particularly in the Koeberg Nature Reserve.

On this walk-through in June 2016 we found that a large fire had extensively burnt large portions of the areas demarcated for the power lines (from the Koeberg Nature Reserve to the Ankerlig Power Station). No vegetation was visible at the Koeberg Nature Reserve and the areas closest to the Ankerlig Power Station. The pans were dry except for one small pond which held only Blacksmith lapwing, Egyptian geese and an Egyptian mongoose in close proximity. The other pans, which previously held 136 birds (23 species, 2 red data species - March 2014) were depauperate of avian species in June 2016.

Photo 2: The large pan in our March 2014 visit (left) where a large number of birds were recorded, in stark contrast to the pan seen in our June 2016 visit (right) after a fire had raged through the area. No birds were observed near, or on, this pan.

Photo 3: Only one pond held water in our June 2016 walk through. The only birds seen here were two Blacksmith lapwings *Vanellus armatus* and two Egyptian geese *Alopochen aegyptius*. An Egyptian mongoose *Herpestes ichneumon* was seen in close proximity to it (inset).

6.2 Avian microhabitats

Bird habitats along the power lines occurred in similar sand plain Fynbos, but some areas (closer to Atlantis) were choked with alien acacias. These offer limited bird habitat and were depauperate of bird species in both our March 2014 and June 2016 visits (photo 4).

Photo 4: The alien trees that dominated the areas closer to the Ankerlig power station in our March 2014 visit had been burnt by a large fire that swept through the area before our arrival in June 2016.

Photo 5: Vegetation at the Koeberg Nature Reserve in March 2014 (left) and in June 2016 (right) after a large fire swept through the West Coast. This is mainly coastal Fynbos and is grazed by Eland and Zebra.

Photos 6 and 7: Raptors present along the line included a single Peregrine Falcon *Falco peregrinus* (above) perched on one of the towers at the Ankerlig Power Station and an African Fish-Eagle *Haliaetus vocifer* perching on a pylon (right) near an active nest.

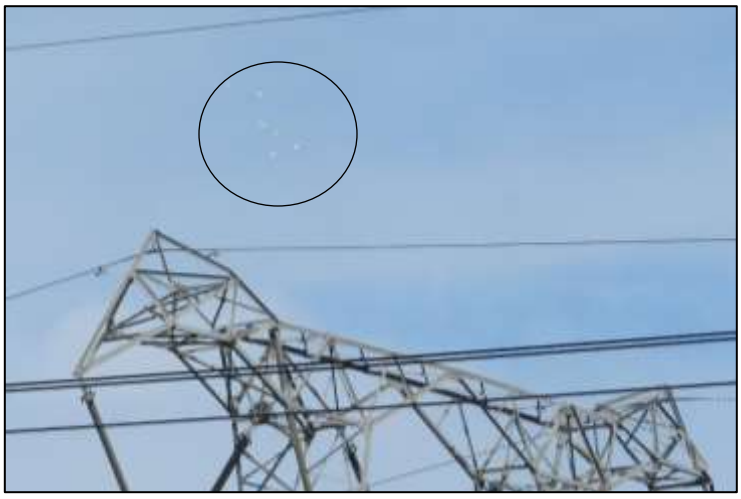

Photo 8: A flock of six Great White Pelicans were previously seen flying over the site. This June 2016 visit saw seven birds soaring beyond the power lines a long distance away (right).

The most important bird habitat is the wetland near the Water Treatment works just off the main Atlantis Road (photo 2). These pans always contain (fresh) water and islands where wetland birds can roost. In the central sections, the line runs parallel with the R27 but also through alien vegetation – again bird-poor habitat. Some raptors are likely to use the existing lines for perching and hunting, and Steppe Buzzards *Buteo vulpinus* often hunt the road verge for mice.

