PROPOSED CONSTRUCTION OF 2X500kV TRANSMISSION LINES FROM NZHELELE SUBSTATION TO CONNECT WITH POWER LINES FROM TRIANGLE SUBSTATION (ZIMBABWE) IN MUSINA, WITHIN THE VHEMBE DISTRICT MUNICIPALITY, LIMPOPO PROVINCE

Avifauna & Fauna Component

April 2015

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EXECUTIVE SUMMARY

Based on the length of the proposed transmission line, three alternative corridors (each 4 km wide and a mean length of 54 km) have been proposed by Eskom:

- Alternative 1 runs northwards along the N1 Highway whereby it deflects westwards at the Sand River. From here it runs northwards along the western side of the Messina Nature Reserve towards Beitbridge;
- Alternative 2A runs eastwards towards the R508 from where it deviates westwards and following the R508 towards Musina. From here it continues northwards to the Limpopo River; and
- Alternative 2B runs north-eastwards to the R508 and continues northwards and west of the Nzhelele River towards the Limpopo River.

The terms of reference for this assessment are to:

- provide a general description of the affected environment concerning the *avifaunal* and *faunal* habitat types;
- conduct an assessment of all available information in order to present the following results:
    - typify the regional vegetation that will be affected by the proposed corridors;
    - provide an indication on the occurrence of threatened, "near-threatened", endemic and conservation important plant, bird or animal species likely to be affected by the proposed corridors;
    - provide an indication of sensitive bird and fauna habitat corresponding to the proposed corridors;
    - highlight areas of concern or hotspot areas;
    - identify potential impacts on the terrestrial ecological environment that are considered pertinent to the proposed development;
    - identify negative impacts and feasible mitigation.

A site visit was conducted during 20 - 23 January 2014 and 14 - 18 July 2014 whereby the physical environment of the proposed corridors was inspected by road and from the air following an evaluation of GIS based information on the biotic and biophysical attributes of the area.

The following key considerations were identified and noted:

- The highest surface area of transformed land (when compared to the other corridors) is traversed by Alternative 2A;
- A large proportion of surface area of Alternative 2B is occupied by the Maremani Nature Reserve;
- Alternative 1 traverses the highest number of non-perennial drainage lines

and (semi-) perennial rivers and streams;

- The study site comprehends four major (macro-) habitat types:
    - *Arid sandy bushveld/woodland* - an important foraging and breeding habitat for taxa, which show evolutionary links to the Zambezian region and the Highveld-Kalahari Zone;
    - *Arid rocky woodland*;
    - *Sandstone and granite ridge/inselberg bushveld* - an important habitat for especially stenotopic and obligate rupiculous invertebrate taxa and important hunting and breeding habitat for the vulnerable Verreaux's Eagle (*Aquila verreauxii* - especially on ridges with a good population of hyrax) and other smaller falconiform taxa (e.g. Lanner Falcon *Falco biarmicus*);
    - *Alluvial floodplains and riverine woodland* - This habitat is particularly important for the potential occurrence of the endangered Pel's fishing-owl (*Scotopelia peli*) and the vulnerable White-backed Night-heron (*Calherodius leuconotus*). It also provides nesting structure and foraging habitat for other large bird species such as the Hamerkop (*Scopus umbretta*), African fish-eagle (*Haliaetus vocifer*) and Saddle-billed Stork (*Ephippiorhynchus senegalensis*). In addition, when inundated, the ephemeral pools attract a large variety of wading birds (including five stork species) and piscivorous taxa.
- A number of smaller azonal habitat units are considered to be very important for certain avifaunal species:
    - *Artificial impoundments and dams* - they provide a refuge for waterbird species during the dry season. In addition, they provide foraging habitat for threatened stork species;
    - *Waterholes for game* - these provide favourite hunting and scavenging areas for the larger bird of prey species (often vultures and marabou storks);
    - *Fallow (arable) land and secondary woodland* - these provide ephemeral foraging habitat for a number of bird species in particular that of the nationally vulnerable Secretarybird (*Sagittarius serpentarius*) and other species that are prone to power line collisions such as the White Stork (*Ciconia ciconia*), Abdim's Stork (*C. abdimii*), Spur-winged Goose (*Plectropterus gambensis*) and Egyptian Goose (*Alopochen aegyptiaca*);
    - *Large canopy trees such as Adansonia digitata and Sclerocarya birrea* - these provide suitable breeding platforms for birds of prey species and other hole-nesting species;
- High numbers of fauna (mammals, reptiles, amphibians and butterflies) corresponds to Alternative 2A, and low values (when compared to the other corridors) were observed on habitat corresponding to Alternative 1;
- The study site is earmarked by a high richness of bird species, especially for habitat corresponding to Alternative 2B;
- High reporting rates were obtained for near-threatened Kori Bustard (*Ardeotis*

kori), followed by the vulnerable Verreaux's Eagle (*Aquila verreauxii*), the endangered Southern Ground Hornbill (*Bucorvus leadbeateri*) and vulnerable Secretarybird (*Sagittarius serpentarius*), the endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*), the endangered Tawny Eagle (*Aquila rapax*) and the endangered Bateleur (*Terathopius ecaudatus*);

- A number of other (non-threatened) bird species are also likely to be affected by the proposed transmission line (e.g. potential collisions with overhead cable structures) and include species such as the White Stork (*Ciconia ciconia*), African Woolly-necked Stork (*Ciconia microscelis*), African Openbill (*Anastomus lamelligerus*), African Fish-eagle (*Haliaeetus vocifer*), Brown Snake-eagle (*Circaetus cinereus*), Black-chested Snake-eagle (*Circaetus pectoralis*) and a number of waterbird species pertaining to the Anatidae (ducks and geese), Phalacrocoracidae (cormorants), Anhingidae (darters), Ardeidae (herons and egrets) as well as Threskiornithidae (ibises); and
- A number of impacts and recommendations are proposed, of which (potential) bird collisions with the earth wires is regarded as significant.

It is evident from a sensitivity analysis that Alternative 2B (and Alternative 1) is the least preferred corridor. Therefore, Alternative 2A is "better suited", since it comprehends a larger surface area of transformed habitat and is positioned in close proximity to existing road infrastructure.

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DECLARATION OF INDEPENDENCE

I, Lukas Niemand (Pachnoda Consulting CC) declare that:

- I act as the independent specialist in this application to Baagi Environmental Consultancy and ESKOM;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have no vested financial, personal or any other interest in the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All the particulars furnished by me in this form are true and correct.

Lukas Niemand (Pr.Sci.Nat)
21 April 2015

Lukas Niemand is registered with The South African Council for Natural Scientific Professionals (400095/06) with more than 13 years of experience in ecological-related assessments and more than five years in the field of bird interactions with electrical infrastructure. He has conducted numerous ecological and avifaunal impact assessments including Eskom Transmission projects, hydro-electric schemes and other activities in South Africa and other African countries.

COMPLIANCE WITH THE APPENDIX 6 OF THE 2014 EIA REGULATIONS

Requirements of Appendix 6 – GN R982	Addressed in the Specialist Report
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Addressed in the Specialist Report; CV part of Appendix in current report.
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page viii of current report
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1 and 1.2
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2
e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Section 2
f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Section 2.1 and Section 3.9
g) an identification of any areas to be avoided, including buffers;	Section 3.9 and Section 3.10
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 3.9 and Section 3.10.
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2.5.
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Section 3
k) any mitigation measures for inclusion in the EMPr;	Section 3.11
l) any conditions for inclusion in the environmental authorisation;	Section 3.11
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 3.11
n) a reasoned opinion- i. as to whether the proposed activity or portions thereof should be authorised; and ii. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 3.10 and Section 3.11
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Consultation took place between the specialist and various landowners of the Maremani Reserve (on 15 July 204)
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Hard copies of bird data received by the Maremani Reserve management; including a review (comments) of draft report by GIBB based on SA Regulations, 2010
q) any other information requested by the competent authority.	n/a

1. INTRODUCTION

The increase in human demand for space and life-supporting resources resulted in a rapid loss of natural open space in South Africa. When natural systems are rezoned for development, indigenous fauna and flora are replaced by exotic species and converted to sterile landscapes with no dynamic propensity or ecological value (Wood *et al.,* 1994). Additionally, development rarely focussed on decisive planning to conserve natural environments, while little thought was given to the consequences on the ecological processes of development in highly sensitive areas.

Transformation and fragmentation are not the only results of unplanned and intended developments, the loss of ecosystem functioning and ultimately the local extinction of species can also result. Therefore, careful planning will not only preserve rare and endemic fauna and flora, but also the ecological integrity of ecosystems of the landscape level which is imperative for the continuation of natural resources, such as fossil fuels, water and soils with agricultural potential.

In 1992, the Convention of Biological Diversity, a landmark convention, was signed by more than 90 % of all members of the United Nations. The enactment of the National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004), together with the abovementioned treaty, focuses on the preservation of all biological diversity in its totality, including genetic variability, natural populations, communities, ecosystems up to the scale of landscapes. Hence, the local and global focus changed to the sustainable utilisation of biological diversity.

1.1 Background

Pachnoda Consulting cc was contracted by Baagi Environmental Consultancy cc to provide an avifauna and fauna impact assessment report for the proposed Nzhelele-Triangle Project in the northern parts of the Limpopo Province. The project entails the proposed construction of two 500 kV transmission lines from Nzhelele substation to connect with power lines from Triangle substation (Zimbabwe) in Musina, within the Vhembe District Municipality, Limpopo Province. The proposed project only has reference to the corridor that falls within the ambit of South Africa (Figure 1).

Based on the length of the proposed transmission line, three alternative corridors (each 4 km wide) have been proposed (Figure 1):

- *Alternative 1 (Alt 1 and Alt1/2* - 51.5 km) runs northwards along the N1 Highway whereby it deflects westwards at the Sand River. From here it runs northwards along the western side of the Messina Nature Reserve towards Beitbridge;
- *Alternative 2 A* (*Alt 2, Alt1/2 and Alt2A* - 57.5 km) runs eastwards towards the R508 from where it deviates westwards and following the R508 towards Musina. From here it continues northwards to the Limpopo River; and

- *Alternative 2 B* (*Alt 1/2, Alt2 and Alt2B* - 52 km) runs north-eastwards to the R508 and continues northwards and west of the Nzhelele River towards the Limpopo River.

1.2 Terms of Reference

The main aim of a scoping exercise is to investigate the ecological attributes of the proposed corridors by means of a desktop analysis of GIS-based information.

The terms of reference for this assessment are to:

- provide a general description of the affected environment concerning the avifaunal and faunal habitat types;
- conduct an assessment of all available information in order to present the following results:
    - typify the regional vegetation that will be affected by the proposed corridors;
    - provide an indication on the occurrence of threatened, "near-threatened", endemic and conservation important plant, bird or animal species likely to be affected by the proposed corridors;
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    - highlight areas of concern or hotspot areas;
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    - identify negative impacts and feasible mitigation.

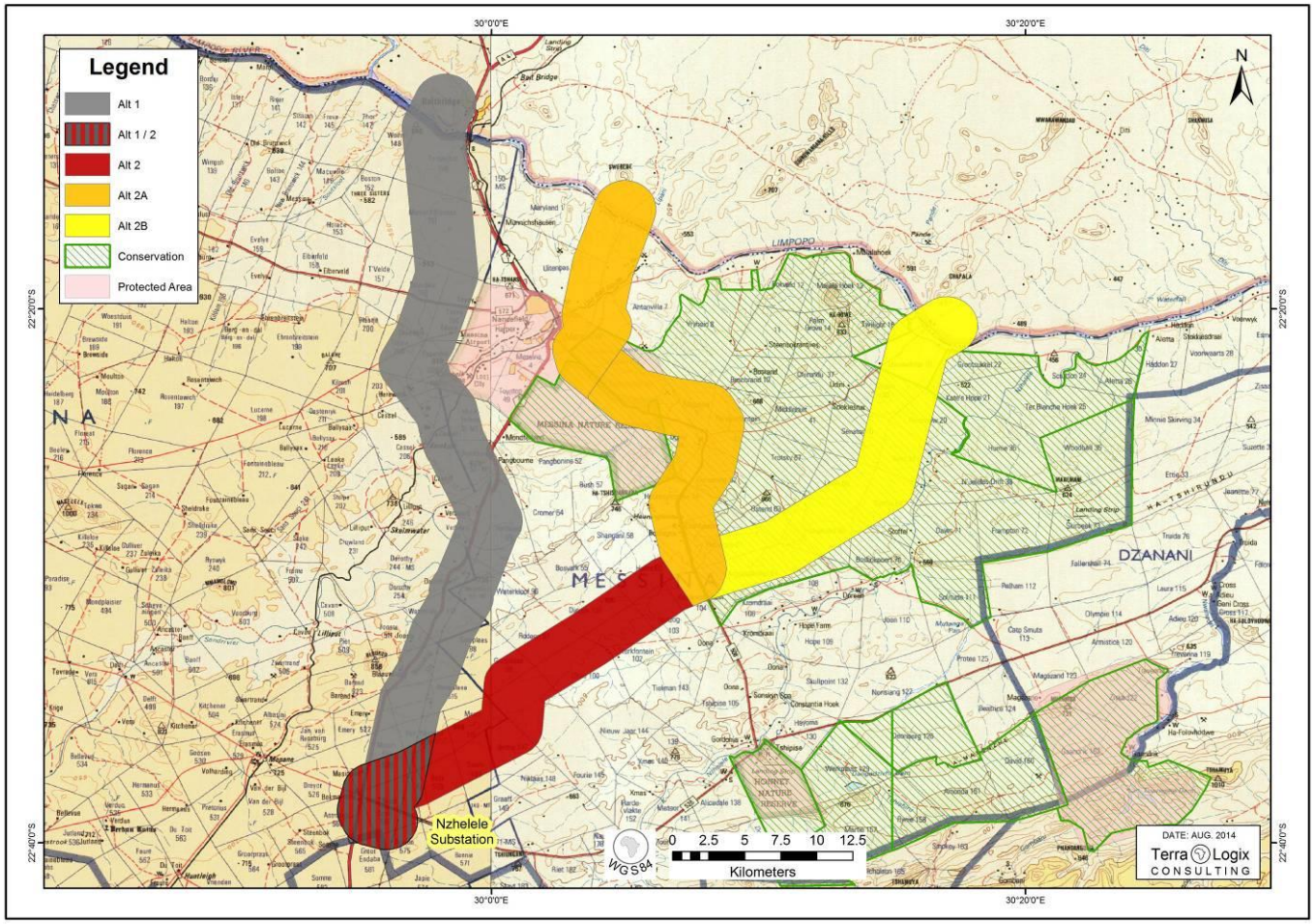


Figure 1: A locality map illustrating the geographic position of the proposed 500 kV Nzhelele transmission line corridor with two proposed alternatives.

2. METHODS & APPROACH

A site visit was conducted during 20 - 23 January 2014 and 14 - 18 July 2014 whereby the physical environment of the proposed corridors was inspected by road and from the air following an evaluation of GIS-based information on the biotic and biophysical attributes of the area.

Visual observations of the proposed corridors were made during the site visits and additional data was obtained by means of selected point counts located on areas consisting of topographical features (ridges), wetland and drainage lines features (dams, rivers and depressions) and areas with high potential to provide habitat for charismatic bird and mammal taxa (pertaining to the Maremani Nature Reserve). The objectives of the assessment are to:

- obtain a basic overview of the variation and general status of habitat types likely to be affected by the proposed development;
- obtain an indication of the bird community structure based on 25 point counts located within the Maremani Nature Reserve (Figure 2); and
- inspect existing transmission lines within the proximity of the proposed alternative routes to obtain an overview of the range of potential impacts and likely effects of long-term management activities on the bird and faunal community.

2.1 Desktop Analysis: Biophysical environment

A desktop analysis of available biotic and biophysical attributes of the proposed study area was performed whereby the following databases were consulted:

- Regional vegetation (Mucina and Rutherford, 2006);
- Land cover classes (2000 & 2009);
- Presence/absence of wetlands, rivers, drainage lines and other impoundments;
- Protected and conservation areas;
- Settlement and transformed areas.

These databases were utilised to identify areas that constitute:

- natural vegetation;
- areas of environmental sensitivity (e.g. outcrops and wetland systems);
- areas likely to sustain high numbers of threatened, “near-threatened” and endemic taxa; and
- protected areas.

2.2 Avifaunal evaluation and desktop analysis

The following references were consulted during the evaluation process, which includes the following:

- Hockey *et al*. (2005) were consulted for general information on bird identification and life history attributes;
- The conservation status of bird species and their respective biogeographic affinities were sourced from the IUCN (2014), Taylor (*in press*) and Barnes (1998). The latter provides an overview of the Important Bird Areas (IBAs) in Southern Africa;
- Distributional data was sourced from the first South African Bird Atlas Project (SABAP1) and verified against Harrison *et al.* (1997) for species corresponding to six[1] quarter-degree grid cells (QDGCs) sympatric to the study site. The SABAP1 data provides a "snapshot" of the abundance and composition of species recorded within a quarter degree grid cell (QDGC) which was the sampling unit chosen (corresponding to an area of approximately 50x50 km). It should be noted that the atlas data makes use of reporting rates that were calculated from observer cards submitted by the public as well as citizen scientists. It provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991;
- Additional distributional data was sourced from the second South African Bird Atlas Project (SABAP2; www.sabap2.adu.org.za). Since bird distributions are dynamic (based on landscape changes such as fragmentation and climate change), SABAP2 was born (and launched on 1 July 2007) from SABAP1 with the main difference being that all sampling is done at a finer scale known as pentad grids (5 min lat x 5 min long, equating to 9 pentads within a QDGC). Therefore, the data is more site-specific, recent and more comparable with observations made during the site visit (due to increased standardisation of data collection). A total of 23 pentad grids are applicable to the project[2];
- To facilitate the corridor selection process, the breeding records (when available) for large birds of prey were requested from EWT[3];
- Data on power line derived bird mortalities were requested from the electrical infrastructure mortality incident register (the dataset was provided by EWT)[4];
- Additional information regarding bird-power line interactions was also provided by Mr. C. van Rooyen and the Endangered Wildlife Trust;

[1] The six relevant QD squares include: 2229DB (Mopane), 2229BD Kumkusi, 2229BB (Beitbridge), 2230AC (Messina), 2230CA (Tshipise) and 2230AD (Esmefour).

[2] The relevant pentad grids include 2240_2955, 2235_2950, 2235_2955, 2230_2955, 2225_2955, 2220_2955, 2215_2955, 2210_2955, 2235_3000, 2230_3000, 2225_3000, 2220_3000, 2215_3000, 2230_3005, 2225_3005, 2220_3005, 2230_3010, 2225_3010, 2525_3010, 2220_3010, 2225_3015 & 2220_3015.

[3] No data were available.

[4] No data were available.

- Conversations with the public sector, in particular the landowners and game farmers of the Maremani Nature Reserve (in particular Mr R Botha the manager of Maremani, Ms G Van Zyl of Humie Farm, Mr J Wolvaardt of Farms Dorothy, Verbaard and Maryland 1, Mr P Lee of the Farms Munnichshoser and Tempelhof, Mr P Thomas of the Farm Rampulana and Mr Dzivhani of Musina Nature Reserve), who also provided additional distributional data on threatened and conservation-dependant bird species;
- The regional vegetation classification was based on Mucina & Rutherford (2006); and
- Additional information regarding bird-power line interactions was provided by my own personal observations obtained during the site visits.

2.3 Vertebrate and Invertebrate Fauna

Mammals

- The occurrence and conservation status of mammal taxa were based on the IUCN Red List (2014) and Friedmann & Daly (2004), while mammalian nomenclature was based on Skinner & Chimimba (2005) unless otherwise specified.
- As part of the assessment, national small-scale datasets managed by the Animal Demography Unit (ADU) and relevant citizen science projects were consulted such as MammalMap; and
- Actual observations of mammal taxa obtained during the site visits.

Herpetofauna

- Red List categories were chosen according to the recent conservation assessment conducted by Bates *et al*. (2014);
- Red List categories and listings of amphibian taxa follow Measey (2010); and
- The distribution of reptile and amphibian species was verified against ADU's database representing ReptileMap and FrogMap.

2.4 Sensitivity Analysis

An ecological sensitivity map was compiled based on the outcome of a desktop analysis.

The ecological sensitivity of any piece of land is based on its inherent ecosystem service (e.g. wetlands) and overall preservation of biodiversity.

2.4.1 Ecological Function

Ecological function relates to the degree of ecological connectivity between systems within a landscape matrix. Therefore, systems with a high degree of landscape connectivity amongst one another are perceived to be more sensitive and will be those contributing to ecosystem service (e.g. wetlands) or the overall preservation of biodiversity.

