BEC Report Reference:	SVE - MPS - 2018/07
Report Version:	2018.04.12.03
Report Status:	FINAL REPORT

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TERRESTRIAL BIODIVERSITY IMPACT ASSESSMENT FOR THE PROPOSED MUTSHO POWER PROJECT NEAR MAKHADO, LIMPOPO PROVINCE©

B E C

Bathusi Environmental Consulting

(Botanical Assessment)

In collaboration with

Ecocheck Environmental Services cc
(Faunal Assessment)

Pachnoda Consulting cc
(Avifaunal Assessment)

This report was produced for

savannah environmental

SECTION A – ADMINISTRATION, PROJECT DETAILS & INTRODUCTARY COMMENTS

This report is compartmentalised as follows:

Section A Project introduction and administrative details, specialist introduction, report navigation, introductory section, Specialist Executive Summaries;

Section B The biophysical environment and available biophysical information and background;

Section C Botanical aspects of the receiving environment, botanical impact assessment, mitigation recommendations and EMPr contributions;

Section D Mammalian, Invertebrate & Herpetofaunal aspects of the receiving environment, faunal impact assessment, mitigation recommendations and EMPr contributions; and

Section E Avifaunal aspects of the receiving environment, avifaunal impact assessment, mitigation recommendations and EMPr contributions.

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II LIST OF FIGURES

Section A

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IV PROJECT DETAILS

Table 1: Relevant Project Details	
Client:	Savannah Environmental (PTY) Limited, on behalf of Mutsho Power (Pty) Ltd
Report Name:	Terrestrial Biodiversity Impact Assessment for the proposed Mutsho Power Project near Makhado, Limpopo Province
Report Type:	Biodiversity EIA Report
BEC Project number:	SVE – MPS – 2018/07
Report Version:	2018.04.12.03
Report Status:	FINAL REPORT
Date of Release:	6th April 2018
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VI REPORT CITATION

When used as a reference, or included as an addendum, this report should be cited as:

Bathusi Environmental Consulting cc (2018). Terrestrial Biodiversity EIA assessment for the proposed Mutsho Power Project near Makhado, Limpopo Province. Reference Number SVE – MPS – 2018/07, Version 2018.04.12.03.

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VIII CONTRIBUTING SPECIALISTS

The Natural Scientific Professions Act of 2003 aims to *'provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP), and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith'.*

Quoting the Natural Scientific Professions Act of 2003: *'Only a registered person may practice in a consulting capacity'* (20(1) – pg 14).

Table 3: Biodiversity specialists for this project	
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IX DECLARATION OF INDEPENDENCE

All specialist investigators, project investigators and members of companies employed for conducting this biodiversity investigation declare that:

» We act as independent specialist consultants conducting the assessment and compiling the report;
» We consider ourselves bound to the rules and ethics of the South African council for natural scientific professions;
» Bathusi Environmental Consulting cc is not a subsidiary, legally or financially, of either the proponent or Savannah Environmental (Pty) Ltd (Environmental Consultants);
» At the time of completing this report, we did not have any interest, hidden or otherwise, in the proposed development or activity as outlined in this document, other than fair financial compensation for work performed in a professional capacity as specified by the 2014 National Environmental Management Act (No 107 of 1998) Regulations GNR 983 and GNR 986, as amended in 2017;
» We will not be affected in any manner by the outcome of the environmental process of which this assessment forms part of, other than being part of the general public;
» We do not necessarily object to or endorse the proposed development, but aim to present facts and recommendations based on scientific data and relevant professional experience;
» We do not have any influence over decisions made by the governing authorities;
» We undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2014; and
» We undertake to provide the competent authority with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not.

Should we consider ourselves in conflict with any of the above declarations, we shall formally submit a Notice of Withdrawal to all relevant parties and register as an Interested and Affected Party.

Principal ecologist (Riaan A. J. Robbeson):

Bathusi Environmental Consulting cc (CK1999/052182/23)

Name of company:

12th April 2018

Date:

X INDEMNITY

» Findings, results, observations, conclusions and recommendations presented in this report are based on the authors' best scientific and professional knowledge as well as the interpretation of information available to them at the time of compiling this report.

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» Results presented in this report are based on a snapshot investigation of the study area and not on detailed and long-term investigations of all environmental attributes and the varying degrees of biological diversity that may be present in the study area.

» To obtain a comprehensive understanding of the dynamics of faunal and floristic associations in an area, as well as the status of endemic, rare or threatened species in an area, ecological surveys should always consider investigations at different time scales (across seasons/ years) and through replication.

» In particular, rare and endemic species normally do not occur in great densities and, because of customary limitations in the search and identification of Red Listed species, the detailed investigation of these species was not possible. Results are ultimately based on estimations and specialist interpretation of imperfect data.