In the southern sections, the proposed line runs through pristine fynbos vegetation within the Koeberg Nature reserve, constituting only 2 km of the total 7 km line. This area, however, supports indigenous bird species such as prinias, sunbirds, sugarbirds, robins and Black Harriers *Circus maurus* (which breed here: RE Simmons unpubl data). Other raptors are likely to occur here and, indeed, were recorded in our site visit (photos 6 and 7).

6.3 Bird Species and habitats found along the authorized Alt 2 power line route

The most up-to-date information available from the SABAP2 bird atlas scheme was used: 75 atlas cards were available along the 7 km length of line, submitted from 2007-2015.

A total of 171 bird species were recorded in the area through which the line passes (including the coast where this line does not pass). Of these, 18 were collision prone species as ranked by the BAWESG (2011), and 13 of these were red-listed. Excluding the coastal waterbirds (cormorants, penguins and oystercatcher), that will not be impacted by this line, 9 red-listed species are likely to occur near the power line option.

The southern part of the Ankerlig site was untouched by fire and, apart from grass beneath the existing power lines (see cover photo), it was invaded by aliens (photo 9 below) and held few birds.

Photo 9: The southern-most part of the site was untouched by fire and either side of the track was infested with alien vegetation (above right). No species of concern were observed in this area in our June 2016 visit.

6.4 Likelihood of occurrence of collision-prone and red-listed birds in the study area

Here we now compare the likelihood of occurrence of the collision-prone and red-listed species using the reporting rate from SABAP2 atlas data.

Table 2. The likelihood of occurrence of Red-listed (**in red**) followed by other collision-prone species that occur along the entire route of the new line option, drawn from SABAP2 atlas cards for 2 pentads. These are based on 75 atlas cards submitted to the SABAP2 project from 2007 to 2014. Reporting rates **in bold** denote relatively common species.

				Susceptible to:	
Common name (collision ranking)	**Scientific name**	**Red-list status**	**Reporting Rate* %**	**Electrocution**	**Disturbance**
Great White Pelican (11)	*Pelecanus onocrotalus*	Near-threatened	**25.3**	-	
Greater Flamingo (19)	*Phoenicopterus ruber*	Near-threatened	5.3	-	High
Secretarybird (9)	*Sagittarius serpentarius*	Near-threatened	2.7	-	
Peregrine Falcon (24)	*Falco peregrines*	Near-threatened	9.3	-	
Lanner Falcon (30)	*Falco biarmicus*	Near-threatened	1.3	-	
Black Harrier (6)	*Circus maurus*	Vulnerable	**21.3**	-	Moderate
Africa Marsh Harrier (15)	*Circus ranivorus*	Vulnerable	**10.7**	Moderate	High
Blue Crane (7)	*Anthropoides paradiseus*	Vulnerable	**24.0**	-	Moderate

				Susceptible to:	
Common name (collision ranking)	**Scientific name**	**Red-list status**	**Reporting Rate* %**	**Electrocution**	**Disturbance**
Caspian Tern (60)	*Sterna caspia*	Near-threatened	2.7	-	High
Black-shouldered Kite (96)	*Elanus caeruleus*	-	**49.3**		
Booted Eagle (56)	*Aquila pennatus*	-	4.0		
African Fish Eagle (23)	*Haliaetus vocifer*	-	**12.0**		
Jackal Buzzard (44)	*Buteo rufofuscus*	-	**21.3**	Moderate	Moderate
Steppe Buzzard (65)	*Buteo vulpinus*	-	**28.0**		
Black Sparrowhawk (102)	*Accipiter melanoleucus*	-	1.3		
Grey-winged Francolin (76)	*Scleroptila africanus*	-	4.0		
TOTALS:	**Of 9 Red data species: 4 species relatively common**				
Of 7 (other) collision-prone species: 4 species relatively common					
All red data and collision-prone species: 8 species relatively common					

*Reporting rate is a measure of the likelihood of occurrence,

** Collision rank derived from the BAWSESG guidelines. Smaller numbers denote more collision-prone.

The likelihood of occurrence of red-listed species in the new line option is shown in Table 2. Of the nine red-listed species, 4 species had a reporting rate above 10%, suggesting they are relatively regular in the study area (pelican, Black Harrier, Marsh Harrier, and Blue Crane). Including the other 7 collision-prone species (Table 2) we see that four further species occurred above 10% - thus also relatively regular (kite, Fish eagle, Jackal Buzzard, and Steppe Buzzard).