2.4.2 Biodiversity Importance

Biodiversity importance relates to species diversity, endemism (unique species or unique processes) and the high occurrence of threatened and protected species or ecosystems protected by legislation.

2.4.3 Sensitivity Scale

- *High* – Sensitive ecosystems with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered important for the maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems OR with high species diversity and usually provide suitable habitat for a number of threatened or rare species. These areas should be protected;
- *Medium* – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems OR ecosystems with intermediate levels of species diversity, but may include potential ephemeral habitat for threatened species; and
- *Low* – Degraded and highly disturbed/transformed systems with little ecological function and are generally very poor in species diversity (most species are usually exotic or weeds).

2.5 Limitations

1. It is assumed that third party information (obtained from government, academic/research institution, non-governmental organisations) is accurate and true;
2. Some of the datasets/information are out of date and therefore extant distribution ranges may have shifted although these datasets could provide insight into historical distribution ranges of relevant species;
3. The datasets/information bases are mainly small-scale and could not always consider azonal habitat types that may be present on the study area (e.g. presence of topographical features, depressions and farm impoundments). In addition, these datasets encompass surface areas larger than the corridor width, thereby including habitat types and species that are not present on the study area itself. Therefore, the potential to overestimate species richness is highly likely, while it is also possible that certain cryptic or specialist species could have been be overlooked in the past;
4. Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town are current and likely to continue indefinitely;
5. Many parts of the study area are "closed" to the public and it is possible that "gaps" are likely to be present within the species distribution ranges concerning the relevant datasets. Many species are deemed to be overlooked or not formally catalogued for the area;
6. In order to obtain a comprehensive understanding of the dynamics of the bird communities on the study area, as well as the status of endemic, rare or threatened species, assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints such long-term studies are not feasible and were based on instantaneous (a “snapshot”) sampling bouts; and
7. The information presented in this document only has reference to the investigated study area(s) and cannot be applied to any other area without prior investigation.

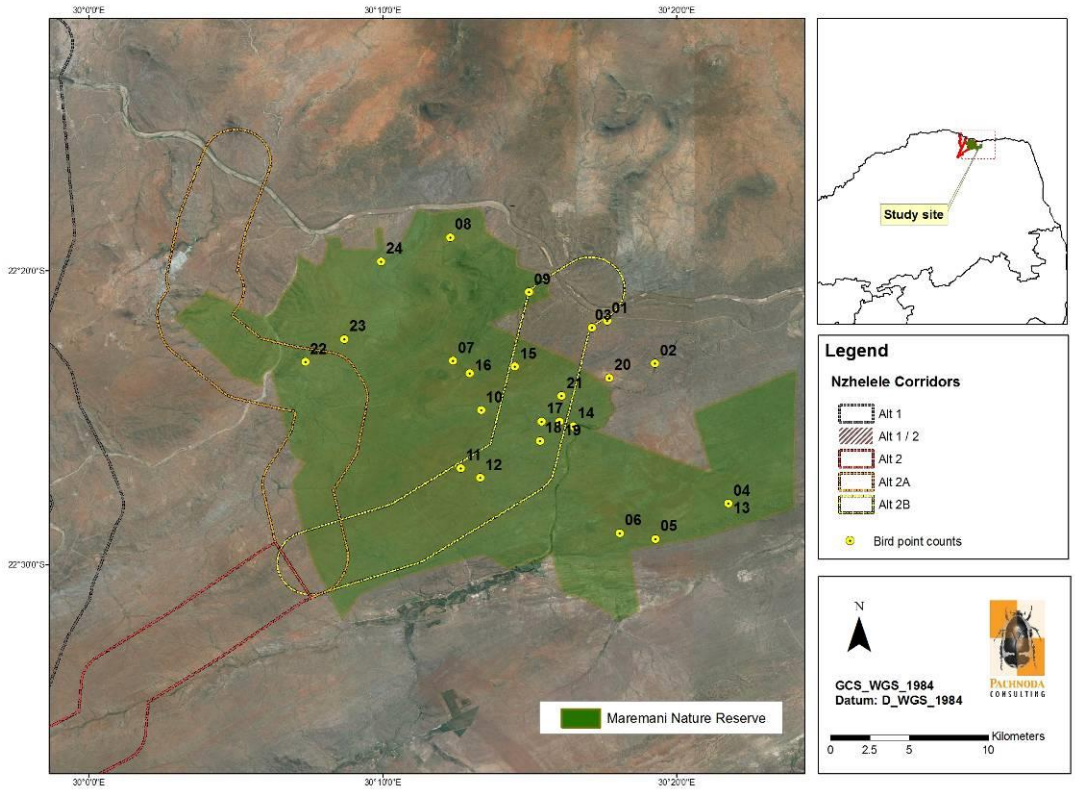


Figure 2: A map of the Maremani Nature Reserve illustrating the geographic placement of 24 bird point counts (satellite image courtesy of GoogleEarth).

3. RESULTS AND DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Regional Vegetation Description

The study area corresponds to the Savanna Biome and more particularly to the Mopane Bioregion as defined by Mucina & Rutherford (2006). The proposed corridors comprehend two ecological types known as (a) Musina Mopani Bushveld, and (b) Limpopo Ridge Bushveld (Figure 3 and Table 1):

(a) Musina Mopani Bushveld: This vegetation type extends from Baines Drift and Alldays in the west, eastwards and north of the Soutpansberg to Banyini Pan. It is predominantly located on undulating plains that are irregularly interspersed by tributaries of the Limpopo River. On the study area, it forms a moderately open, albeit arid savanna dominated by *Colophospermum mopane*, *Terminalia prunoides*, *Commiphora* species and *Combretum apiculatum*. The field layer is well developed and tends to become more open during the dry season. The herbaceous layer is poor in species richness.

This vegetation type was widespread, least threatened and dominant in the study area. It is an important foraging habitat for large bird species such as the Kori Bustard (*Ardeotis kori*), while the presence of *Adansonia digitata* (baobab) provides suitable nesting habitat for many hole-nesting species and large charismatic birds of prey (in particular vulture taxa). In addition, the numerous drainage lines and lowland rivers, when inundated, attract large numbers of wading birds species in particular storks. The area is frequently colonised by the regionally endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*) and often attracts large numbers of near-threatened Marabou Storks (*Leptoptilos crumeniferus*) (*pers. obs*.)

(b) Limpopo Ridge Bushveld: This bushveld type is associated with low hills and outcrops (mainly Clarens Formation sandstone) scattered within the Mucina Mopani Bushveld. It conforms to a typical and moderately open savanna, dominated by *Kirkia acuminata* and *Adansonia digitata,* especially on areas of calcareous soils. These isolated ridges and "koppies" are often occupied by smaller falconiform taxa (e.g. Lanner Falcon *Falco biarmicus*).

This ecological type is localised consisting of prominent sandstone hills and ridges.

Table 1: The surface area (ha) of each regional vegetation type in relation to the approximate total surface area of the proposed corridors.

Vegetation Type	Alt 1		Alt 2 A		Alt 2 B	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Musina Mopani Bushveld	13173.13	60.95%	19123.06	77.55%	17198.94	77.12%
Limpopo Ridge Bushveld	8440.41	39.05%	5536.86	22.45%	5103.89	22.88%
Total	**21613.54**	**100.00%**	**24659.92**	**100.00%**	**22302.83**	**100.00%**

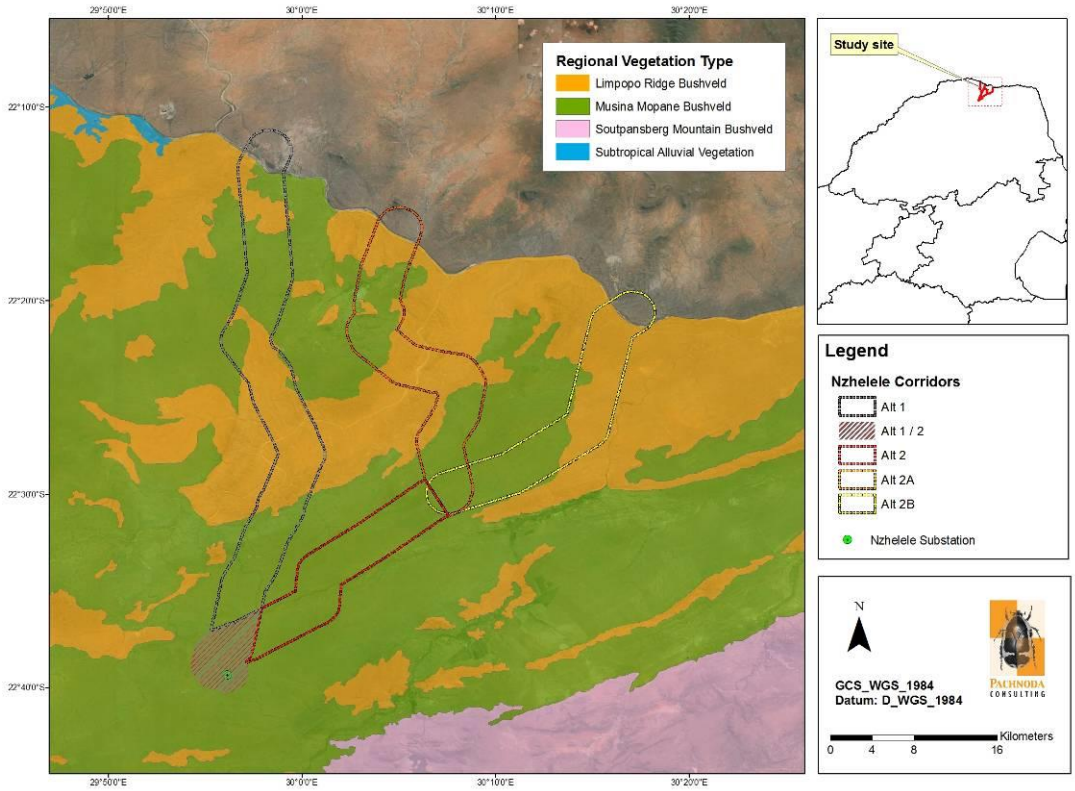


Figure 3: A satellite image illustrating the regional vegetation types traversed by the proposed corridors. Vegetation type categories were chosen according to Mucina & Rutherford (2006).

It is evident that Alternative 1 traverses a higher percentage of Limpopo Ridge Bushveld compared to Alternative 2. This means that Alternative 1 is more likely to cross or be positioned in close proximity to hills and ridges, which are often focal habitat for birds of prey and substrate-specialist taxa (e.g. scorpions). In addition, the high spatial heterogeneity in micro-habitat types presented by these landscape features are more likely to hold a higher floristic richness than the Musina Mopani Bushveld.

3.2 Geology & Soils

Although geology was never really considered to be an important factor contributing towards faunal community structure, it does play a role in segregating floral communities (Figure 3). Of even more importance is the relationship between certain geological formations and plant compositions in explaining areas with high floristic endemism and richness (so-called centres of endemism). Therefore, differences in floristic composition and structure is likely to be present in nutrient-poor soils derived from quartzite and anorthosite lithologies as opposed to the gneiss. The former lithologies were more prominent on Alternative 1.

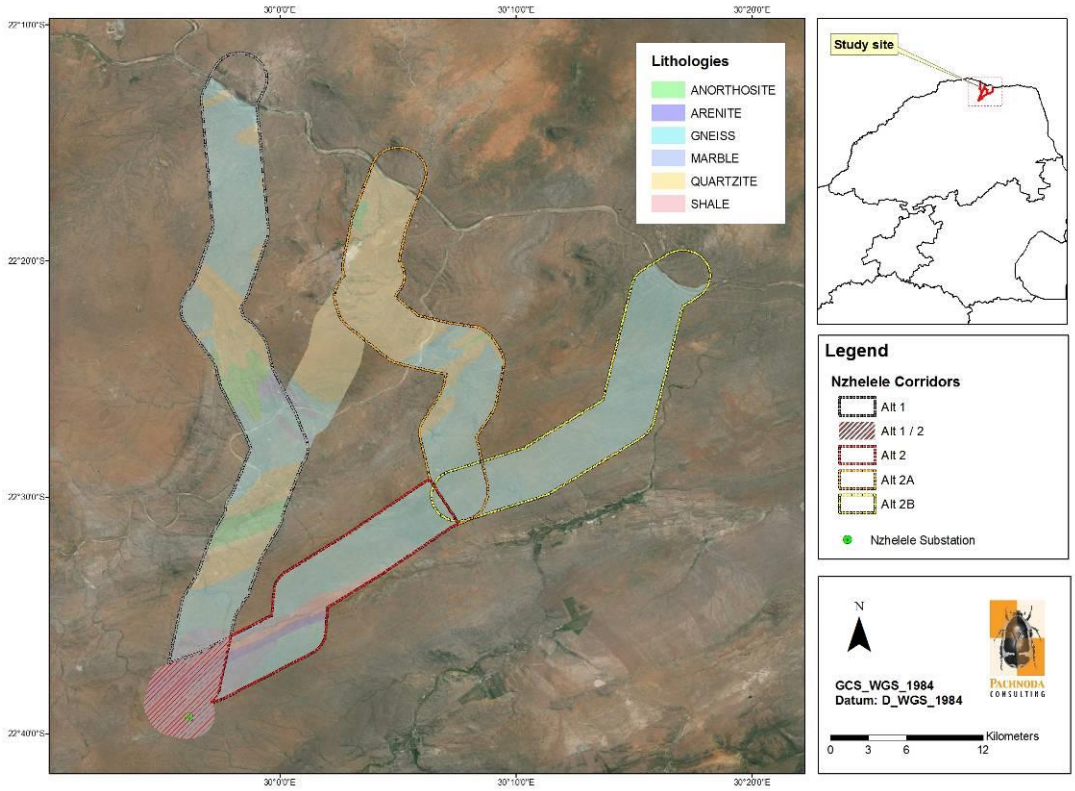


Figure 4: A map illustrating the regional geology and lithologies underlain by the proposed corridors.

3.3 Land Cover

The local land cover classes (2000 & 2009) on the respective corridors include (Figure 5; Table 2):

Natural areas:

- Woodland;
- Thicket and bushland; and
- Various water bodies and rivers.

Transformed areas:

- Cultivated land (primarily commercial land);
- Mines and quarries; and
- Urban / built-up areas.

From the land cover analysis, it is evident that the proposed corridors are dominated by woodland and bushveld habitat (Table 2 & Figure 5). It clearly shows that over 95 % of the study site is covered in natural habitat types as opposed to transformed areas (see Figure 6).

Even though the corridors are predominantly covered by natural (untransformed) woodland and bushveld habitat, the ecological condition of the woodland units often differs significantly from area to area (ranging from open woodland to secondary shrubland). Unsubstantiated observations made during the respective site visits (according to access) testified that certain parts of the study area that are classified as thicket and bushland is of secondary ecological condition and shows historical transformation (e.g. past clearing events or regenerating woodland on old agricultural lands). These areas should be re-classified as "degraded woodland and bushland".

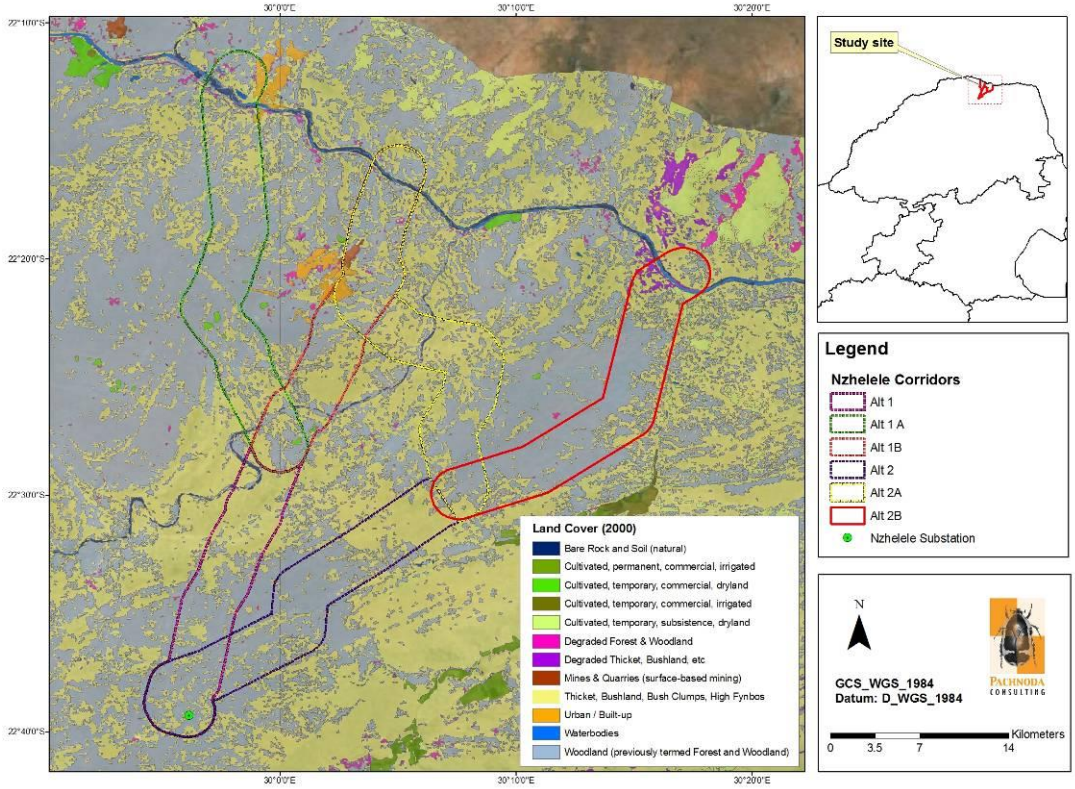


Figure 5: A map illustrating the land cover classes (2000) corresponding to the proposed corridors.

The extent and diversity of the land cover categories on each respective corridor show that Alternative 2B is *less* transformed when compared to the other corridors (Table 2). However, the highest surface area of transformed habitat corresponds to Alternative 2A.

Table 2: The respective surface area (ha) of the land cover classes, natural and transformed land cover categories on each of the proposed power line corridors (based on a 2 km buffer allocated to each alternative and the 2000 land cover dataset).

Land Cover Class	Alternative 1		Alternative 2A		Alternative 2B	
	Surface area (ha)	Percentage total area (%)	Surface area (ha)	Percentage total area (%)	Surface area (ha)	Percentage total area (%)
Bare Rock & soil	236.22	1.03%	127.05	0.50%	23.84	0.10%
Cultivated (commercial)	108.94	0.48%	0.00	0.00%	98.52	0.42%
Degraded woodland & bushland	118.75	0.52%	82.66	0.32%	296.84	1.28%
Woodland	12600.78	55.13%	13877.62	54.40%	14499.65	62.37%
Thicket & Bushland	9486.53	41.51%	11030.08	43.24%	8230.53	35.40%
Water bodies	100.71	0.44%	45.78	0.18%	92.35	0.40%
Urban/built-up	202.50	0.89%	212.11	0.83%	5.30	0.02%
Mines & Quarries	0.00	0.00%	134.45	0.53%	0.00	0.00%
Natural	22424.24	98.12%	25080.53	98.32%	22846.38	98.28%
Transformed	430.19	1.88%	1720.94	**6.75%**	400.66	1.72%
Total	**22854.43**	**100.00%**	**25509.75**	**100.00%**	**23247.04**	**100.00%**

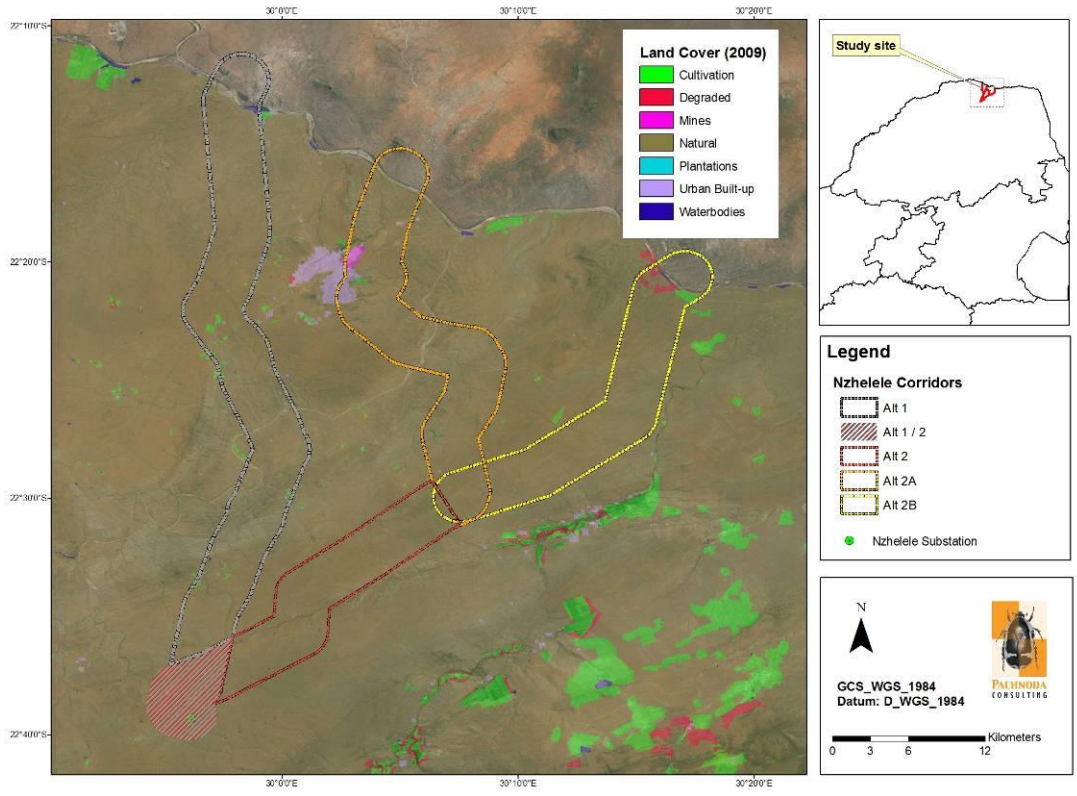


Figure 6: A map illustrating the land cover classes (2009) corresponding to the proposed corridors.