6.5 Numbers of collision-prone red data species on site

While the reporting rates (Table 2) indicate the likelihood of occurrence, it does not reveal numbers of birds. So we undertook two 1-day walk-through visits in March 2014 and June 2016 and sampled at the two sensitive areas: (i) the open-water dams near the Atlantis Water treatment works and (ii) the 2 km length that falls within the Koeberg Nature Reserve.

At the burned water treatment wetland area, we counted just 4 birds (2 species) in the June 2016 visit; compared to the 136 birds (23 species) in March 2014. This was due to the devastating fire that decimated the area in June 2016, leaving the site with very little to no vegetation.

This being said: the fires around the Koeberg Nature Reserve and the substation at Ankerlig (Figure 1) make only temporary changes to the number of birds at risk. All of the species recorded in 2014 are expected to return to the area post-fire regeneration.

Despite the fire, five of the 17 species recorded in June 2016, in and around the proposed power line were highly collision-prone bird species.

These were (with their collision-ranking):

- Black Harrier *Circus maurus* (6th) Endangered
- White Pelican *Pelecanus onocrotalus* (8th) Vulnerable
- African Fish Eagle *Haliaetus vocifer* (27th)
- Jackal Buzzard Buteo rufofuscus (42nd)
- Peregrine Falcon *Falco peregrinus* (45th)

Sensitive areas and mitigation

Despite the removal of most of the vegetation by fire, the northern area from the water treatment works wetland to the Ankerlig power station remains a **High-Risk area** due to the presence of the five collision-prone species. Thus all new lines here require mitigation within 540 m of the proposed line (red line in Figure 2). Personal observations of a Black Harrier crossing the road on the 2nd June 2016, and previous observations by personnel at the conservation centre (K McKie pers obs), indicate that Black Harriers often cross the road here and would pass close to the lines. Since we believe a Black Harrier pair may breed in the reserve (R.E. Simmons unpubl data), these birds may well display in this area and expose themselves to risk from unmarked power lines.

In the southern section of the line near the Koeberg power station, no birds were recorded in June 2016. This was again due to the extensive burning. Nevertheless previous research shows that the fynbos here is the main summer foraging area of Black Harriers which breed in the Koeberg Reserve. This remains, therefore, a **medium-risk area** (Orange area in Figure 2)**.**

Table 3. Wetland and raptorial birds recorded in wetland near the Water Treatment work, 6 March 2014. Note none were seen in June 2016 because the fire had removed most vegetation and all but one pond was dry.

SPECIES	Pond 1	Pond 2	Pond 3
Little Grebe	2	7	
White Pelican	6		
White-b Cormorant	6	11	
Reed Cormorant	1	1	
African Darter	3	2	
Purple Heron	1		
Black-headed Heron	2		

Grey Heron	1		
Black-crowned Night Heron	9		
Great White Egret	5		1
Glossy Ibis	1	1	
African Spoonbill		2	
Egyptian Goose		9	2
Sacred Ibis		2	
Yellow-billed Duck	3	4	
Red-billed Teal		2	
Duck spp		32	
Blacksmith Plover	5		
Black-winged Stilt	2		
Hartlaub's Gull	3	4	
African Marsh Harrier	**1**		
Blacksmith Plover	5		
African Fish Eagle	**2**		
African Goshawk	1		
Black shouldered Kite		**1**	**1**
TOTALS:	**45**	**87**	**4**
Species: 23 **Red-listed spp: 2**		**Birds: 136**	

National Bird sensitivity in relation to the power line

If we include the BAWESG sensitivity map in the assessment (Figure 3 below) we see that the line passes through 2 **medium-risk** squares. This corroborates our findings that the area requires mitigation in the form of bird diverters to reduce risk of collisions with the lines.

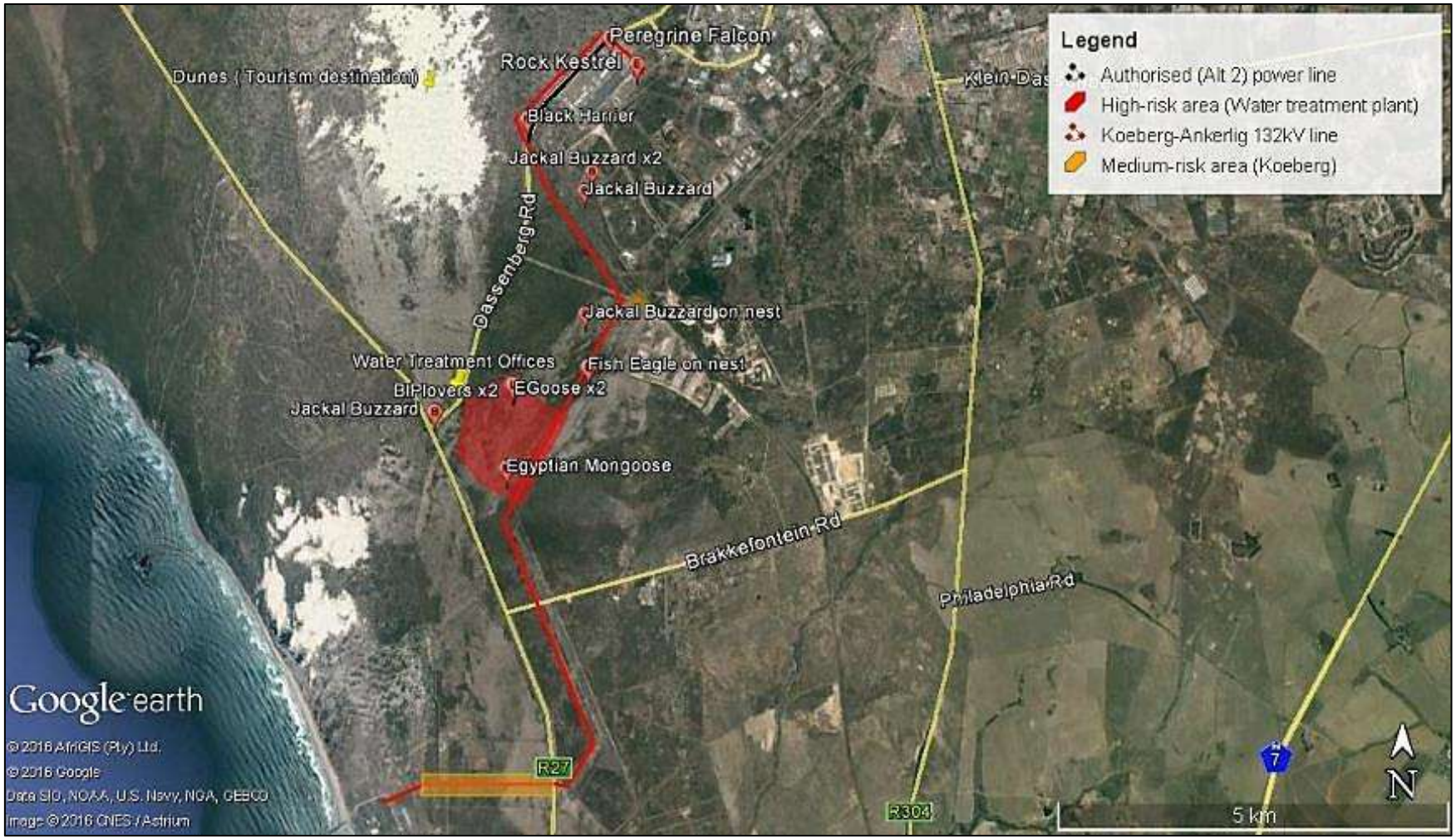

Figure 2: Locations of all avian species recorded on/around the ~14 km of 132 kV power line from the Ankerlig Power Station in the north to the Koeberg Nature Reserve in June 2016. Most birds occurred around the Water Treatment works, although in much smaller numbers than in our March 2014 visit (because of a large fire that raged from Koeberg to Ankerlig Power Station). The Black Harrier, Fish