3.4 Conservation & Protected Areas

According to Figure 7, it is evident that Alternative 2A traverses the Messina (Musina) Nature Reserve. In addition, a large part of Alternative 2A and Alternative 2B traverses the Maremani Nature Reserve.

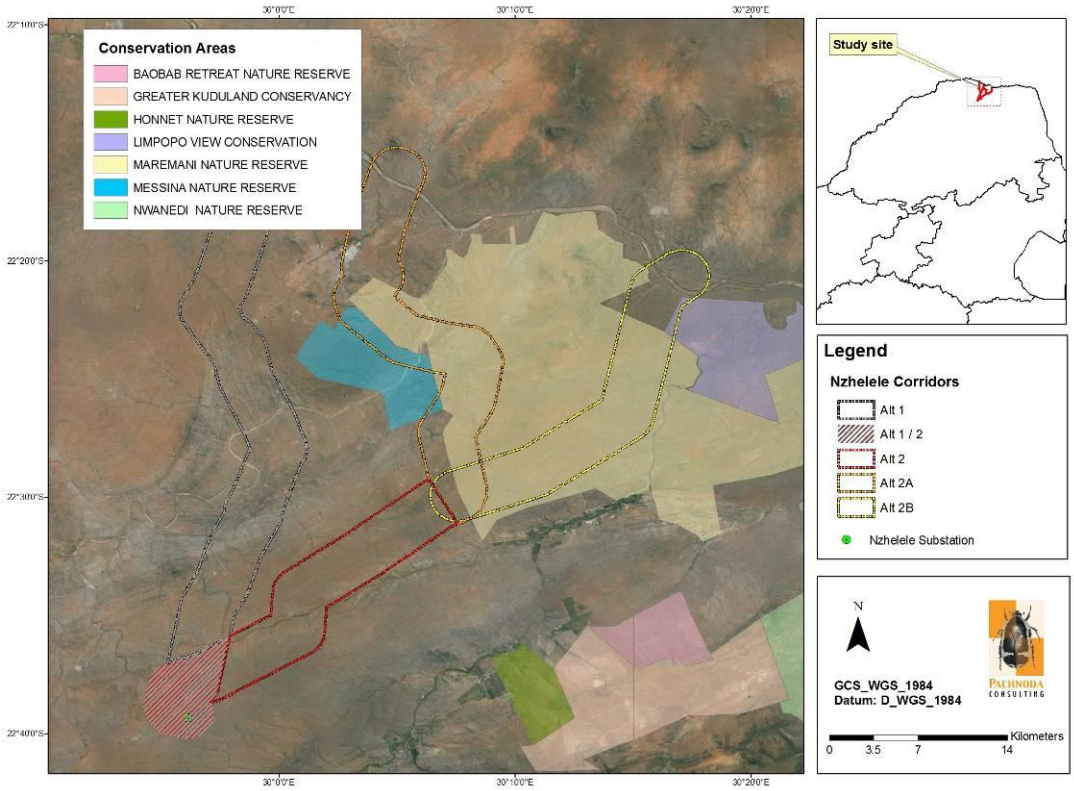


Figure 7: The spatial position of conservation and protected areas on the study area.

3.5 Wetland and drainage line crossings

The proposed corridors are located within the Limpopo River Catchment. The important rivers and drainage lines to be crossed by the proposed corridors are few and include the Sand River (Figure 7) although numerous seasonal tributaries and drainage lines are to be crossed (see Table 3). It is evident that Alternative 2A and Alternative 2B will, by approximation, cross more drainage lines when compared to Alternative 1.

Table 3: The number of anticipated river and seasonal drainage line crossings inferred from a line in the centre of each corridor.

Corridor	Non-perennial drainage line/river	Perennial drainage line/river	Total
Alternative 1	121	2	123
Alternative 2A	134	2	136
Alternative 2B	124	1	125

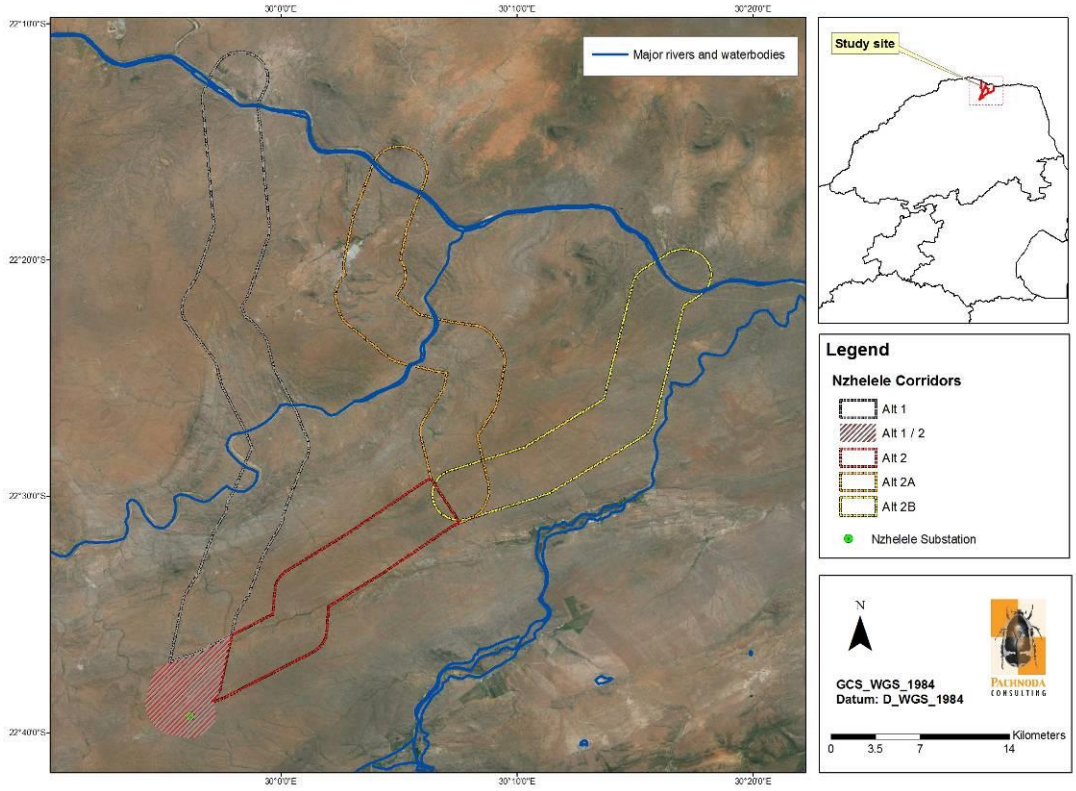


Figure 8: A map illustrating the major anticipated river/drainage line crossings corresponding to the proposed corridors.

3.6 Local (Macro-) Habitat Description and Biotopes

The dominant habitat types on the study site were widespread and occur on all the alternatives. However, the habitat descriptions were adopted and modified from Pachnoda Consulting (2009):

(a) Arid Sandy Woodland/Bushveld

The majority of the study site consists of open, arid woodland located on sandy soils. It comprises of a well-developed woody layer of *Terminalia prunioides*, *T. sericea, Acacia tortilis, Peltophorum africanum, Grewia flava, Boscia albitrunca* and

Sclerocarya birrea subsp*. caffra* (Figure 9: a-d). Typical canopy constituents include *Schotia brachypetala, Xanthocercis zambesiaca, Acacia nigrescens* and *Adansonia digitata*. The graminoid layer includes dominant taxa such as *Panicum maximum, Schmidtia pappophoroides* and *Stipagrostis uniplumis*. The composition of the avifaunal and faunal assemblages occurring on this habitat type is likely to include a high proportion of taxa with evolutionary links to that of the Zambezian region and the Mega-Kalahari basin. The latter is evidenced by the abundance of the scarab (dung beetle) genera *Metacatharsius,* which include many basal (or ancient) lineages within the revised Tribe Coprini.

From an avifaunal perspective, as of the presence of many game species it is not unlikely that the area will yield a high proportion of birds of prey including many charismatic taxa such as Martial Eagle (*Polemaetus bellicosus*), Bateleur (*Terathopius ecaudatus*) and White-backed Vulture (*Gyps africanus*). In addition, typical bird species restricted to the Kalahari-Highveld Biome (*sensu* Barnes, 1998) that are present in the study site include the Kalahari Scrub-robin (*Erythropygia paena*) and Barred Wren-warbler (*Calamonastes fasciolatus*). More importantly, areas with a low woody and sparse graminoid cover provides important foraging and breeding habitat for the near-threatened Kori Bustard (*Ardeotis kori*), endangered Southern Ground Hornbill (*Bucorvus leadbeateri*) and vulnerable Secretarybird (*Sagittarius serpentarius*).

(b) Arid Rocky Bushveld

The northern section of the study site and large sections of the Limpopo River Valley are earmarked by shallow rocky soils and a poorly developed grassy layer (Figure 9:e-h). The floristic composition is essentially similar to the arid sandy bushveld although the woody taxa such as *Commiphora spp*., *Terminalia prunioides, Kirkia acuminata* and *Colophospermum mopane* appears higher.

(b) Sandstone and Granite Ridge/inselberg Bushveld

The arid sandy woodland types are occasionally interrupted by sandstone and granite outcrops (Figure 9:i-l). In general, the vegetation composition surrounding these shallow soils tends to differ structurally from the other woodland habitat types, being a short bushveld dominated by *Terminalia prunioides*, *Sclerocarya birrea* and *Boscia albitrunca*. The vegetation on the outcrops consists of tall *Ficus spp., Philenoptera violacea* and *Kirkia acuminata.* These outcrops represent an important habitat type (e.g. the presence of rock exfoliations) in an otherwise homogenous woodland matrix, especially for stenotopic and obligate lithophilous invertebrate taxa. The latter includes the widespread rock scorpion, *Hadogenes troglodytes*. In addition, the outcrops contribute to a myriad of microhabitat types and niche space, especially when surrounded by a landscape of flat topography. It also serves as important hunting and breeding habitat for the vulnerable Verreaux's Eagle (*Aquila verreauxii* - especially on ridges with a good populations of hyrax) and other smaller falconiform taxa (e.g. Lanner Falcon *Falco biarmicus*).

It is essential to remark on the significant role these outcrops serve. Firstly, the ridges and mountains act as “evolutionary windows” and “stepping stones”, therefore, these specialised habitat types act as refugia, and are important speciation centres or “hotspots” for localised invertebrate species. Secondly, the ridges are important landscape features assisting winged invertebrates (in particular butterfly species) in locating potential mating partners – a behavioural characteristic known as “hill-topping”.

(d) Alluvial floodplains and Riverine Woodland along drainage lines and rivers

This habitat type represents a linear riparian zone along some of the larger rivers such as the Limpopo, Sand and Nzhelele Rivers (Figure 9:q-t). In some areas the riparian woodland consists of a tall closed canopy of *Schotia brachypetala, Xanthocercis zambesiaca, Diospyros mespiliformis, Ficus sycomorus* and *Trichilia emetica.* The understorey is often thicket-like, consisting of *Grewia flava, G. hexamita* and *Ziziphus mucronata*. *Panicum maximum* dominates the graminoid layer. This habitat is particularly important for the potential occurrence of the endangered Pel's fishing-owl (*Scotopelia peli*) and the vulnerable White-backed Night-heron (*Calherodius leuconotus*). It also provides nesting structure for other large bird species such as the Hamerkop (*Scopus umbretta*), African fish-eagle (*Haliaetus vocifer*) and Saddle-billed Stork (*Ephippiorhynchus senegalensis*).

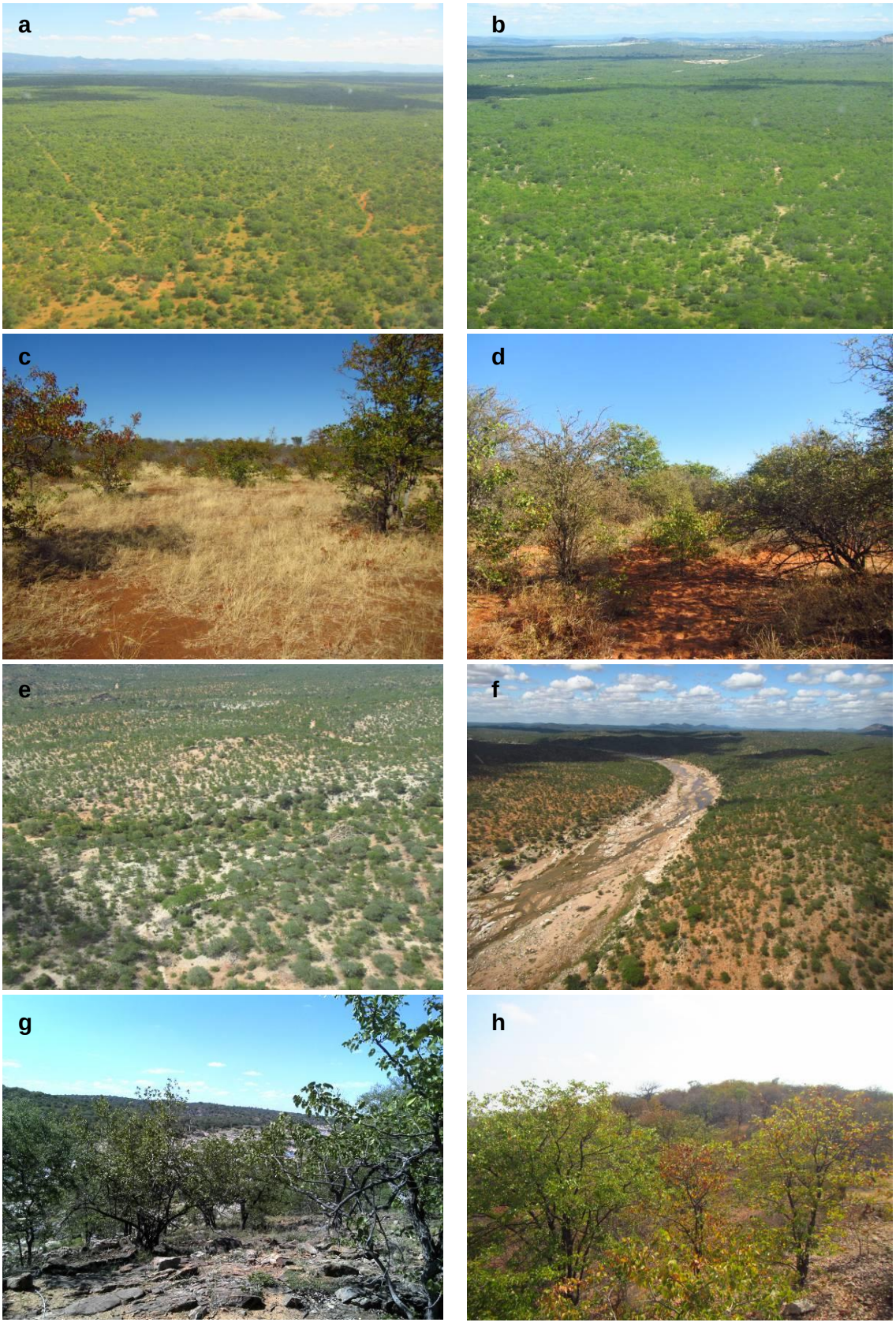
The high vertical heterogeneity and leaf litter deposition associated with the alluvial vegetation, allow for avifaunal and invertebrate compositions (or more precisely guilds) not typically associated with adjacent bushveld habitat types - thereby enhancing local biodiversity. From a functional perspective, these habitat types play an important role in maintaining genetic stability between faunal populations along their entire length. These constitute important dispersal corridors for faunal species, since it increases the probability of colonisation of areas outside of the study site, thereby reducing the isolation of residing populations.

The major rivers and their tributaries comprise of an intricate mosaic of alluvial (sandy) floodplains and sandbars, which provide roosting and breeding habitat for many aquatic bird species include waterfowl and a variety of shorebirds (e.g. Blacksmith Lapwing *Vanellus armatus*, Three-banded Plover *Charadrius tricollaris* and Water Thick-knee *Burhinus vermiculatus*) (Figure 9:m-p). In addition, when inundated, the ephemeral pools attract a large variety of wading birds and piscivorous taxa, which include amongst others the Pied Kingfisher (*Ceryle rudis*), Reed Cormorant (*Microcarbo africanus*), African Fish-eagle (*Haliaetus vocifer*), Saddle-billed Stork (*Ephippiorhynchus senegalensis*) and a rich variety of herons and egrets of the genera *Ardea* and *Egretta*.

(e) Ephemeral and azonal habitat

A number of smaller azonal habitat units are present on the study site. Most of these are patchy and localised in occurrence, depending levels of inundation, while others are very widespread in the landscape - but never present in large densities. These units are considered to be very important for certain avifaunal species and their numbers are often dictated by the presence of these habitat features (Figure 10):

a. *Artificial impoundments and dams* - these represent small to fairly large water bodies and weirs, many being maintained to provide drinking water for various game species. However, these water bodies have undoubtedly benefit the colonisation and range expansion of many waterbird species that favours open water habitat. These water bodies also provide a refuge for waterbird species during the dry season. In addition, they provide foraging habitat for threatened stork species or are utilised as breeding habitat by stork species;
b. *Reservoirs and game waterholes* – These are favourite hunting and scavenging areas for the larger bird of prey species (often vultures and marabou storks).
c. *Fallow (arable) land and secondary woodland* - These represent secondary woodland and fallow land that were previously used for agricultural purposes. These provide ephemeral foraging habitat for a number of bird species in particular that of the nationally vulnerable Secretarybird (*S. serpentarius*) and other species that are prone to power line collisions such as the White Stork (*Ciconia ciconia*), Abdim's Stork (*C. abdimii*), Spur-winged Goose (*Plectropterus gambensis*) and Egyptian Goose (*Alopochen aegyptiaca*). This habitat is characterised by a high potential to absorb and irradiate solar heat owing to its sparse vegetation cover, thereby creating thermal air movement, which are often utilised by large birds of prey (e.g. vultures).
d. *Large canopy trees such as Adansonia digitata and Sclerocarya birrea* – these provide suitable breeding platforms for a diversity of birds of prey species (e.g. Wahlberg's Eagle *Hieraaetus wahlbergi* and White-backed Vulture *Gyps africanus*). In addition, The *A. digitata* trees often produce holes and hollows which are occupied by cavity-nesting birds species or are used as roosting sites for certain bat species.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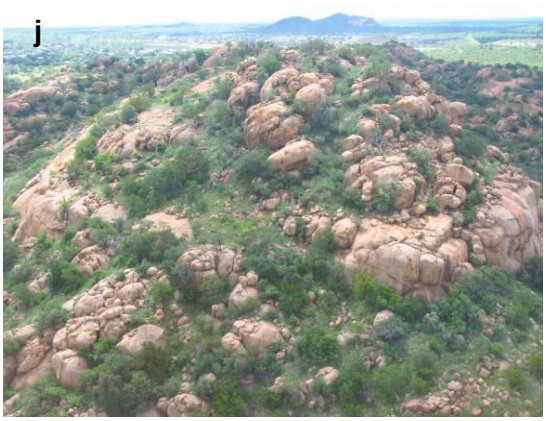
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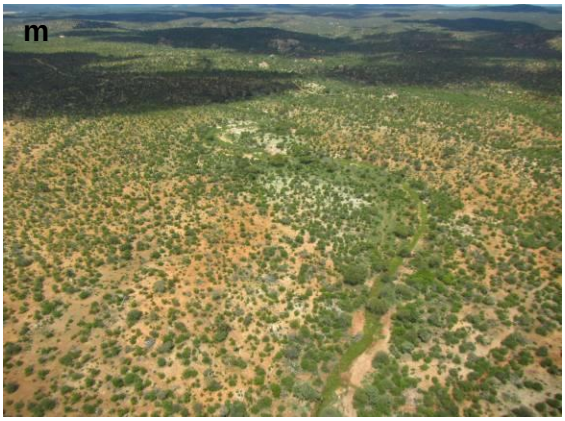
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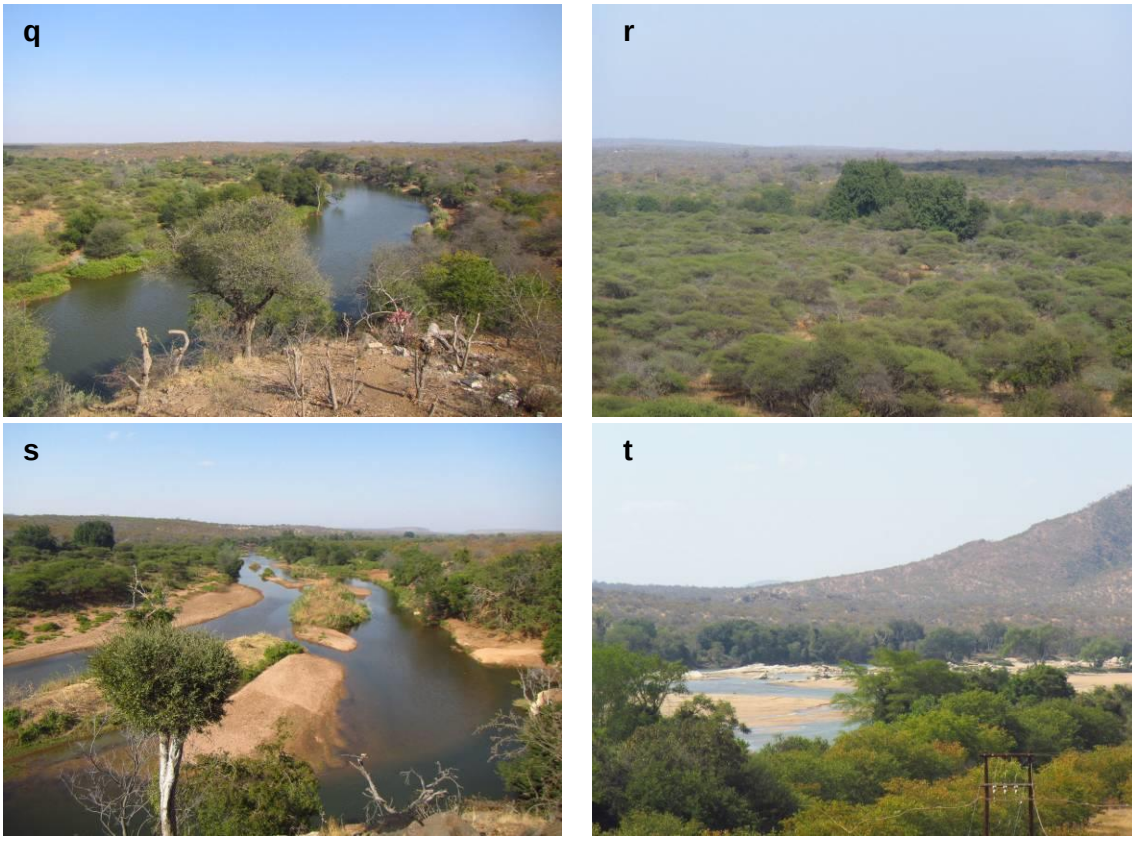
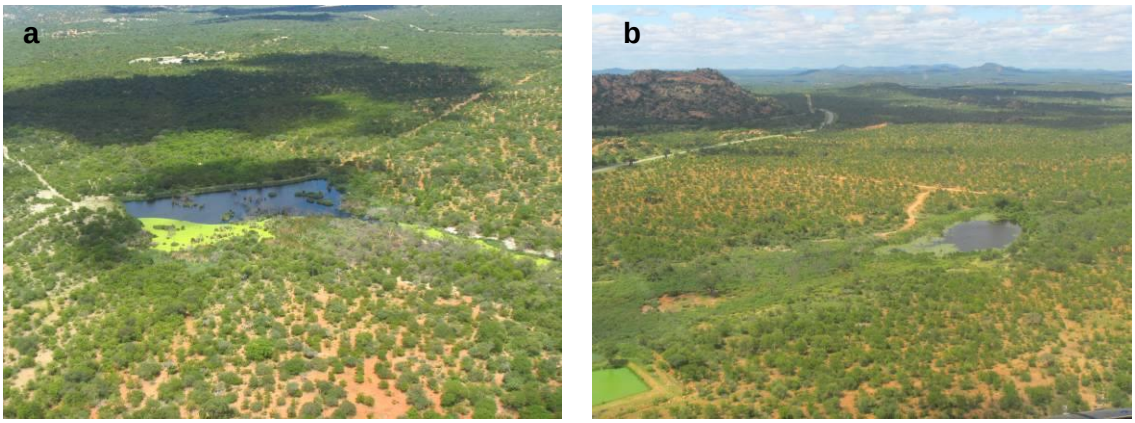


Figure 9: A collage of images illustrating the different macro-habitat types on the study site: (a-d) Arid Sandy Woodland/Bushveld, note the open basal layer (c) which provides suitable foraging habitat for Kori Bustards (*Ardeotis kori*), (e-h) Arid rocky bushveld/woodland, (i-l) Sandstone and Granite Ridge Bushveld, (m-p) Alluvial floodplains, large ephemeral pools and seasonal rivers and (q-t) Riparian woodland along the Limpopo and Nzhelele Rivers.

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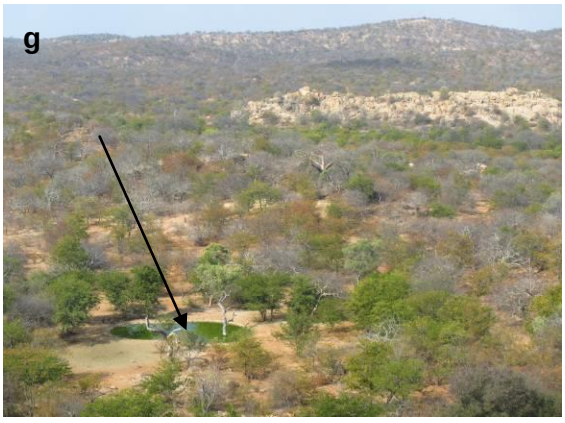
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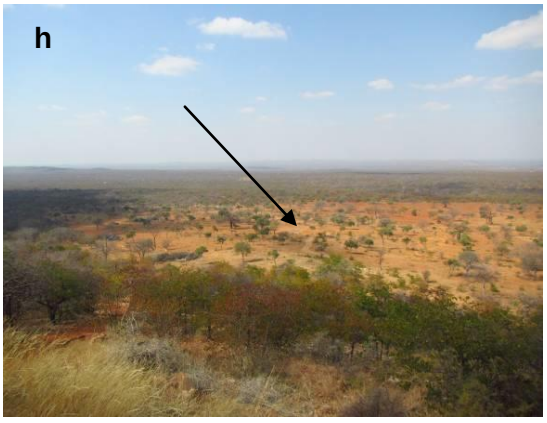
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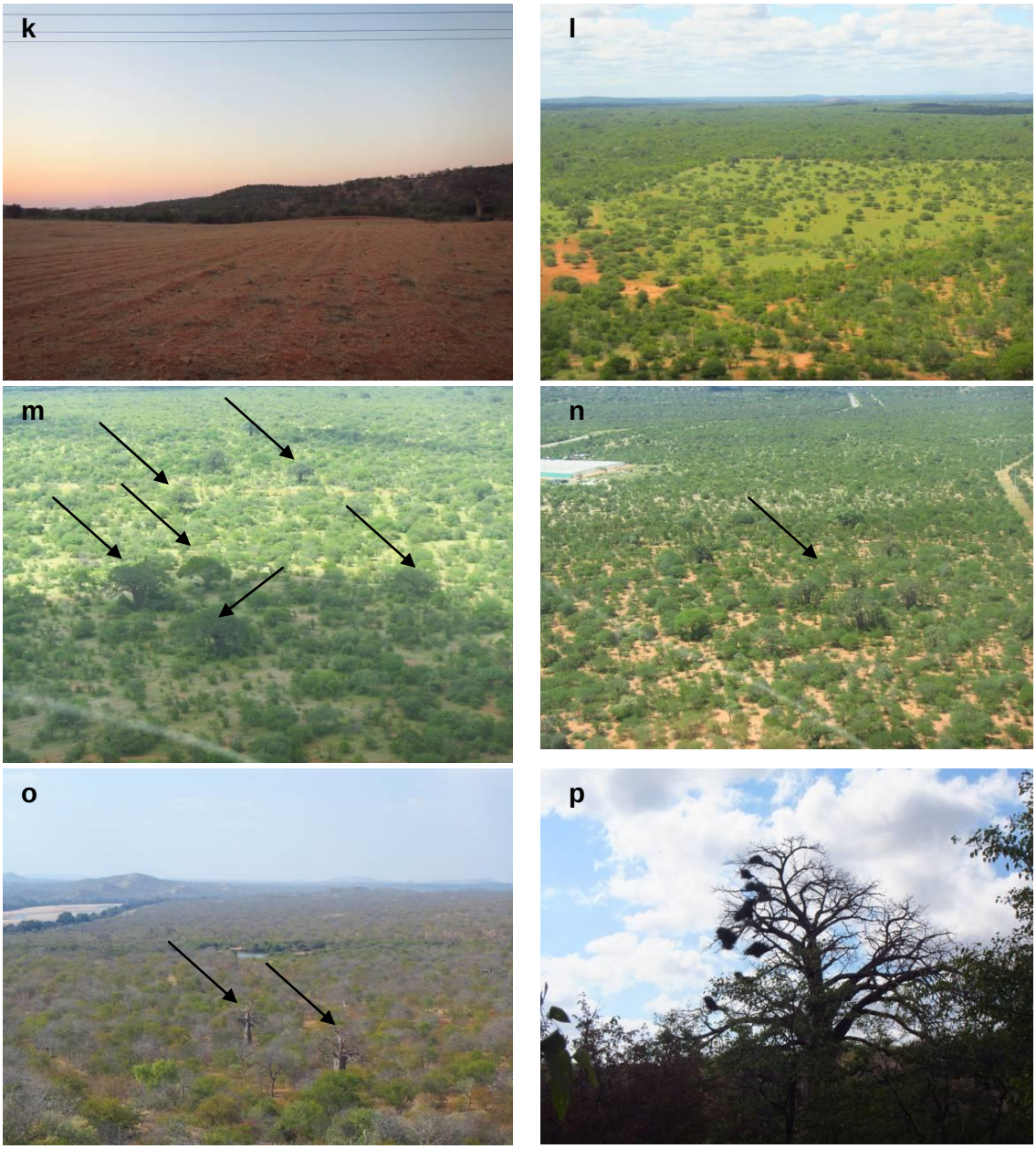

Figure 10: A collage of images illustrating the different azonal and ephemeral habitat types on the study area: (a-d) Artificial impoundments and farm dams, (e-h) waterholes and reservoirs, (i-l) fallow (arable) land and secondary woodland and (m-p) tall canopy constituents such as *Adansonia digitata*.

3.7 Red Listed, Endemic and Conservation Important Fauna Taxa[5]

The proposed corridors will traverse through extensive areas of natural woodland and game reserves, especially on the eastern and central section of the study area, which provide suitable habitat for a variety of large and charismatic mammal species. Likewise, the perennial rivers provide suitable habitat for a number of near-threatened and data deficient taxa that are wetland-dependant (e.g. shrew taxa of the genus *Crocidura*). However, the area is likely to support a high richness of near-

[5] Please note that the avifauna is excluded from this section and will be dealt with under a separate heading in the report.

threatened meso- and meta-carnivores on a global and national level (e.g. Leopard *Panthera pardus* and Brown Hyaena *Parahyaena brunnea*). The objective is not to provide a detailed account on the various animal communities present, but merely to provide an indication of the diversity and potential occurrence of taxa of conservation concern.

Table 4 provides a list of threatened, “near-threatened” and conservation important faunal species with geographic distribution ranges sympatric (overlapping) to the study area. It is evident that a high richness (especially mammal species) is expected to occur. This emphasises the untransformed ecological condition of the various habitat types in the area and the extensive surface areas occupied by these habitat types. Many of these areas coincide with large private game reserves, which provide sanctuary for taxa with large body sizes.

High numbers of fauna taxa (mammals, reptiles, amphibians and butterflies) were recorded from habitat corresponding to Alternative 2A, while Alternative 2B sustains habitat with intermediate fauna richness values (Figure 11). Low richness values (when compared to the other corridors) were observed on habitat corresponding to Alternative 1. Nevertheless, Alternative 2B sustains higher numbers of threatened and near-threatened fauna taxa when compared to the other proposed corridors. Please note that the observed richness patterns are probably biased, since habitat with high fauna richness corresponds to areas that are frequently accessed by observers (these areas consist of a high density of infrastructure - 2230AC). Likewise, south of the study area, the QDC 2230CA comprehends in part with the Soutpansberg, which is known as a Centre of Endemism and holds a high diversity of both vascular plants and animals (Van Wyk & Smith, 2001).

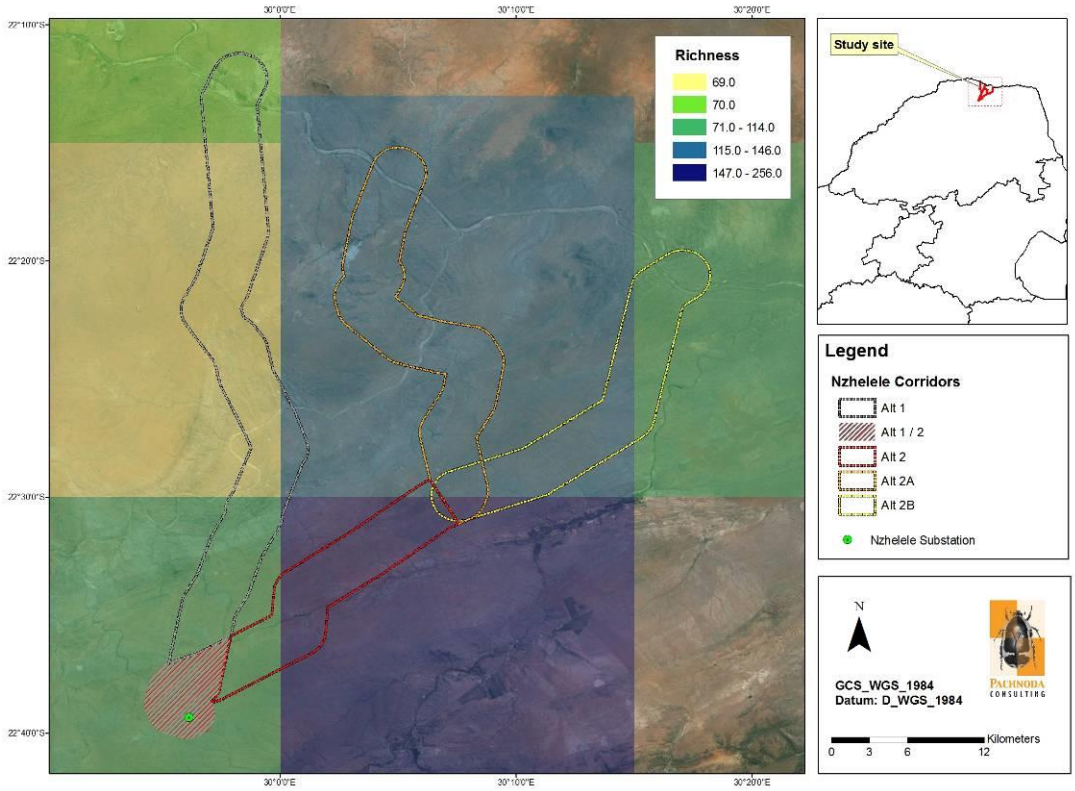

Figure 11: A spatial presentation of the fauna richness (mammals, reptiles, amphibians and butterflies) recorded from the quarter degree squares on the study area (according to ADU).

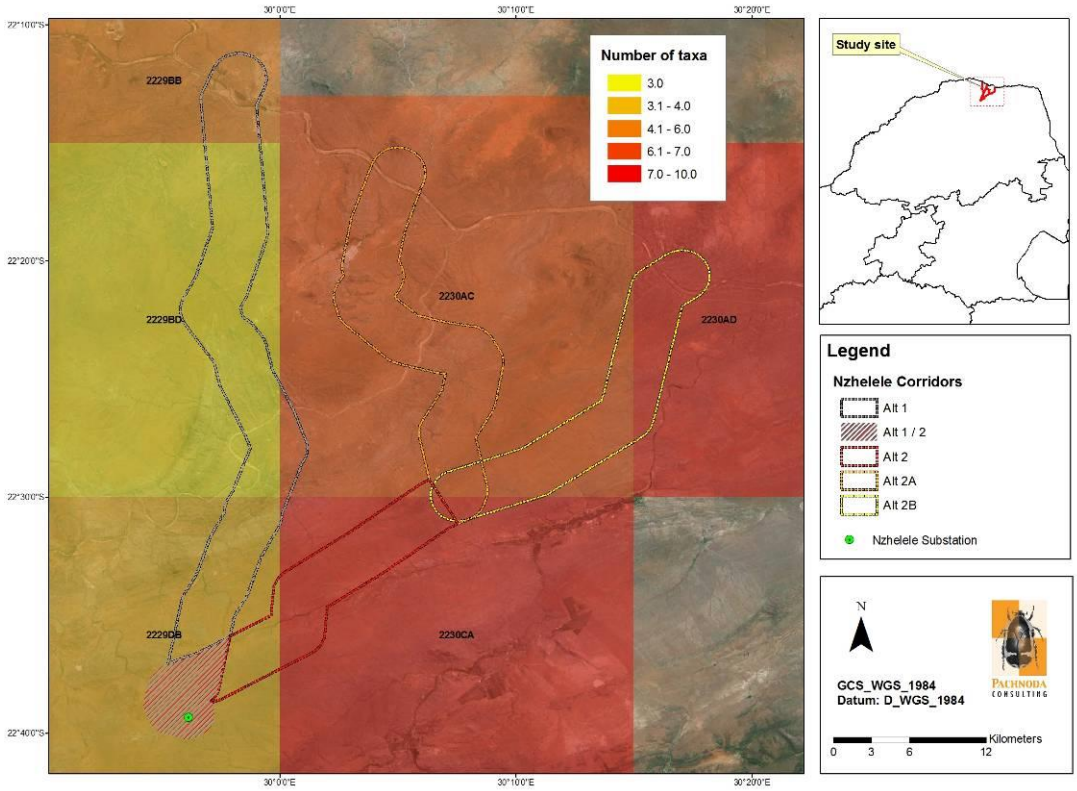

Figure 12: A spatial presentation of the number of fauna taxa (mammals, reptiles, amphibians and butterflies) recorded from the quarter degree squares on the study area (according to ADU and personal observation obtained during the site visits).

3.7.1 Faunal impacts

Impacts regarding power lines consist of (1) disturbances, (2) habitat loss (3) and various secondary impacts caused during the construction phase and maintenance phase. These include the construction and positioning of the tower structures, laydown areas, construction camps and access roads. However, the significance of the impacts related to *transmission* lines also depend on the tower structure, whereby a larger footprint is imposed during the construction of self-supporting towers.

In most cases, the impact is proportional to vegetation structure. Therefore, woodland or bushveld compositions are subjected to clearing or "pruning" of the trees/vegetation underneath the power line servitude will contribute to some loss of habitat or at least habitat modification, thereby affecting at least animal populations that are inherently less mobile (e.g. substrate specialists and sessile organisms).

Most mammal species are, in general, mobile and therefore able to vacate areas should adverse environmental conditions prevail. Therefore, direct impacts associated with construction activities on adult mortality are less likely to occur, although indirect impacts will have consequences on their “fitness” (e.g. the ability of

a species to reproduce). However, persistent disturbances across extended temporal scales will eventually affect any population's ability to sustain itself, and will more than likely result in total abandoning of a particular area.

Species most likely to be affected are either K-selected species or habitat specialists e.g. substrate specialists (e.g. baboon spiders). K-selected species are mostly long-lived species with slow reproductive rates, while habitat specialists are those restricted to a particular type of microhabitat or niche, being it structurally, altitudinal or floristic. Most of these species are therefore threatened, "near-threatened" or Red Listed.