Eagle, Peregrine Falcon and Jackal Buzzards are all collision-prone species at risk from collision with the lines.

6.6 Authorised (Alt 2) power line in relation to national bird sensitivity areas

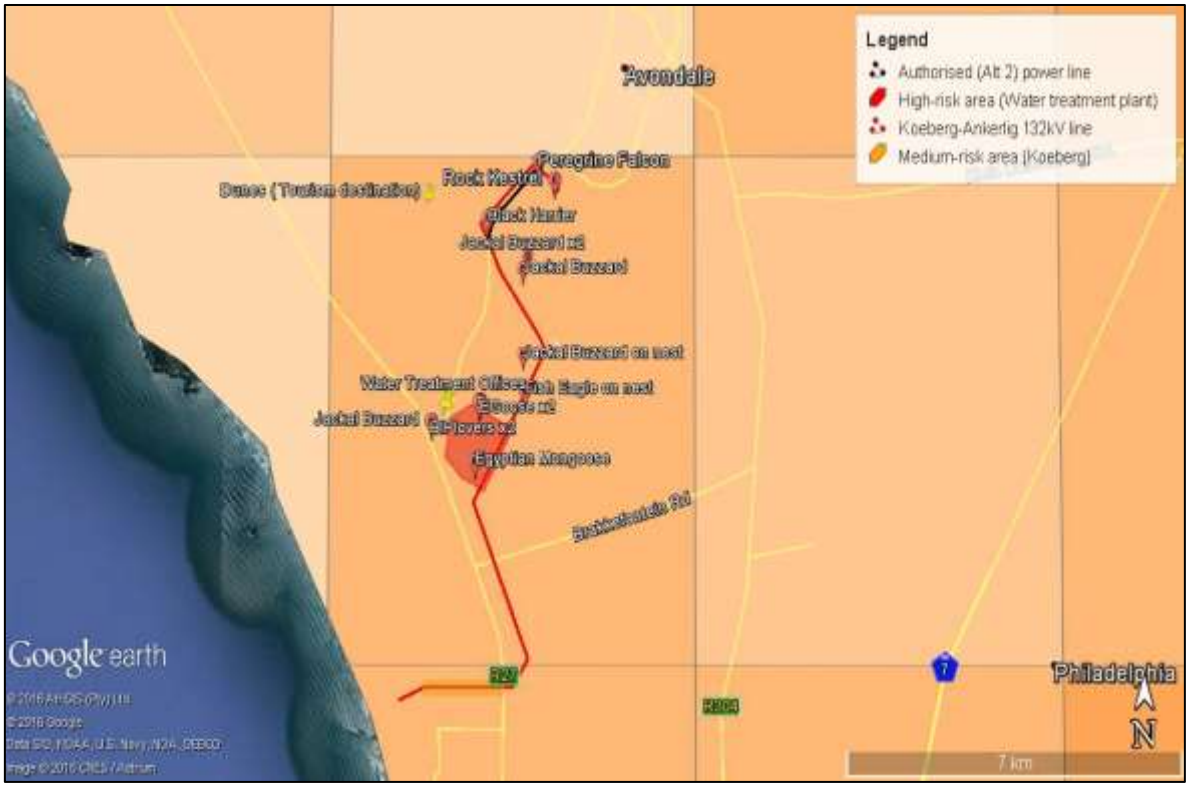

Figure 3: The main **line option** relative to the national bird sensitivity map (BAWESG 2011). The darker shaded areas (representing pentads of 9 x 7 km), indicate medium risk areas for birds.