Faunal compositions are believed to remain the same irrespective of the intensity of the construction activities (e.g. road construction) associated with the power lines, but the distribution and abundance of species could effectively change. Many habitat specialists (in particular those restricted to outcrops) could eventually suffer from local range contraction.

In addition, construction activities go hand in hand with high ambient noise. Although the construction phase is considered to be of short duration, many of the larger terrestrial species will vacate the study area during the construction phase and will become temporarily displaced.

The following impacts are anticipated during the *construction* phase (see Appendix 1):

Loss of woodland/bushveld habitat: It is anticipated that the placement of tower structures and access roads (especially when corresponding to untransformed woodland, tall (closed-canopy) riparian woodland and tall canopy constituents such as the *Adansonia digitata* trees) could alter the ecological condition of the grassland seres and the faunal species specific to it (e.g. stenotopic species).

Loss of conservation important faunal species: During the construction phase, it is possible that areas corresponding to the footprint of the proposed tower structures could provide habitat for threatened or protected fauna species. However, the impact is predicted to be more eminent when the placement of the tower structures occurs on sandstone and granite outcrops, riparian woodland or large (semi-perennial) rivers/streams.

Disturbances caused during the construction phase: Disruption of functional ecological habitat types (outcrops and drainage lines, rivers and streams): It is possible that areas with high ecological function could become disrupted during the construction phase, especially during the demarcation of access roads on landscapes with a linear configuration which act as important dispersal corridors.

The following impacts are anticipated during the *operational/maintenance* phase (see Appendix 1):

Disturbances associated with maintenance procedures: Maintenance procedures (e.g. pruning of trees, fault detection) are generally believed to produce lower ambient noise levels in contrast to those experienced during the construction phase.

Maintenance of the vegetation on the power line servitude: Fires and tall trees are detrimental to the proper functioning of power lines, which necessitates the early burning of the graminoid cover and pruning of emergent trees. The removal of vegetation along the power line servitude and persistent maintenance procedures (e.g. clearing) could change the floristic properties (both structurally and compositionally) of the vegetation sere along the servitude. For example, it is expected that maintenance procedures will favour the establishment of a "good" secondary basal cover of graminoid species, which will - in turn - attract grazing game species to the servitude.

Increased hunting, poaching and removal of firewood: It is possible that the labour force could engage in activities that could lead to the hunting of game for food or medicinal purposes. In addition, the removal of firewood could alter the natural structure of the vegetation, which could eventually lead to shifts in the natural faunal species composition and increased competition between species for resources.

Table 4: A list of threatened, near-threatened and conservation important faunal species likely to occur on the study area (excluding introduced game, e.g. Lion, buffalo and rhino). The conservation status of mammal, amphibian, reptile and invertebrate taxa was based on IUCN Red List (2014), Friedman & Daly (2004), Measey (2010), Bates *et al.* (2014), Mecenero *et al.,* (2013) and Schedule 10 of the list of protected invertebrate species issued in terms of Section 61(1)(a) and (b) of the Limpopo Environmental Management Act, 2003 respectively.

Scientific Name	Common Name	Global Conservation Status	National Conservation Status	Probability of Occurrence	Habitat
Mammals					
Manis temminckii	Ground Pangolin		Vulnerable	Could occur, was historically recorded from the region	Varied, from open grassland to woodland and rocky bushveld.
Acinonyx jubatus	Cheetah	Vulnerable	Vulnerable	Potentially restricted to conservation areas on the extreme north and on the eastern parts of the study area.	Open and lightly wooded savanna.
Leptailurus serval	Serval		Near-threatened	High.	Along moist grassland near rivers and dams.
Panthera pardus	Leopard	Near-threatened		High, regarded to be widespread on study area.	Widespread, from open woodland to hills and ridges.
Raphicerus sharpei	Sharp's Grysbok		Near-threatened	Could occur, known to occur on western (Alternative 1A) part of the study area.	Dense shrub and woodland areas, especially riverine woodland.
Atelerix frontalis	South African Hedgehog		Near-threatened	Could occur.	A widespread species that prefer dry habitat types and will often utilise urban gardens.
Elephantulus intufi	Bushveld Elephant-shrew		Data Deficient	High, likely to be present.	Sandy soils with low basal cover.
Petrodromus tetradactylus	Four-toed Elephant-shrew		Endangered	Low, only known from a single recent observation on the southern part of the study area (2230CA).	Dense forested areas with well-developed understorey and leaf litter - most likely to be present in well-developed riverine woodland.
Hippotragus niger niger	Sable Antelope		Vulnerable	Probably introduced.	Well-wooded savanna, dependent on water bodies.
Paracynictis selousi	Selous' Mongoose		Data Deficient	Could occur, known to be present in QDS 2230AC.	Savanna within the Limpopo River valley.

Scientific Name	Common Name	Global Conservation Status	National Conservation Status	Probability of Occurrence	Habitat
Pipistrellus rusticus	Rusty Bat		Near-threatened	High, likely to be present.	Well-developed savanna, mainly riparian woodland.
Mellivora capensis	Honey Badger		Near-threatened	High, likely to occur.	Catholic, widespread and tolerant to most habitat types.
Crocidura cyanea	Reddish-Grey Musk Shrew		Data Deficient	High.	Dry terrain among rocks in dense scrub and grass, in moist places and in hedges.
Crocidura hirta	Lesser Red Musk Shrew		Data Deficient	High.	Wide habitat tolerance.
Crocidura mariquensis	Swamp Musk Shrew		Data Deficient	High.	Moist habitats, e.g. thick grass along riverbanks, reedbeds and in swamps.
Graphiurus platyops	Rock Dormouse		Data Deficient	High.	Rocky habitat.
Epomophorus gambianus crypturus	Gambian Epauletted Fruit Bat		Data Deficient	Could occur.	Riverine woodland with a high density of *Ficus* spp.
Hipposideros caffer	Sundevall's Leaf-nosed Bat		Data Deficient	Likely to be present.	Forages over savanna, roost in caves.
Rhinolophus hildebrandtii	Hildebrandt's Horseshoe Bat		Near-threatened	Could occur, especially in the vicinity of hills and ridges.	Forages over savanna, roost in caves.
Reptiles					
Crocodylus niloticus	Nile Crocodile		Vulnerable	High.	Mainly confined to the Limpopo River and its tributaries (often common in some of the perennial dams on game farms)
Homopholis mulleri	Muller's Velvet Gecko		Vulnerable	Possible, known from the southern part of the study area.	Holes in *Sclerocarya birrea, Colophospermum mopane* and *Acacia nigrescens* trees in Mopani woodland.
Chirindia langi occidentalis	Soutpansberg Worm Lizard		Vulnerable	Could occur, probably peripheral to study site.	Low-lying areas under stones embedded in sandy soils.
Invertebrates					
Thoracistus viridicrus	Green-kneed Seedpod Shieldback		Vulnerable	Status uncertain - only known from six localities in Limpopo pre-1985.	Savanna.
Pterinochilus lugardi			Protected	Could occur.	Known from the Soutpansberg district near the Nwanedzi River.
Augacephalus (=Pterinochilus)	Junodi's Golden Baboon Spider		Protected	High.	Widespread.

Scientific Name	Common Name	Global Conservation Status	National Conservation Status	Probability of Occurrence	Habitat
junodi					
Ceratogyrus darlingi	South African horned baboon spider		Protected	High.	Widespread.

3.8 Avifauna: Bird populations likely to be affected

3.8.1 Bird impacts associated with transmission lines

Birds are impacted in three ways by transmission lines. It is however a common rule that large and heavy-bodied terrestrial bird species are more at risk of being affected in a negative way when interacting with transmission lines. These include the following:

- *Electrocution*

Electrocution happens when a bird bridges the gap between the live components or a combination of a live and earth component of a power line, thereby creating a short circuit. This happens when a bird, mainly a species with a fairly large wingspan attempts to perch on a tower or attempts to fly-off a tower. Many of these species include vultures (of the genera *Gyps* and *Aegypius*) as well as other large birds of prey such as the Martial Eagle (*Polemaetus bellicosus*) (Ledger & Annegarn, 1981; Kruger, 1999; Van Rooyen, 2000). These species will attempt to roost and even breed on the tower structures if available nesting platforms are a scarce commodity. Other types of electrocutions happen by means of so-called “bird-streamers”. This happens when a bird, especially when taking off, excretes and thereby causing a short-circuit through the fluidity excreta (Van Rooyen & Taylor, 1999). This method of electrocution is however a rare phenomena. Other species also likely to be affected include species prone towards roosting on towers such as the Black Stork (*Ciconia nigra*).

However, it is recommended that the “Cross-rope Suspension” tower, a bird-friendly design, be used since it does not provide a suitable roosting or nesting substrate for birds, and discourages birds from breeding or roosting on the tower (Vosloo, 2003; Figure 13). However, the use of other towers that do offer perching or nesting habitat, for example the “Self-supporting” (which is commonly used at bend points) and “Guyed-Suspension” towers should be limited and fitted with bird guards (Figure 14) and sleeves to insulate certain phases of the lines (Vosloo, 2003).

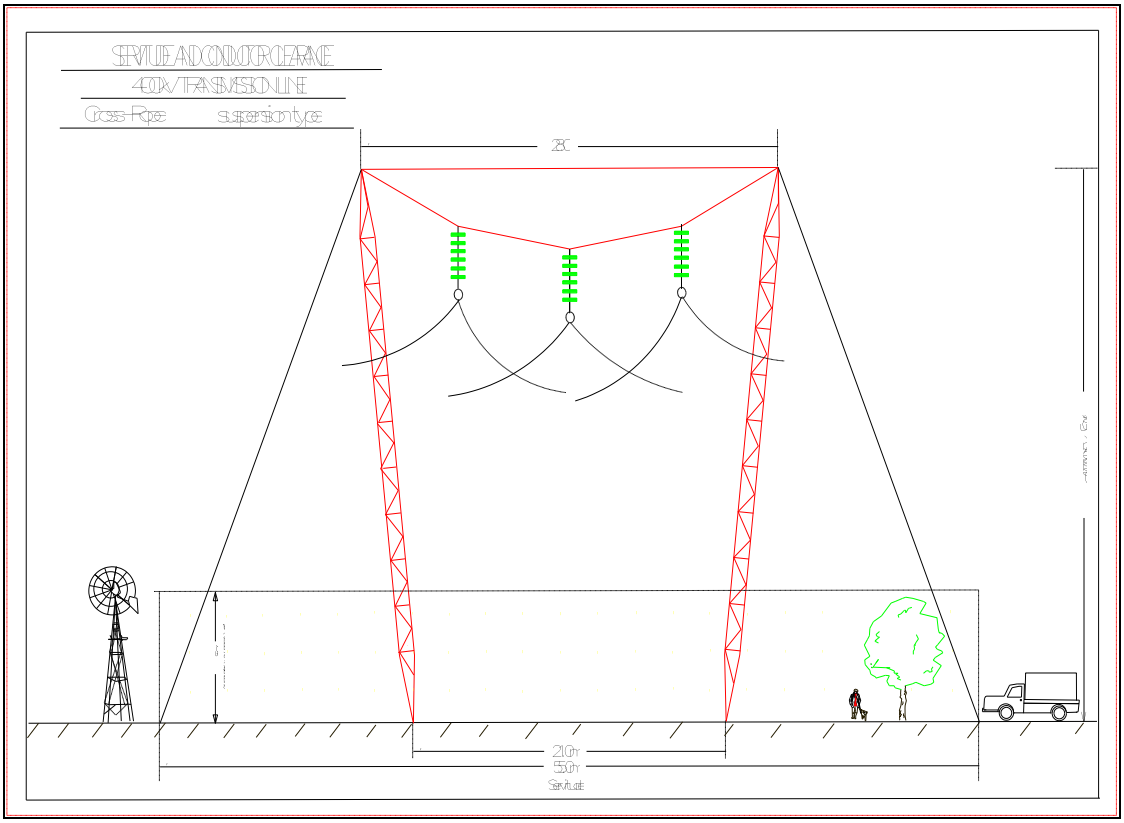

Figure 13: The “cross-rope suspension” tower design, a bird-friendly design.

Figure 14: Bird guards (‘spikes’) fitted to a self-supporting tower.

- *Collision*

Collisions with earth wires have probably accounted for most bird-transmission line interactions in South Africa. In general, the earth wires are much thinner in diameter when compared to the live components, and therefore less visible to approaching birds. Many of the species likely to be affected include heavy, large-bodied terrestrial species such as storks, bustards, korhaans and a variety of waterbirds that are not very agile or manoeuvrable once airborne. These species, especially those with the habit of flying with outstretched necks (e.g. most species of storks) find it difficult to make a sudden change in direction while flying – resulting in the bird flying into the earth wires.

Areas where bird collisions are likely to be high could be ameliorated by marking the lines with bird devices such as “bird diverters” and “flappers” to increase the visibility of the lines (APLIC, 1994). Many studies have proved that “bird diverters” can reduce mortalities by up to 60 % (Alonso & Alonso, 1999) and if applied correctly (e.g. utilising large devices spaced at least 5 m apart), they appear to be very effective. For the current project it is proposed that all river and dam crossings, including proximal areas of arable land and open woodland areas be fitted with "Double Loop Bird Flight Diverters" (BFDs; Figure 15 & 16).

In addition, by placing the transmission line along an existing power lines will also greatly increase the visibility of the overhead cables.

- *Physical disturbances and habitat destruction caused during construction and maintenance*

It is anticipated that a number of access roads need to be constructed as well as the clearing of vegetation as part of the power line servitude. However, intensive clearing and pruning of trees is likely to take place along corridors corresponding to woodland or bushveld characterised with a well-developed canopy structure (e.g. areas corresponding riverine woodland and bushveld dominated by *Adansonia digitata*).

Birds in general are highly mobile and therefore able to vacate areas should such adverse environmental conditions prevail. Therefore, direct impacts associated with construction activities on adult mortality are less likely to occur, although indirect impacts will have severe consequences on their “fitness” (e.g. the ability of a species to reproduce). Likely examples include habitat loss and disturbances preventing individuals from breeding successfully, especially considering the close proximity of crane nesting areas. However, persistent disturbances across extended temporal scales will eventually affect any population’s ability to sustain itself, and will more than likely result in total abandoning of a particular area.

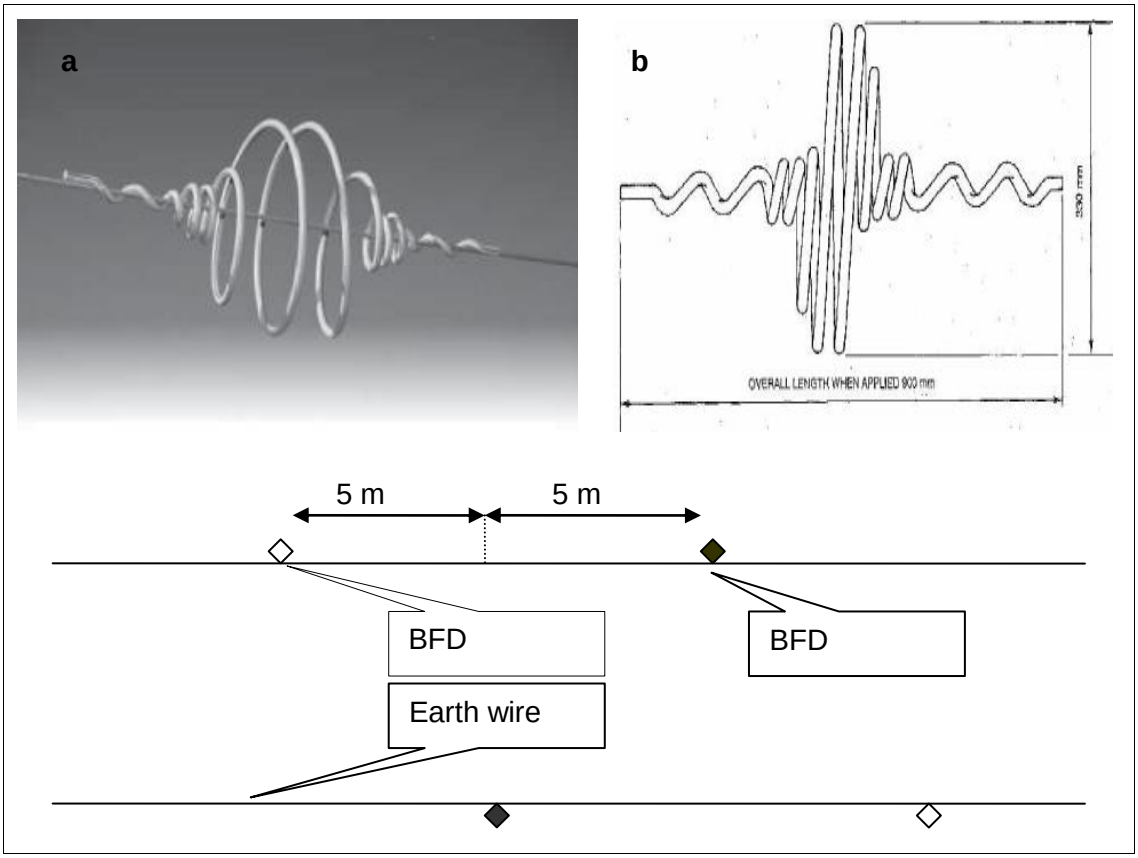

Figure 15: The recommended bird diverter to be used and installation guidelines: (a-b) – the Double Loop Bird Flight Diverter (copyright Preformed Line Products, www. preformedsa.co.za) and (c) – installation procedures (kindly provided by C. van Rooyen).

Figure 16: An example of the Double Loop Bird Flight Diverter fitted to the earth wires of a 500 kV transmission line (image courtesy and copyright of Shaw, 2013).

3.8.2 Bird species likely to be impacted: Historical perspective (SABAP1)

Richness

In general, the study area sustains a high richness of bird species (mean of 243.6 spp, n=6 QDGs), which is explained by the extensive area of woodland habitat and the occurrence of tropical riverine habitat along the Sand and Limpopo Rivers. The latter support many marginal species that have their southern distribution limits pertaining to the study area in South Africa. The number of bird species recorded for each quarter degree square range from 192 species at Kumkusi (2229BD) to as many as 278 species at Beitbridge (2229BB). It is evident that high richness values were obtained from habitat corresponding to Alternative 2B and Alternative 1 from habitat located along the Limpopo River. The lowest values on average were recorded along Alternative 1 south of the Limpopo River (Figure 17).

Threatened and Near-threatened Species

The highly seasonal and ephemeral nature of surface water retention in the area, along with the presence of large rivers with extensive sandy floodplains and pools are responsible for the occurrence of many threatened and near-threatened stork species (*c*. five species) in the region. These habitat features, in combination with the open structure of the woodland habitat (which favour large terrestrial bird species such as bustards, ground hornbills and Secretary birds), an abundance of game species (which attract scavengers), the rural practice of ranching in neighbouring Zimbabwe (which favours the occurrence scavenging taxa e.g. the genera *Terathopius, Gyps* and *Aegyptius*) and the presence of isolated, although prominent landscape features (e.g. ridges which provide optimal hunting habitat for Verreaux's Eagle *Aquila verreauxii* and Lanner Falcon *Falco biarmicus*) have all contributed to the high richness of threatened and near-threatened bird species in the area, especially large birds of prey. Therefore, a total of 19.5 % (133 spp) of all national threatened and near-threatened bird species are present on the study area. In retrospect, the majority of species are also highly prone towards collisions with earth wires, and therefore at risk.

Table 5 and Figure 18 summarizes the Red listed species that could potentially occur in the study area. It is evident that the highest reporting rates (according to Harrison *et al*., 1997) were recorded from the southern and western sections of the study area corresponding to 2229DB (Mopane), 2229BD (Kamkusi) and 2230CA (Thipise). Those areas with high reporting rates were utilised by the Kori Bustard (*Ardeotis kori*), followed by the Verreaux's Eagle (*Aquila verreauxii*), Southern Ground Hornbill (*Bucorvus leadbeateri*) and Secretary bird (*Sagittarius serpentarius*).

According to Figure 18, Alternative 1 is the most sensitive alignment due to the high reporting rates recorded for conservation important species along this alignment. It is

in these areas where proper mitigation actions to reduce collisions or disturbances (through the loss of habitat) are required. However, richness (concerning species of conservation concern) is inversely proportional to an increase in reporting rates. Therefore, areas with high reporting rates for taxa of conservation concerns appear to hold fewer species of conservation concern (see also Figure 17).

Non-threatened species

A number of other bird species are also likely to be affected by the proposed transmission line and include species such as the White Stork (*Ciconia ciconia*), African Woolly-necked Stork (*Ciconia microscelis*), African Openbill (*Anastomus lamelligerus*), African Fish-eagle (*Haliaeetus vocifer*), Brown Snake-eagle (*Circaetus cinereus*), Black-chested Snake-eagle (*Circaetus pectoralis*) and a number of waterbird species pertaining to the Anatidae (ducks and geese), Phalacrocoracidae (cormorants), Anhingidae (darters), Ardeidae (herons and egrets) as well as Threskiornithidae (ibises).

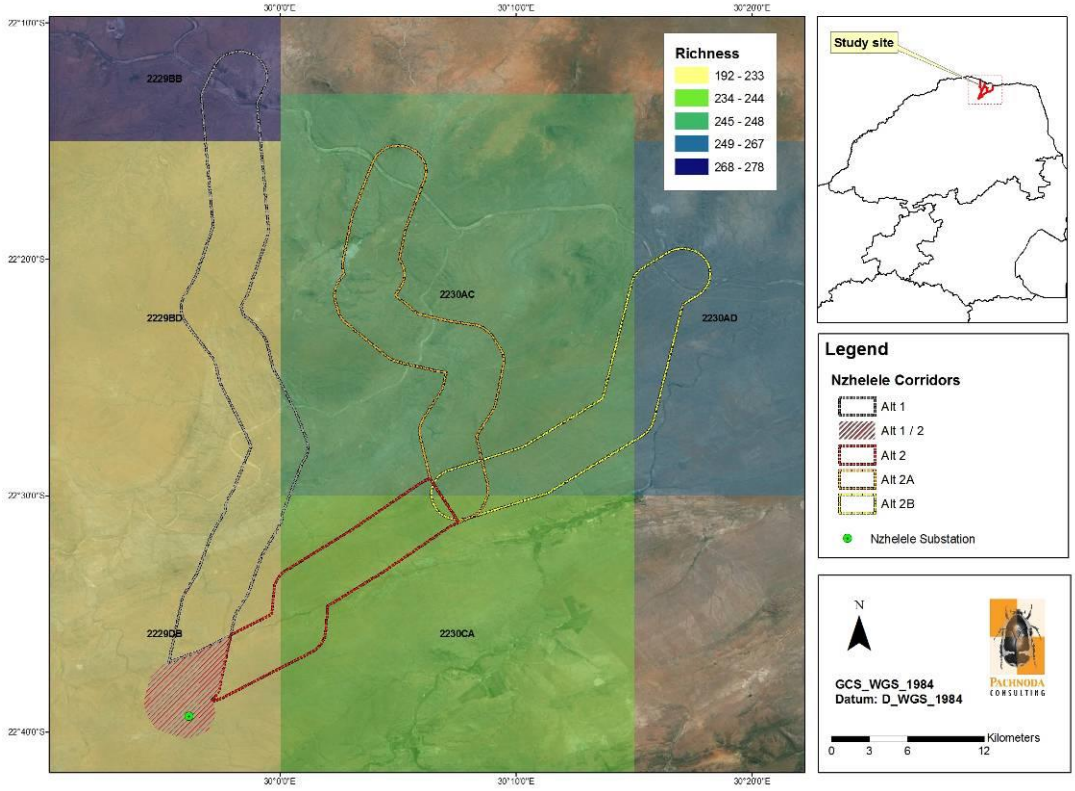

Figure 17: A spatial presentation of the mean bird species richness recorded from the quarter degree squares on the study area (according to Harrison *et al*., 1997).

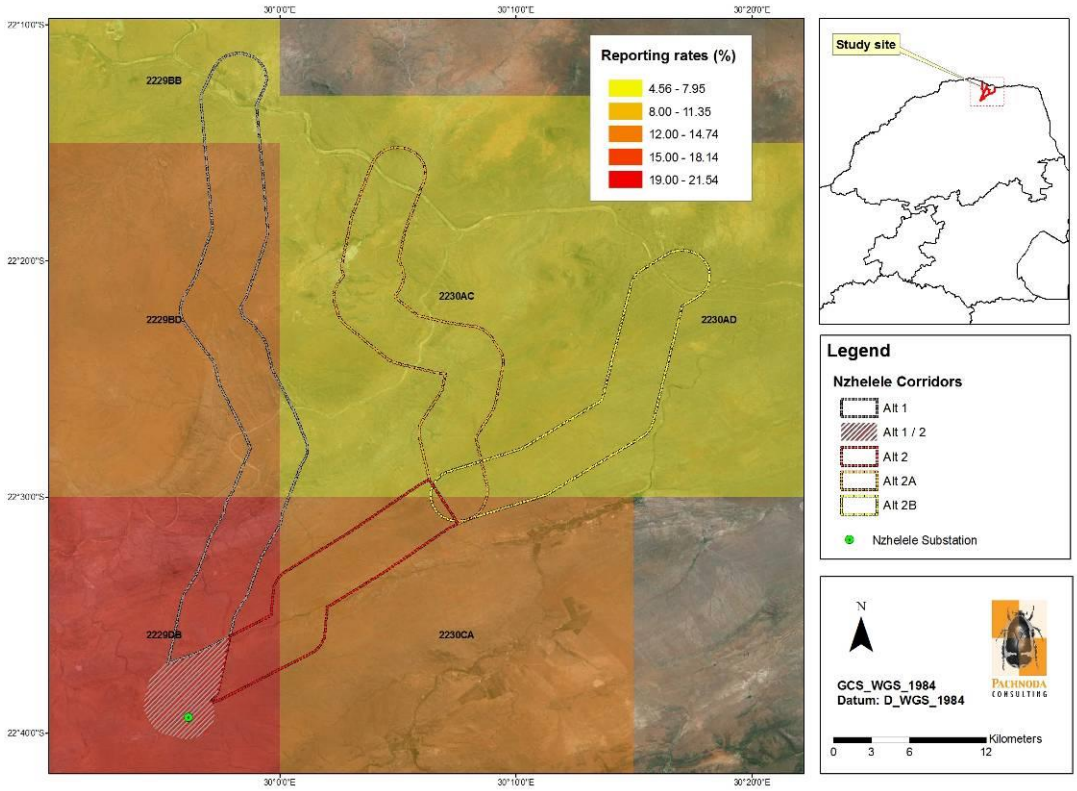

Figure 18: A spatial presentation of the mean reporting rates (%) for Red listed bird taxa recorded from the quarter degree squares on the study area.

Table 5: The average reporting rates (%) for Red listed species (IUCN, 2014; Taylor, *in press*) and species with a high probability to interact with power lines that are present in six quarter degree grids corresponding to the study area. CE – Critically Endangered, EN - Endangered, V- Vulnerable and NT – Near-threatened *.

QDGC	Global Status	Regional Status	2229BB	2229BD	2229DB	2230AC	2230CA	2230AD
Species			**Beitbridge**	**Kamkusi**	**Mopane**	**Musina**	**Thipise**	**Esmefour**
Great White Pelican (*Pelecanus onocrotalus*)	-	V	3					3
Pink-backed Pelican (*Pelecanus rufescens*)	-	V	6					
White-backed Night-heron (*Calherodius [Gorsachius] leuconotus*)	-	V						3
African Openbill (*Anastomus lamelligerus*)	-	-						3
Yellow-billed Stork (*Mycteria ibis*)	**-**	**EN**		**8**		**2**		**9**
White Stork (*Ciconia ciconia*)	-	-	2	1	2		2	2
African Woolly-necked Stork (*Ciconia microscelis*)	-	-						1
Black Stork (*Ciconia nigra*)	**-**	**V**	**3**			**5**		**9**
Abdim's Stork (*Ciconia abdimii*)	**-**	**NT**	**3**		**14**	**2**	**6**	
Saddle-billed Stork (*Ephippiorhynchus senegalensis*)	**-**	**EN**	**6**					**6**
Marabou Stork (*Leptoptilos crumeniferus*)	**-**	**NT**	**10**			**2**		
Greater Flamingo (*Phoenicopterus ruber*)	-	NT	3					
Lesser Flamingo (*Phoeniconaias minor*)	NT	NT	3					
Secretarybird (*Sagittarius serpentarius*)	**V**	**V**		**8**	**29**	**2**		
African White-backed Vulture (*Gyps africanus*)	EN	EN	3	8	21			3
Cape Vulture (*Gyps coprotheres*)	V	EN		8	21			
White-headed Vulture (*Trigonoceps occipitalis*)	V	EN		8				
Lapped-faced Vulture (*Torgos tracheliotus*)	V	EN			21			
Verreaux's Eagle (*Aquila verreauxii*)	-	V	6			31	13	
Tawny Eagle (*Aquila rapax*)	-	EN	3		7	7	6	15
Martial Eagle (*Polemaetus bellicosus*)	V	EN	6	8	21	11		6
Bateleur (*Terathopius ecaudatus*)	NT	EN			29	2	6	3
Pallid Harrier (*Circus macrourus*)	NT	NT				2	6	
Lanner Falcon (*Falco biarmicus*)	-	V	10		7	7	6	6

QDGC	Global Status	Regional Status	2229BB	2229BD	2229DB	2230AC	2230CA	2230AD
Species			**Beitbridge**	**Kamkusi**	**Mopane**	**Musina**	**Thipise**	**Esmefour**
Kori Bustard (*Ardeotis kori*)	**NT**	**NT**	**3**	**62**	**50**	**13**	**31**	**15**
Greater Painted Snipe (*Rostratula benghalensis*)	-	V	6			2		3
Chestnut-banded Plover (*Charadrius pallidus*)	NT	NT	3					
European Roller (*Coracias garrulus*)	NT	NT	3	8	29	15	38	15
Southern Ground Hornbill (*Bucorvus leadbeateri*)	**V**	**EN**		**8**	**29**			**12**
Average Reporting Rate			**4.56**	**12.7**	**21.54**	**7.36**	**12.67**	**6.71**
Total Richness			**18**	**10**	**13**	**14**	**9**	**17**

* Species highlighted in **red** are critically endangered or endangered, and very susceptible to habitat transformation and disturbance.
Species highlighted in **black bold** are especially vulnerable to power line collision.
Total values in red refer to QDGs with a high relative abundance of Red Listed species.

3.8.3 Bird species likely to be impacted: Current perspective (SABAP2 & personal observations)

Richness

Recently acquired data (according to SABAP2, personal observations and the 2011 counts by the Danish Nature Council at Maremani Nature Reserve) of the study area clearly illustrates that high richness values for bird species were obtained from the extreme north-western (Alternative 1) and eastern (Alternative 2B) parts (Figure 19). It is evident that high richness values were obtained from habitat corresponding to Alternative 2B[6] (pentad 2220_3015) and from Alternative 1[7] (pentad 2210_2955). The lowest richness[8] of 11 species was recorded from the southern section of the study site (pentad 2240_2955).

Threatened and Near-threatened Species

The highest frequency of threatened and near-threatened species was observed from Alternative 1 and Alternative 2B (according to SABAP2, personal observations and the 2011 counts by the Danish Nature Council at Maremani Nature Reserve) (Figure 20). Low frequencies were observed from the southern parts of the study area corresponding to Alternative 2 (in particular Alternative 2A). Most of the species occur along the Limpopo, Sand and the Nzhelele Rivers.

The most frequently observed species include the near-threatened European Roller (*Coracias garrulus*), a Palaearctic summer visitor (Figure 21). Other prominent threatened and near-threatened species include the regionally endangered Southern Ground-hornbill (B*ucorvus leadbeateri*), the endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*), the vulnerable Verreaux's Eagle (*Aquila verreauxii*), the endangered Tawny Eagle (*Aquila rapax*) and the endangered Bateleur (*Terathopius ecaudatus*).

[6] The highest number recorded per pentad was 160 species.

[7] The highest number recorded per pentad was 141 species.

[8] The pentad grids 2215_3015 and 2220_2955 have not yet been surveyed during the SABAP2 period.

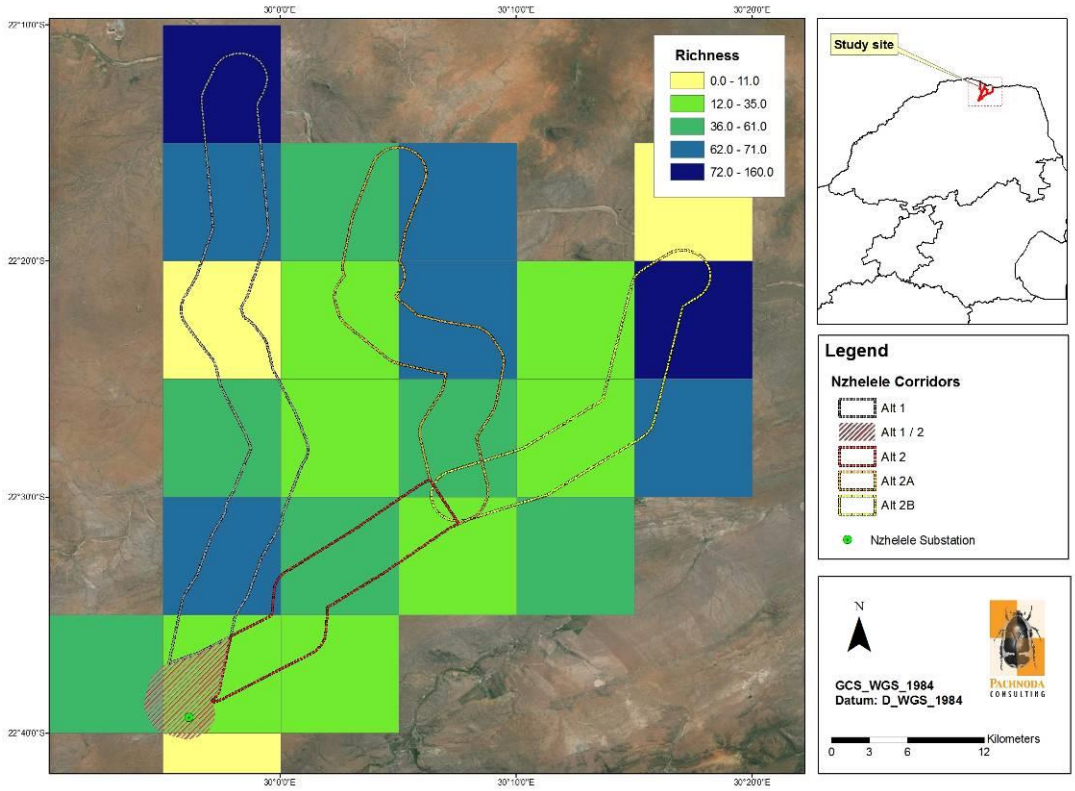

Figure 19: A spatial presentation of the bird species richness recorded from 23 pentad grids on the study area (according to SABAP2).

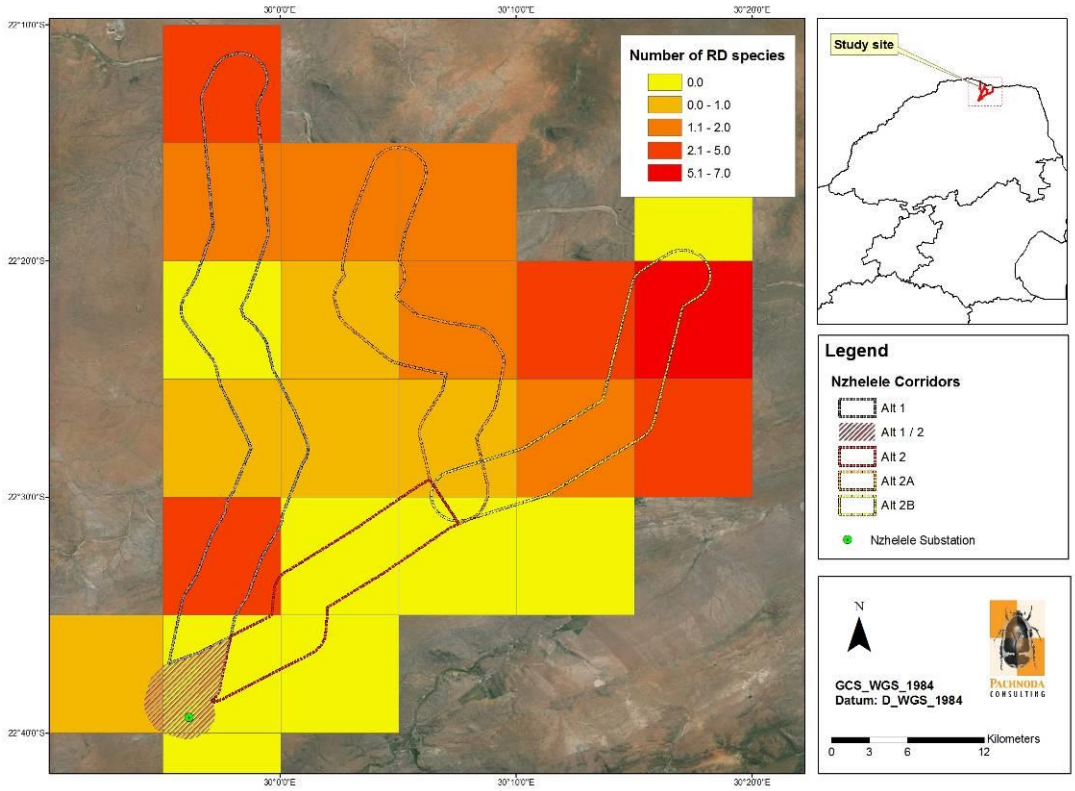

Figure 20: A spatial presentation of observed frequencies (%) for Red listed bird taxa recorded from pentad grids on the study area (according to SABAP2, personal observations obtained during the site visits and the 2011 counts from Maremani Nature Reserve).

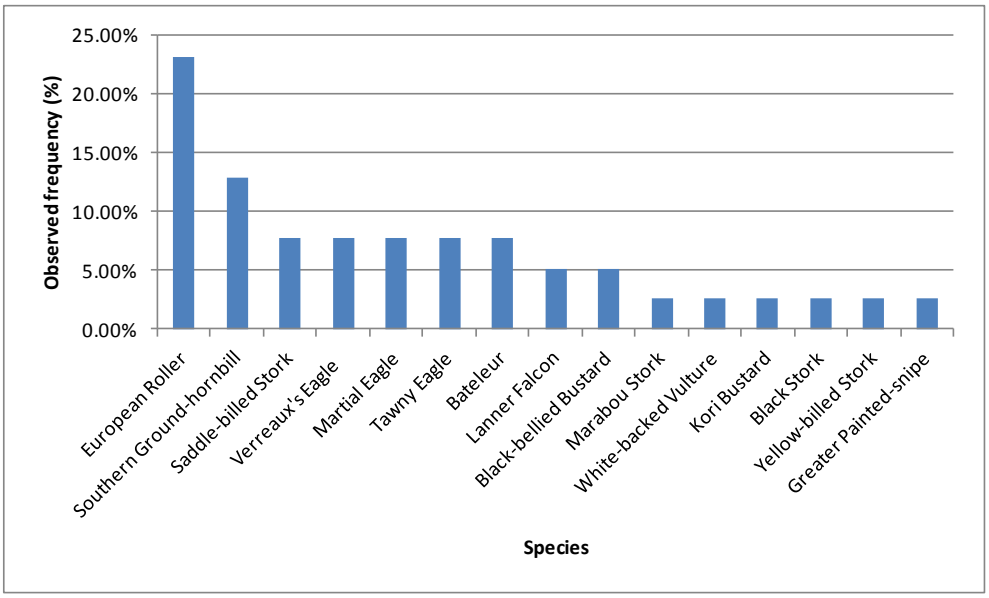

Figure 21: The frequency of observed threatened and near-threatened birds on the study area.

3.8.4 Regional dominant and rarity (low abundance species)

The dominant (typical) species on the study site are presented in Table 6. Only those species that cumulatively contributed to more than 90% of a similarity analysis (using SIMPER of the software package PRIMER) are presented. It is evident that the dominant composition is insensitive towards habitat type and structure, and includes many granivore taxa. The dominance of these taxa is best explained by their affinity to waterholes, since most of these taxa are frequently observed near surface water (many seed-eating species require daily intake of water). These taxa are also secondary species and will often be present in localised areas of disturbances as evidenced by the high densities observed within pioshpere of watering holes and sodic systems where game tend to congregate.

Table 6: The 10 most dominant bird species recorded on the study area (according to 2011 count data obtained from Maremani Nature Reserve).

Species	Average abundance	Consistency	Percentage Contribution
Cape Turtle Dove (*Streptopelia capicola*)	10.17	1.84	14.03
Laughing Dove (*Spilopelia senegalensis*)	10.21	1.32	10.43
European Swallow (*Hirundo rustica*)	21.21	0.80	7.35
Southern Grey-headed Sparrow (*Passer diffuses*)	3.17	0.93	6.98
Cinnamon-breasted Bunting (*Emberiza tahapisi*)	2.79	0.82	6.30
Emerald-spotted Wood-Dove (*Turtur chalcospilos*)	1.46	0.72	4.49
Golden-breasted Bunting (*Emberiza flaviventris*)	1.29	0.67	3.83
Yellow-fronted Canary (*Crithagra mozambica*)	2.38	0.59	3.78
Southern Yellow-billed Hornbill (*Tockus leucomelas*)	1.13	0.68	3.45
Blue Waxbill (*Uraeginthus angolensis*)	2.67	0.54	2.87
Red-billed Quelea (*Quelea quelea*)	13.63	0.41	2.50

Table 7 lists the “rare” species with low abundance values on the study site. Many of these species were only recorded once during the point count surveys. However, the majority are widespread, but occur naturally at low densities.