7 SUMMARY OF IMPACTS

From the summary of all data sets (Table 4), we see that the proposed lines intersect habitat with 18 collision-prone species, 9 red-listed species, all of which are relatively common in the study area. The number of areas requiring mitigation are the open wetlands (High-Risk area - red rhomboid) and the Koeberg Nature Reserve (medium-risk area: Figure 2).

Table 4. Summary of all data sets: atlas data (red-listed, collision-prone), likelihood of occurrence, actual numbers of birds in sensitive areas and number of sensitive areas (wetland and Koeberg NR) along the proposed line.

Category	Number
Atlas data: Collision prone species	**18**
Atlas data: **Red-listed** species	**9**
Relatively regular (>10% reporting rate) Red-listed species	**4 of 9**
Number of high and medium risk crossings	**1 High risk** **1 Medium risk**
Highly sensitive bird pentads (from Fig 4)	**0**

Table 5. Semi-quantified assessment of the risks associated with the power lines through the different areas. The two areas of concern (high-risk and medium-risk) marked red and orange in Figures 2 and 3 respectively above, are treated together in the table below.

Nature: Power lines generally have a negative influence on birds in the landscape and often kill large unmanouverable species such as bustards, cranes, and vultures through direct impact or (less often) electrocution. They also provide nesting sites for Pied Crows in tree-less environments and these species often interact negatively with small passerines and larger raptors. Power lines can have a positive influence where they provide nesting sites for large threatened raptors (Martial Eagles and Vultures) in otherwise open habitats. This is a rarer occurrence.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Low (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate-High (7)	Medium-Low (5)
Probability	Probable (4)	Probable (3)
Significance	**Medium (56)**	**Medium-Low (33)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, the main method of mitigating impacts of power lines (i) Affixing bird diverters (spirals or bird flappers) to the earth wire, which alerts birds to a danger ahead of them. We **strongly recommended this** to be employed on the high and medium sensitive areas on the line from Ankerlig to Koeberg	
Mitigation: For the **High Risk area (Figure 2),** the best mitigation is to affix bird diverters (diurnal and nocturnal) to the lines in this area. For the **medium risk areas (Figure 2)** in the Koeberg Nature reserve, the line could not be moved and bird diverters are the best way to reduce bird impacts. Black Harriers breed in this reserve (to the north-west of the power station (R.E. Simmons unpubl), and they forage under these lines. Sometimes they perform aerial displays which bring them close these lines. Bird diverters would help reduce impacts by this Endangered species. To prevent crows breeding on the lines all pylon platforms should be fixed with "spikes" similar to those presently in use along these lines.		
Cumulative impacts: Thousands of kilometers of Eskom power lines occur throughout South Africa and large numbers of birds impact these lines each year. For example, 40% of the Ludwig's Bustard population are estimated to be killed by these lines every year (Shaw et al. 2012, Shaw 2013). An estimated 1 bird/km of line/year is killed so it is logical that the more lines there are the more deaths will occur. Every new line that is erected therefore must have mitigation measures (position, diverters, size, length and design for safety as possible). Without mitigation, some species (such as the bustards) are in danger of suffering such large population losses that their populations will decline in certain areas where power lines occur in highest densities.		
Residual Impacts: After mitigation, there may still be impacts to birds. For example, by moving the line away from the settling ponds at Atlantis water treatment ponds there is no guarantee that birds will not still impact the line. The ideal way to avoid further impacts is for longer-term studies in the areas around the ponds at Atlantis and the line through the Koeberg NR to determine flight paths of collision-prone species. Many wetlands are approached		

from certain directions depending on the wind direction and openness of the surrounding vegetation (wetland birds have high wing-loading i.e. they are heavy fliers) and land and take off into the wind.