Table 7: The low abundant (rare) species on the study site with contributions of < 0.05 %.

Species	Habitat preference
Purple Indigo bird (*Vidua purpurascens*)	Open areas near waterholes
Red-headed Finch (*Amadina erythrocephala*)	Open areas near waterholes
Zitting Cisticola (*Cisticola juncidis*)	Open savannoid grassland
Black-chested Prinia (*Prinia flavicans*)	Arid bushveld (microphyllous)
Crimson-breasted Shrike (*Laniarius atrococcineus*)	Arid bushveld (microphyllous)
Grey-headed Bush-Shrike (*Malaconotus blanchoti*)	Tall mesophyllous bushveld/woodland

Species	Habitat preference
African Golden Oriole (*Oriolus larvatus*)	Tall mesophyllous bushveld/woodland
European Golden Oriole (*Oriolus oriolus*)	Tall mesophyllous bushveld/woodland/Mopane veld
Kurrichane Thrush (*Turdus libonyanus*)	Tall mesophyllous bushveld/woodland
Mocking Cliff-Chat (*Thamnolaea cinnamomeiventris*)	Wooded granite outcrops
Grey Penduline-Tit (*Anthoscopus caroli*)	Tall mesophyllous bushveld/woodland
Marsh-Warbler (*Acrocephalus [Notiochichla] palustris*)	Thickets
African Hoopoe (*Upupa africana*)	Varied
Greater Honeyguide (*Indicator indicator*)	Varied
Black-collared Barbet (*Lybius torquatus*)	Varied/partial to dead trees
Yellow-fronted Tinkerbird (*Pogoniulus chrysoconus*)	Varied/partial to dead trees
Cardinal Woodpecker (*Dendropicos fuscescens*)	Varied/partial to dead trees
Golden-tailed Woodpecker (*Campethera abingoni*)	Varied/partial to dead trees
Lesser Striped Swallow (*Cercropis abyssinica*)	Varied/partial to dead trees
African Wood-Owl (*Strix woodfordii*)	Dense riparian woodland
African Scops-Owl (*Otus senegalensis*)	Woodland/bushveld
Common Sandpiper (*Actitis hypoleucos*)	Wetland features
Greater Painted-Snipe (*Rostratula benghalensis*)	Wetland features
Reed Cormorant (*Microcarbo africanus*)	Wetland features
Hamerkop (*Scopus umbretta*)	Wetland features
African Fish-Eagle (*Haliaeetus vocifer*)	Wetland features
Brown Snake-Eagle (*Circaetus cinereus*)	Varied
Tawny Eagle (*Aquila rapax*)	Varied/partial to game management areas
Gabar Goshawk (*Melierax gabar*)	Arid microphyllous woodland (open structure)

A significant proportion of low abundance species include taxa that are widespread, but restricted to certain habitat types that are localised/patchy on the study area. These habitat types are patchy in the landscape and have a "density-dependant" effect on their numbers. For example, some of the barbets, tinkerbirds, woodpeckers and their brood parasites, the honeyguides, are partial to dead trees, which provide nesting habitat. Other taxa are partial to shoreline habitat while the birds of prey occupy large home ranges and are therefore a sampling artefact, since they are less conspicuous during the surveys.

3.8.5 Community structure and composition

A cluster analysis[9] of the bird abundance values suggests three distinct assemblages based on the presence of outcrops and the seasonality of "wetland-associated" features (Figure 22). The main avifaunal assemblages on the study site are as follow (according to a clustering ordination - Figure 22):

1. *An assemblage confined to (semi-)perennial drainage lines and large impoundments (dams)*: This assemblage is confined to structures or geo-

[9] The ordination was performed using Hierarchical Agglomerative Clustering after the data was converted to Bray-Curtis similarity coefficients.

morphological features holding surface water, often for longer periods to enable the colonisation of fish prey and many have a well defined shoreline habitat which are frequented by shorebird and wading bird taxa. Typical species include Cape Turtle Dove (*Streptopelia capicola*), European Swallow (*Hirundo rustica*), Red-billed Quelea (*Quelea quelea*), Woodland Kingfisher (*Halcyon senegalensis*) and African Palm-swift (*Cypsiurus parvus*).

Indicator species (species mainly restricted to this assemblage) include waterbird taxa such as Egyptian Goose (*Alopochen aegyptiaca*), Pied Kingfisher (*Ceryle rudis*), Three-banded Plover (*Charadrius tricollaris*), Wood Sandpiper (*Tringa glareola*), Green-backed Heron (*Butorides striatus*) and Common Sandpiper (*Actitis hypoleucos*). Other noteworthy taxa include Meve's Starling (*Lamprotornis mevesii*) and Burchell's Coucal (*Centropus burchellii*).

2. *An assemblage confined to the dominant bushveld/woodland types on flat topographies (surrounding waterholes)*: It is characterised by a high richness of bird species and is particularly well-represented by granivores pertaining to the Cape Turtle Dove (*S. capicola*), Laughing dove (*Spilopelia senegalensis*), Golden-breasted Bunting (*Emberiza flaviventris*), Southern Grey-headed Sparrow (*Passer diffuses*), Yellow-fronted Canary (*Crithagra mozambica*), Cinnamon-breasted Bunting (*E. tahapisi*) and Emerald-spotted Wood Dove (*Turtur chalcospilos*).

Indicator species include the Spotted Flycatcher (*Muscicapa striata*), Chinspot Batis (*Batis molitor*), Fork-tailed Drongo (*Dicrurus adsimilis*), Red-crested Bustard (*Lophotis ruficrista*), Brubru (*Nilaus afer*), Common Scimitarbill (*Rhinopomastus cyanomelas*), Double-banded Sandgrouse (*Pterocles bicinctus*), Red-billed Oxpecker (*Buphagus erythrorhyncha*) and the near-threatened European Roller (*Coracias garrulus*).

3. *An assemblage confined to granite and sandstone ridges and outcrops*: This assemblage is typified by rupicolous taxa such as the Cinnamon-breasted Bunting (*E. tahapisi*) and Mocking Cliff-chat (*Thamnolaea cinnamomeiventris*) and wide-ranging and migratory taxa such as the European Bee-eater (*Merops apiaster*) and European Swallow (*H. rustica*). It is also a favourite foraging habitat for medium-sized birds of prey, which include the Black-breasted Snake-eagle (*Circaetus pectoralis*) and the Lesser Spotted Eagle (*Clanga [Aquila] pomarina* - a passage migrant to the area).

Indicator species include the Dusky Lark (*Pinarocorys nigricans*), Southern Carmine-Bee-eater (*Merops nubicoides* - a passage migrant), Booted Eagle (*Hieraaetus [Aquila] pennatus*), Verreaux's Eagle (*Aquila verreauxii*) and the Brown Snake-eagle (*Circaetus cinereus*).

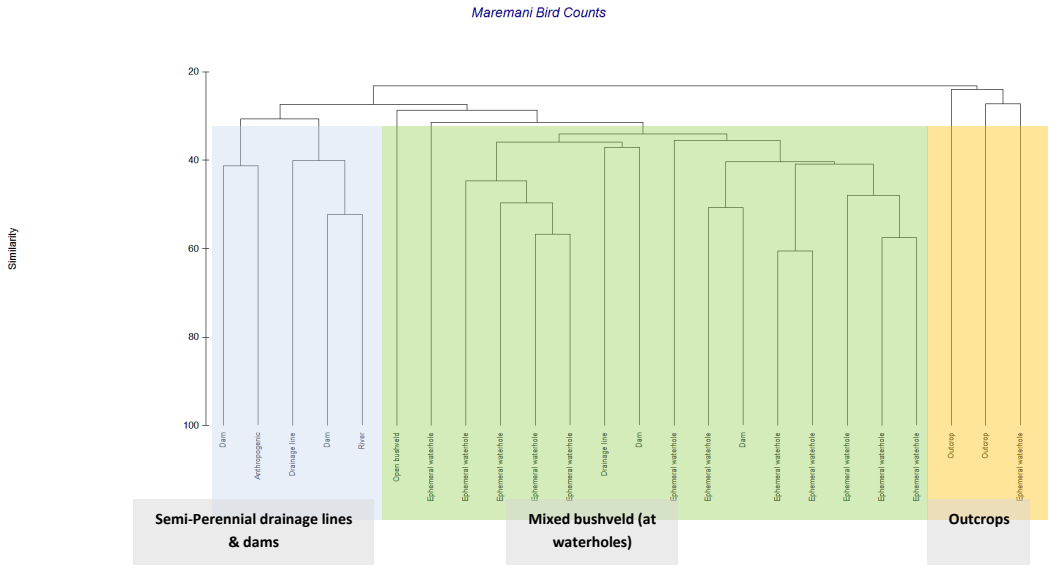

Figure 22: A dendrogram based on hierarchical agglomerative clustering of the abundance values of bird species on the study area.

3.8.6 Bird impacts

Potential bird impacts regarding transmission lines comprise of electrocution, collision and disturbances caused during the construction and maintenance of transmission lines. These were discussed in some detail earlier on in this report. A summary table of impacts are provided under Appendix 2.

- *Electrocution*

It is recommended from an avifaunal perspective that the “cross-rope suspension” type be implemented for the proposed line. This design poses little electrocution risk due to the large clearances between the live components and the earth wires. Electrocution by means of bird streaming is also less likely to occur due to an absence of suitable perching areas above the conductors. The main risk associated with this design is collision.

- *Collision*

The following bird species, based on the availability of habitat types and their densities in the area, could potentially collide with the earth wires of the proposed transmission line:

- *Arid woodland/bushveld*: Kori Bustard, Martial Eagle, Bateleur, Tawny Eagle, White-backed Vulture, Lappet-faced Vulture (rare), Red-crested Bustard, Helmeted Guineafowl, Wahlberg's Eagle, Southern Ground-hornbill, Secretary bird and other large birds of prey (e.g. snake-eagles);

- *Secondary woodland and fallow (arable land)*: Black-headed Heron, White Stork, Abdim's Stork, Kori Bustard, Secretary bird, Egyptian Goose and Spur-winged Goose;
- *River/Stream and drainage line crossings*: African Fish Eagle, Saddle-billed Stork, Black Stork, Woolly-necked Stork, African Openbill, Yellow-billed Stork, Marabou Stork including a number of wading birds (herons, storks), waterfowl (Egyptian Goose and anatid ducks) and waterbirds such as cormorants, darters and ibises;
- *Impoundment crossings*: African Fish Eagle, African Openbill, Black Stork, Yellow-billed Stork, Marabou Stork, Woolly-necked Stork and a variety of other waterbird species such as ducks and geese, cormorants, darters, ibises, coots, kingfishers and herons; and
- *Granite and sandstone outcrops*: Verreaux's Eagle, Lanner Falcon, Booted Eagle, Brown Snake-eagle, Black-breasted Snake-eagle and Lesser Spotted Eagle.

- *Loss of habitat*

Habitat destruction is not considered to be a major impact since many of the bird species will temporarily vacate the area during the construction phase. It is inevitable that most bird taxa (including the smaller passerine) species will be affected by road construction, the construction of pylons and stringing operations. However, the impact is considered to be severe within or in close proximity of dams, rivers, streams and tall woodland could displace large bodied bird species (especially if these are breeding in the proximal vicinity - *c*. 100 m):

- All foraging and breeding large-bodied terrestrial bird taxa and birds of prey as well as hole-nesting bird taxa (in the event that dead trees are to be removed).

- *Disturbances caused by construction/decommissioning activities and maintenance of the transmission line*

It is inevitable that disturbances during construction and maintenance will occur. *These will especially be significant near or in close proximity of foraging or breeding large-bodied terrestrial bird taxa and birds of prey.* Although it is not anticipated to pose a significant impact on bird species, special care should also be exercised during the crossing of dams, rivers and stream, including tall woodland (e.g. woodland dominated by tall trees such as *Adansonia digitata* and dense riparian woodland with tall canopy constituents) to prevent unnecessary disturbances caused to potential breeding and roosting species.

3.9. Ecological sensitivity

A sensitivity map was compiled, illustrating areas comprising of potential sensitive elements based on the following arguments (Figure 23):

Areas of high ecological sensitivity

- *Extensive (contiguous) natural woodland units with open canopy and poorly developed field layer*: A large part of the study area is characterised by arid woodland dominated by *Colophospermum mopane* or mixed *Commiphora* woodland, which support high reporting rates for large terrestrial bird species (in particular the vulnerable Secretarybird *Sagittarius serpentarius*, near-threatened Kori Bustard *Ardeotis kori* and endangered Southern Ground-hornbill *Bucorvus leadbeateri*). These species are invariably susceptible to power line mortalities;
- *Large conservation areas and natural preserves*: These areas provide refuge for a high richness of mammal species, including large non-ruminant herbivores and apex predators. The presence of game is a mutual attractant for large-bodied scavengers (e.g. vulture taxa, endangered Tawny Eagle *Aquila rapax* and endangered Bateleur *Terathopius ecaudatus*) to the area;
- *Prominent topographical features (>600m amsl)*: These include isolated ridges and hills which, based on their high spatial heterogeneity and shallow rocky soils, provide habitat for a number of rupiculous taxa. In addition, these areas provide critical important foraging habitat for the vulnerable Verreaux's Eagle (*Aquila verreauxii*) and Lanner Falcon (*Falco biramicus*). In addition, anecdotal observations (according to point count data) showed that the ridges are utilised as important dispersal corridors for Palaearctic migratory birds (when on passage);
- *Tall canopy constituents* (e.g. *Adansonia digitata*): These provide optimal breeding, hunting and roosting platforms for birds of prey species;
- *Presence of large river systems, drainage lines and manmade dams*: These habitat types provide ephemeral foraging habitat for a large number of stork species (all prone to collisions with earth wires, especially the endangered Saddle-billed Stork *Ephippiorhynchus senegalensis*), while the linear configuration of the rivers and drainage lines facilitate animal dispersal across the landscape.

Areas of medium-high ecological sensitivity

- *Arable land and cultivated land*: These areas often attract numbers of foraging stork taxa and large-bodied anatids (geese). Any placement of a transmission line proximal to these habitat types could increase the

probability of bird collisions with overhead cables. In addition, this habitat often attracts foraging Secretarybirds and bustards when left fallow.

Areas of medium ecological sensitivity

- These areas refer to short, dense bushveld which is often less suitable as foraging habitat for large terrestrial birds and mammal species. These areas are in general widespread in the region.

Areas of low ecological sensitivity

- These areas are not considered to be pristine and occurred on areas where severe habitat transformation took place;
- Many of these areas are composed of built-up land and provide habitat for invader taxa, thus contributing little towards local biodiversity; and
- The vegetation assemblages are at an advanced state of degradation and will seldom (if ever) revert back to that of a late-successional unit that typifies the regional vegetation types.

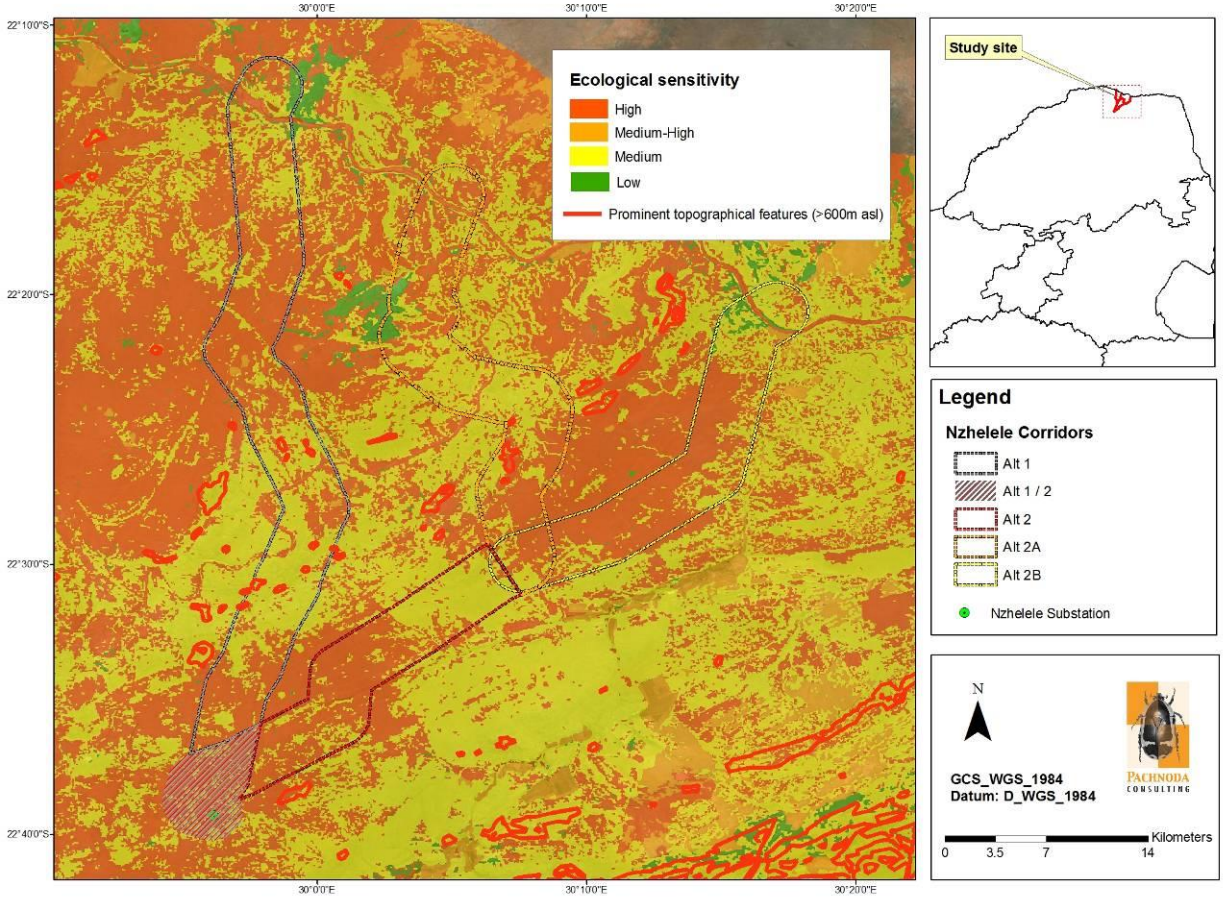

Figure 23: A map illustrating the preliminary ecological sensitivity of the area based on habitat types which is perceived to support high faunal richness and habitat for bird species prone towards power line collisions.

3.10 Analysis of proposed alternatives & an opinion regarding the feasibility of the project (as per Appendix 6)

As per Appendix 6 of the Environmental Impact Assessment Regulations of 2014 (No. R. 982) of the National Environmental Management Act (Act No. 107 of 1998) a reasoned opinion should be provided as to whether the proposed activity or portions thereof should be authorised:

3.10.1 Analysis of alternatives

It should be borne in mind that the current sensitivity map (Figure 23) shows a large surface area that is earmarked as sensitive woodland. This is based on information as provided by the national land cover dataset (2000 & 2009) and personal observations. Nevertheless, not all of this woodland/bushveld habitat was evaluated during the site visits (see limitations). It is unlikely that all of these woodland/bushveld units are pristine due to current habitat modifications or poor habitat management. Therefore, it is expected that some of these woodland and bushveld units represent secondary (transformed) compositions.

From a bird impact perspective, for any corridor to be regarded as a suitable candidate it must (a) traverse the least number of vegetation types, in particular vegetation in pristine condition, (b) traverse the least number of wetland/drainage lines/rivers (c) correspond to an area with low reporting rates for bird species considered to be threatened or “near-threatened” (in this case referring to areas with low occurrence of large terrestrial bird taxa, bird of prey and stork taxa), and (d) follow existing servitudes (or transmission lines).

In summary, the three corridors correspond to an area that is well known for its high diversity of avifauna and mammal taxa consisting of many threatened and near-threatened species. More importantly, the study area is known for the high density of storks and birds of prey, and it is apparent that Alternative 1 and alternative 2B will have more eminent impacts when compared to Alternative 2A. *The low(er) occurrence (according to mean reporting rates) of threatened and near-threatened birds and the presence of a higher volumes of road traffic (e.g. R508) alongside the proposed corridor, renders Alternative 2A as the “better” option when compared to the other corridors.*

It is also evident from the sensitivity analysis (and dominant land cover) that Alternative 2B (and Alternative 1) is the least preferred corridor. Therefore, Alternative 2A is "better suited" since it comprehends a larger surface area of transformed habitat and is positioned in close proximity to existing road infrastructure (please note that it is only feasible if the proposed power line servitude strives to avoid prominent ridge habitat).