By **summarizing** all these different risk assessments (Table 4) we see that the proposed line option has:

- 9 red-listed species that occur along the proposed path;
- 4 of 9 red-listed species are relatively frequent (two harriers, pelican and Blue Crane) and collision-prone Black Harriers forage through the Koeberg section.
- The wetland area near the Water Treatment works is a **High risk area**, because of the large number of wetland birds (136) and species (23) recorded there.
- The Koeberg Nature Reserve is a **medium risk area** because of the collision-prone raptors there – Black Harriers, Jackal Buzzards, and Black-shouldered Kites. That 7 existing lines occur there already and three species (the buzzard, the kite and Rock Kestrels) use the pylons on which to perch and breed, means that these species are unlikely to be adversely affected. However, it is noted that **no bird diverters** were present in either area, adding to the danger of the area for birds.
- The semi-quantitative summary (Table 8.2) indicates that the significance of the impacts is likely **medium (score 56)** before mitigation for the entire line and **low-medium (score 33)** after mitigation.
- We favour the routing power line alternative 2, (black) around the substation at Ankerlig because it does not cross natural vegetation within the conservation area, and is less likely to impact or displace birds.

7.1 Mitigation

Where the proposed line passes within 540 m of the wetland in the north (categorized as high risk because of the number of wetland birds) all lines (or their earth wires) should be **marked with bird diverters**. This will help reduce bird impacts with this line.
Within the Koeberg NR, the line must also be marked with nocturnal and diurnal bird diverters, as it goes up.

There are many power lines that already cross highly sensitive areas (i.e. those close to the wetlands mentioned above) and **these should <u>all</u> be marked with bird diverters** to reduce

possible collisions by pelicans, Black Harriers, marsh harriers and fish eagles that regularly use the wetland**.**

Construction work timing - should avoid the breeding season of the most sensitive species, particularly the raptorial species such as the African Marsh Harriers and Black Harriers. These species start to breed in July and end by December (Simmons 2005a, b). **Thus, work is best carried out from January to May.**

Electrocutions can be avoided using the present devices (spikes) found on the pylons in Koeberg NR that prevent large birds from perching on the pylons. These are recommended for all pylons to be erected.

8 CONCLUSIONS AND RECOMMENDATIONS FOR OPERATION AND LINE INSPECTION

This walk-through assessment study has identified that the proposed line option has one high risk area (Water Treatment wetland) and one medium risk area (Koeberg NR) for birds.

The study identified several areas that require further assessment and monitoring: the above wetland where large numbers of wetland species occur throughout the year. The area holds over 100 birds in summer and few of the existing power lines have adequate forms of bird mitigation. Assessments in other seasons to (i) identify the use of the pans by flamingos and other collision-prone species, (ii) the mortality rate, and (iii) which sections are most dangerous, should also be undertaken by a trained ornithologist.

The use of the Fynbos region in the Koeberg NR where the Black Harriers forage should also be assessed for (i) breeding birds (nests are known west of here but could occur here too), and (ii) foraging birds and the hotspots of hunting.

Thus, the operation and line inspection phase should include:

(i) Regular surveys of large collision-prone species, especially pelicans, flamingos and large raptors within the study area to determine the relative importance of local populations of priority taxa;

(ii) Study of the movements of the wetland species and raptors at different times of year through the wetland and Koeberg bird-sensitive areas;

(iii) Surveys of the effectiveness of bird diverters and especially any hot spots of collisions along the existing lines.

The results will allow a more detailed assessment of all impacts and the efficacy of the recommended mitigation where necessary (particularly with reference to the usefulness of the bird diverters). Ultimately, it will improve our understanding of the long-term effects of power lines on birds in South Africa.

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