3.10.2 Additional proposed servitude

Figure 24 illustrates an additional proposed servitude, which coincides with Alternative 1 and Alternative 2A. It basically runs parallel to an existing power line, which will increase the visibility of the line, thereby reducing any potential bird collisions with overhead cables. The servitude is also recommended since many of the proposed impacts are existing and are "clustered" together while the servitude is traversing less areas of sensitive habitat. In summary, the proposed servitude will traverse land that is historically transformed.

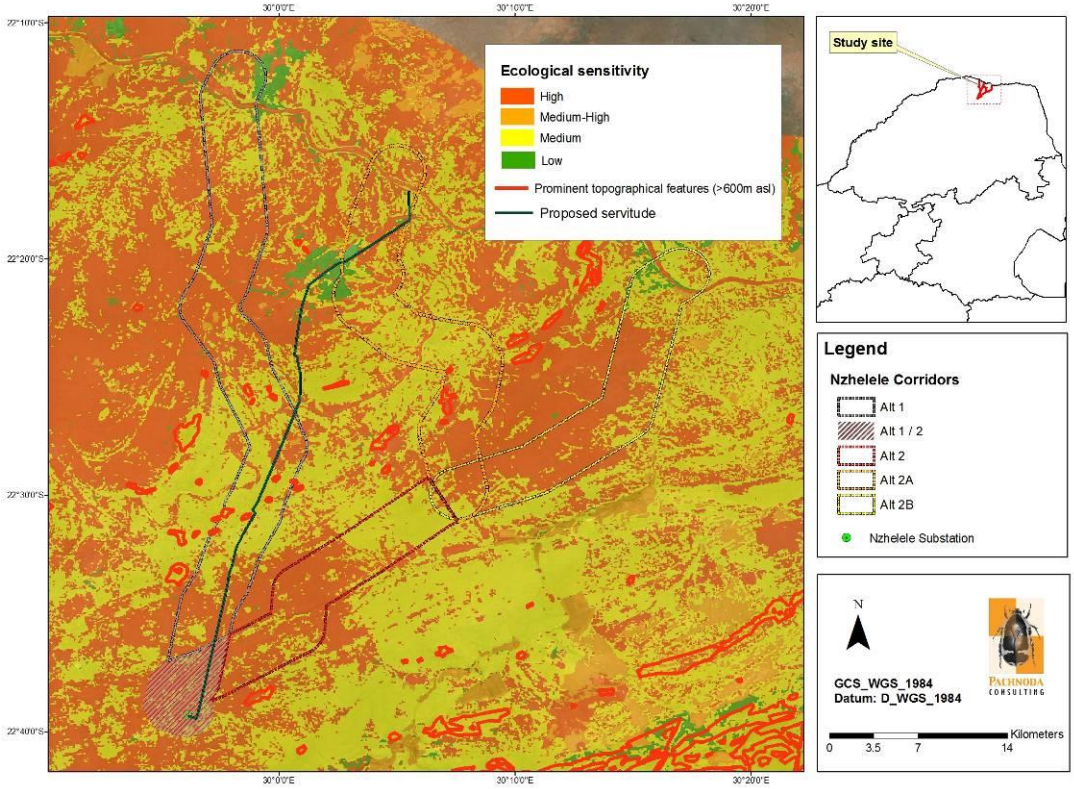

Figure 24: A map illustrating an additional servitude for consideration.

3.11 Recommendations & mitigation measures

As a general rule the following recommendations should be taken into consideration by the engineers and civil planning units when the actual power line servitude is established within the proposed feasible corridor:

1. Where possible the servitude should aim to cross the least number of drainage lines, rivers and streams;
2. Where possible, the direct crossing of any dam, impoundment, depression, reservoir or waterhole should be avoided;
3. Where possible, the direct crossing of any ridge, mountain or "koppie" should be avoided;

4. River/stream and drainage lines crossing should be perpendicular to the natural channel of the river/stream/drainage line;
5. The servitude should be positioned 200 m or more from any dam, impoundment or semi-perennial river/stream with the ability to hold surface water for most of the year; and
6. The servitude should be positioned 100 m or more from any waterhole (used by game) or smaller drainage lines (intermittent or non-perennial drainage lines that are dry for most of the year).

3.11.1 Avifauna

There are many ways to ameliorate or mitigate bird impacts imposed by power line interactions. Probably the best way is to proactively avoid areas where the potential for bird interaction is evident by means of subsequent route deviations or modifications. However, route deviations are not always financially plausible unless significant bird mortalities or habitat destruction is inevitable. An option to overcome bird collisions is to replace overhead lines with underground cables. This method does come at a huge expense, and construction activities could irreparably damage sensitive habitat types. It is also more time-consuming to repair faults on underground *versus* overhead cables.

The following obligatory recommendations are applicable to the project area, and only if a Record of Decision for Alternative 2B is issued by the authorities:

1. A “walk-through” of the selected route must be conducted prior to the construction phase:
    - The ”walk-through” will aim to identify areas where marking of lines by means of “deterrent devices” is considered to be beneficial or compulsory;
    - All river/stream and drainage line crossings should by default be marked;
    - Where the line crosses a wetland/river, the actual crossover span as well as one span on either side of the wetland/river/ should be marked;
    - Marking devices to be used should include large Double Loop Bird Flight Diverters; and
    - All devices should be applied in a staggered fashion to the phase while alternating between black and white diverters. The maximum distance between the diverters should not exceed 5 m.

2. Mandatory measures to be implemented during the construction phase:
    - All construction sites must be confined to disturbed areas or those identified with low conservation importance. All construction sites must be demarcated on site layout plans (preferably), and no construction personnel or vehicles may leave the demarcated area except those authorised to do so. Those

areas surrounding the construction sites that are not part of the demarcated development area should be considered as “no-go” areas for employees, machinery or even visitors;

- A natural buffer zone (to be announced by the wetland specialist) should be allowed between the line servitude and any wetland/river/stream or other sensitive habitat type;
- All road networks must be planned with care to minimize dissection or fragmentation of important avifaunal habitat type. Where possible, the use of existing roads is encouraged. Access must be determined during the “walk-through” process;
- The breeding status of threatened and near-threatened species corresponding to the servitude, in particular bustards and birds of prey should be evaluated prior to construction/decommissioning. If breeding is confirmed, the nest site must be barricaded and appropriately buffered (by at least 500 m). Construction/decommissioning activities shall only commence once the fledglings are successfully reared and has left the nesting site;
- It is recommended that the “cross-rope suspension” type tower be used for the proposed transmission line;
- Open fires is strictly prohibited and only allowed at designated areas; and
- Killing or poaching of any bird species should be avoided by means of awareness programmes presented to the labour force. The labour force should be made aware of the conservation issues pertaining to the bird taxa occurring on the study area. Any person found deliberately harassing any bird species in any way should face disciplinary measures, following the possible dismissal from the site.

3.11.2 Other fauna

The following obligatory recommendations are applicable to the project area, and only if a Record of Decision for Alternative 3 is issued by the authorities:

1. *A “walk-through” of the selected route must be conducted prior to the construction phase*:

    - The ”walk-through” will aim to identify areas where conservation-dependant species are likely to occur; and
    - When a threatened or near-threatened faunal species/population is identified, a route/pylon deviation is advised to minimise the interference of the servitude/pylon footprint on the respective faunal species/population.

2. Mandatory measures to be implemented during the construction and operational phases:

- The attached sensitivity map should be used as a decision tool to guide the layout design of the proposed development - all wetland areas (including man-made areas, rivers and streams), tall woodland with eminent canopy

constituents, ridges and outcrops (irrespective of their surface area) are regarded as sensitive habitat units;

- The construction of “new” access roads should be limited, and existing roads should be used during the construction phase. It is suggested that the construction of roads be avoided and that all access roads be limited to "tracks";
- The extent of the construction sites and access roads should be demarcated on site layout plans and should be restricted to disturbed areas or those identified with low conservation importance. Therefore, no construction personnel or vehicle may leave the demarcated area except those authorised to do so. Those areas surrounding the construction site that are not part of the demarcated development area should be considered as “no-go” areas for employees, machinery or even visitors;
- Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of eroded areas should be undertaken;
- Open fires is strictly prohibited and only allowed at designated areas;
- Harvesting of firewood or any plant material (for medicinal or cultural purpose) during the construction phase is strictly prohibited. Labour or personnel shall only assist with the removal of plant matter if requested to do so by the ECO;
- Hunting/snaring is strictly prohibited. Any person found hunting or in the possession of any indigenous animal (including invertebrate taxa) should face disciplinary measures, following the possible dismissal from the site;
- Intentional killing of any faunal species (in particular invertebrates and snakes[10]) should be avoided by means of awareness programmes presented to the labor force. The labor force should be made aware of the conservation issues pertaining to the taxa occurring on the study area. Any person found deliberately harassing any animal in any way should face disciplinary measures, following the possible dismissal from the site;
- Potential dangerous game is present on many of the game farms and the awareness programme should include proper training of staff and personal regarding personal safety when working in environments where dangerous game/animals are present;
- If any subterranean/fossorial reptile, scorpion or mammal species is recovered during the construction phase, this species must be relocated to the nearest area or natural open space with suitable habitat for the particular species to continue its life history. If accidentally killed, then this species should be adequately preserved as a “voucher” specimen (with the assistance and knowledge of the ECO). These specimens may contribute towards a better understanding of biogeography and animal systematics; and
- All construction activities must be limited to daylight hours.

[10] The study area is home to some very large specimens of South African Pythons (Python natalensis). These specimens are old and occupy discrete home ranges. However, they are often also killed since they are valued for muthi.

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5. APPENDICES

Appendix 1: Fauna impact table and description of impact ratings.

The construction impacts associated with the proposed alignment corridors are detailed in the table below:

Impact	Alternative	Management Measures	Magnitude	Scale	Duration	Probability	Significance	
Loss of important habitat (tall riparian woodland, outcrop habitat)	1	Without Management	High 8	Site 2	Medium term 3	Definite 5	65	High
		With Management	Medium 6	Local 1	Medium-term 3	Highly Probable 4	20	Low
	2A	Without Management	High 8	Site 2	Medium term 3	Highly Probable 4	65	High
		With Management	Medium 6	Local 1	Medium-term 3	Probable 2	20	Negligible
	2B	Without Management	High 8	Site 2	Medium term 3	Definite 5	65	High
		With Management	Medium 6	Local 1	Medium-term 3	Highly Probable 4	40	Low
Loss of threatened/near-threatened/protected taxa	1	Without Management	High	Local	Medium term	Highly probable		

			8	1	3	4	48	Moderate
		With Management	Medium 6	Local 1	Medium-term 3	Highly Probable 4	40	Low
	2A	Without Management	High 8	Local 1	Medium term 3	Probable 2	24	Low
		With Management	Medium 6	Local 1	Medium-term 3	Probable 2	20	Negligible
	2B	Without Management	High 8	Local 1	Medium term 3	Highly probable 4	48	Moderate
		With Management	Medium 6	Local 1	Medium-term 3	Highly Probable 4	40	Low
Disturbances	1	Without Management	High 8	Local 1	Medium term 3	Highly probable 4	48	Moderate
		With Management	Medium 6	Local 1	Medium-term 3	Highly Probable 4	40	Low
	2A	Without Management	High 8	Local 1	Medium term 3	Highly probable 4	48	Moderate
		With Management	Medium 6	Local 1	Medium-term 3	Highly Probable 4	40	Low

	2B	Without Management	High 8	Local 1	Medium term 3	Highly probable 4	48	Moderate
		With Management	Medium 6	Local 1	Medium-term 3	Highly Probable 4	40	Low
Loss of ecological function/dispersal corridors	**1**	Without Management	High 8	Regional 3	Long term 4	Definite 5	75	High
		With Management	Medium 6	Site 2	Long term 4	Highly Probable 4	48	Moderate
	2A	Without Management	High 8	Regional 3	Long term 4	Highly probable 2	30	Moderate
		With Management	Medium 6	Site 2	Long term 4	Probable 2	24	Low
	2B	Without Management	High 8	Regional 3	Long term 4	Definite 5	75	High
		With Management	Medium 6	Site 2	Long term 4	Highly Probable 4	48	Moderate
Hunting/snaring/poaching	**1**	Without Management	Medium 6	Local 1	Long term 4	Probable 2	22	Low
		With Management	Medium 6	Local 1	Medium-term 3	Probable 2	20	Negligible
	2A	Without Management	Medium 6	Local 1	Long term 4	Probable 2	22	Low

		With Management	Medium 6	Local 1	Medium-term 3	Probable 2	20	Negligible
	2B	Without Management	High 8	Local 1	Long term 4	Highly Probable 4	52	Moderate
		With Management	Medium 6	Local 1	Long term 4	Probable 2	22	Low

The operational impacts associated with the proposed alignment corridors are detailed in the table below:

Impact	Alternative	Management Measures	Magnitude	Scale	Duration	Probability	Significance	
Disturbances	**1**	Without Management	High 8	Local 1	Short term 1	Definite 5	50	Moderate
		With Management	Medium 6	Local 1	Short term 1	Highly Probable 4	32	Low
	2A	Without Management	Medium 6	Local 1	Short term 1	Highly Probable 4	32	Low
		With Management	Medium 6	Local 1	Short term 1	Probable 2	16	Negligible
	2B	Without Management	High 8	Local 1	Short term 1	Definite 5	50	Moderate
		With Management	Medium	Local	Short term	Highly Probable		

			6	1	1	4	32	Low
Maintenance of servitude (fire/composition shifts)	1	Without Management	High	Site	Long term	Highly Probable		
			8	2	4	4	56	Moderate
		With Management	Medium	Site	Long term	Probable		
			6	2	4	2	24	Low
	2A	Without Management	High	Site	Long term	Highly Probable		
			8	2	4	4	56	Moderate
		With Management	Medium	Site	Long term	Probable		
			6	2	4	2	24	Low
	2B	Without Management	High	Site	Long term	Highly Probable		
			8	2	4	4	56	High
		With Management	Medium	Site	Long term	Probable		
			6	2	4	2	24	Low
Hunting/snaring/poaching	1	Without Management	Medium	Local	Long term	Probable		
			6	1	4	2	22	Low
		With Management	Medium	Local	Medium-term	Probable		
			6	1	3	2	20	Negligible
	2A	Without Management	Medium	Local	Long term	Probable		
			6	1	4	2	22	Low
		With Management	Medium	Local	Medium-term	Probable		
			6	1	3	2	20	Negligible
	2B	Without Management	Medium	Local	Long term	Highly Probable		

	6	1	4	4	44	Moderate
With Management	Medium	Local	Long term	Probable		
	6	1	4	2	22	Low

Appendix 2: Bird impact table and description of impact ratings.

The overall bird impacts associated with the proposed alignment corridors are detailed in the table below:

Alternative 1 **Impact**	**Management Measures**	**Magnitude**	**Scale**	**Duration**	**Probability**	**Significance**	
Collision (operational only)	Without management	High 8	Regional 3	Long term 4	Definite 5	75	High
	With management	High 8	Regional 3	Long term 4	Highly Probable 4	60	Moderate
Loss of habitat & disturbance (construction & operational)	Without management	High 8	Site 2	Medium-term 3	Highly Probable 4	52	Moderate
	With management	Medium 6	Site 2	Medium-term 3	Probable 2	22	Low
Poaching of birds (construction & operational)	Without management	Medium 6	Site 2	Short term 1	Probable 2	18	Negligible
	With management	Medium 6	Local 1	Short term 1	Probable 2	16	Negligible
Alternative 2A **Impact**	**Management Measures**	**Magnitude**	**Scale**	**Duration**	**Probability**	**Significance**	
Collision (operational only)	Without management	High 8	Regional 3	Long term 4	Highly Probable 4	60	Moderate
	With management	High	Regional	Long term	Probable		

		8	3	4	2	30	Low
Loss of habitat & disturbance (construction & operational)	Without management	High	Site	Medium-term	Highly Probable		
		8	2	3	4	52	Moderate
	With management	Medium	Site	Medium-term	Probable		
		6	2	3	2	22	Low
Poaching of birds (construction & operational)	Without management	Medium	Site	Short term	Probable		
		6	2	1	2	18	Negligible
	With management	Medium	Local	Short term	Probable		
		6	1	1	2	16	Negligible
Alternative 2B							
Impact	**Management Measures**	**Magnitude**	**Scale**	**Duration**	**Probability**	**Significance**	
Collision (operational only)	Without management	High	Regional	Long term	Definite		
		8	3	4	5	75	High
	With management	High	Regional	Long term	Highly Probable		
		8	3	4	4	60	Moderate
Loss of habitat & disturbance (construction & operational)	Without management	High	Site	Long-term	Definite		
		8	2	4	5	70	High
	With management	Medium	Site	Medium-term	Highly Probable		
		6	2	3	4	44	Moderate
Poaching of birds (construction & operational)	Without management	Medium	Site	Short-term	Probable		
		6	2	1	2	18	Negligible
	With management	Medium	Local	Short term	Probable		
		6	1	1	2	16	Negligible

Impact Assessment Methodology

The impact methodology concentrates on addressing key issues. Activities within the framework of the proposed project give rise to certain impacts. For the purposes of assessing these impacts, the project has been divided into three phases from which impact activities can be identified, namely:

Construction phase

This phase is concerned with all the construction and construction related activities on site, until the contractor leaves the site. Thus, the main activities will be the establishment of construction camp sites, access routes, clearance of servitude to facilitate access, digging the foundations for towers, excavation of pits for transformer foundation, erection of transformer and associated structures, movement of construction workforce, equipment, construction vehicles and materials, etc. The above-mentioned activities result in different types of impacts and some contribute to cumulative impacts.

Operational phase

This phase involve activities that are post construction, i.e. the transmission of power between substations. This phase requires a rehabilitation plan and monitoring system that will ensure the impacts of construction, such as vegetation pruning, erosion, colonisation of area by alien species, etc. are monitored and inspected as an ongoing process. This involves the maintenance of the facilities to ensure continuous proper functioning of the equipment or resource

The impact rating enables the analysis of the impact results, in terms of:

1. The severity criteria applicable as an indicator of influence/ severity;
2. The changes in number of low, moderate and high ratings before and after mitigation, and
3. The changes in quantitative/weighted magnitude before and after mitigation.

Assessment Criteria

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need.

The significance of the aspects/impacts of the process will be rated by using a matrix derived from Plomp (2004) and adapted to some extent to fit this process. These matrices use the consequence and the likelihood of the different aspects and associated impacts to determine the significance of the impacts.

The significance of the impacts will be determined through a synthesis of the criteria below:

Probability: *This describes the likelihood of the impact actually occurring.*

- **Improbable:** The possibility of the impact occurring is very low, due to the circumstances, design or experience.
- **Probable:** There is a probability that the impact will occur to the extent that provision must be made therefore.
- **Highly Probable:** It is most likely that the impact will occur at some stage of the development.
- **Definite:** The impact will take place regardless of any prevention plans and there can only be relied on mitigatory measures or contingency plans to contain the effect.

Duration: *The lifetime of the impact.*

- **Short Term:** The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.
- **Medium Term:** The impact will last up to the end of the phases, where after it will be negated.

- **Long Term:** The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.
- **Permanent:** The impact is non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

Scale: *The physical and spatial size of the impact.*

- **Local:** The impacted area extends only as far as the activity, e.g. footprint.
- **Site:** The impact could affect the whole, or a measurable portion of the above mentioned properties.
- **Regional:** The impact could affect the area including the neighbouring residential areas.

Magnitude/ Severity: *Does the impact destroy the environment, or alter its function.*

- **Low:** The impact alters the affected environment in such a way that natural processes are not affected.
- **Medium:** The affected environment is altered, but functions and processes continue in a modified way.
- **High:** Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

Significance: *This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.*

- **Negligible:** The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.
- **Low:** The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.
- **Moderate:** The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.
- **High:** The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

The following weights were assigned to each attribute:

Aspect	Description	Weight
Probability	**Improbable**	**1**
	Probable	**2**
	Highly Probable	**4**
	Definite	**5**
Duration	**Short term**	**1**
	Medium term	**3**
	Long term	**4**
	Permanent	**5**
Scale	**Local**	**1**
	Site	**2**
	Regional	**3**
Magnitude/Severity	**Low**	**2**
	Medium	**6**
	High	**8**
Significance	**Sum (Duration, Scale, Magnitude) x Probability**	
	Negligible	**≤20**
	Low	**>20 ≤40**
	Moderate	**>40 ≤60**
	High	**>60**