» It is emphasised that information, as presented in this document, only have bearing on the site as indicated on accompanying maps. This information cannot be applied to any other area, however similar in appearance or any other aspect, without proper investigation.

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XI EXECUTIVE SUMMARY – BIOPHYSICAL BACKGROUND

Available satellite imagery and brief site observations indicate that the general region is notably rural, with extremely little anthropogenic developments and transformed environments. It is therefore a natural assumption that the development of a coal-fired power station and the appurtenant infrastructure within a definitively rural region will inevitably result in a significant increase in human movement, influx and transformative activities. A preliminary estimation of the expected cumulative impacts on a local and regional scale would suggest that the effects would be significant and high, representing a significant consideration, albeit not a fatal flaw.

No declared conservation areas or protected areas occur within the immediate surrounds of the study sites; the closest being Baobab Tree Reserve (32 km north-east) and Honnet Nature Reserve (35 km east).

No major rivers are present in the immediate surrounds; the Sand River is situated approximately 8.5 km to the north of the Farm Du Toit and the Mutamba River 12.3 km south of the Farm Vrienden. The BGIS (2015) database indicates no RAMSAR sites being present in the Musina Municipality. However, the general region exhibits attributes of periodic flooding with both ill-defined floodplains and seasonal water courses. The north-western part of Farm Du Toit comprises a significant floodplain with a drainage line in which an artificial impoundment has been constructed. This drainage line flows northwards towards the Sand River and, likely, will comprise of atypical vegetation attributes. Similarly, ill-defined flood zones are noted on Farm Vrienden, which will contribute towards habitat diversity on a local scale.

The Limpopo Conservation Plan (LCP), which provides a broad indication of the conservation importance of the province, indicates the presence of Ecological Support Areas within both Farms Du Toit and Vrienden. ESAs cover approximately 22 % of the Limpopo Province, of which 16 % are intact natural areas (ESA 1) and 7 % are degraded or areas with no, or little, natural habitat remaining, which are nevertheless required as they potentially retain some value for supporting ecological processes (ESA 2).

The geographical placement of the study sites within a definitively rural environment represents an aspect that will undoubtedly result in significant cumulative impacts, specifically on temporal and spatial scales as could be construed from similar developments within definitively rural environs.

XII EXECUTIVE SUMMARY – BOTANICAL ASSESSMENT

Focus areas include Farm Du Toit 563 and Farm Vrienden 589 (excluding the section south of the main dirt road which passes through Farm Vrienden), comprising a total surface area of approximately 1 899 ha.

A site visit (during 12 - 19 January 2018) was conducted to obtain baseline information on the floristic environment. Floristic data was compiled from a total of 58 sample plots that were placed in a stratified random approach across the study areas and subjected to a basic data analysis.

The study area corresponds to the Savanna Biome and more particularly to the Central Bushveld Bioregion as defined by Mucina & Rutherford (2006), comprising an ecological type known as the Musina Mopane Bushveld, of which the conservation status is currently set at Least Threatened.

The following key findings and considerations are noted for the floristic environment:

» No plant species with IUCN status were recorded during the brief survey effort. However, taking cognisance of the habitat variability and existing status of the environment, the likelihood of plants of conservation concern persisting within the study area cannot be excluded.

» Four tree species that are protected under the National Forest Act (1998) were recorded in abundant numbers across the sites:
  - *Adansonia digitata* L. (Baobab);
  - *Boscia albitrunca* (Burch.) Gilg & Gilg-Ben. (Shepard's tree);
  - *Combretum imberbe* Wawra (Leadwood); and
  - *Sclerocarya birrea* (A.Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro (Marula).

» The localised presence of massive *Adansonia digitata* is regarded an important consideration. At every available opportunity, individuals with an estimated circumference more than 15 m (maximum approximately 22 m) were recorded.

» The average number of species recorded in releveès during the survey period is 23.5 per sampling bout (std. dev. = ±6.0), reflecting a poor floristic species richness of the vegetation on a local and regional scale.

» Typical woodland vegetation of the sites strongly reflects regional ecological attributes (Musina Mopane Bushveld).

» Twinspan analysis revealed a major community that accounts for the typical savanna woodland vegetation. Minor communities were recognised that accounts for ephemeral pans, anthropogenically transformed woodland (old fields) and emergence of calcareous washes and plains that is a typical and natural occurrence in the immediate region.

» Although not proven to be floristically distinct in the Twinspan analysis of this brief assessment, physiognomic variations are regarded as important units on a local and regional scale, contributing to the ecological infrastructure and functionality of the region and are therefore described as physiognomic variations within the typical woodland habitat.

» The following communities and variations were recognised from the TWINSPAN classification:

- Community 1 – *Combretum imberbe – Phyllanthus reticulatus* ephemeral pans;
- Community 2 - *Vachellia grandicornuta – Boscia foetida* eroded watercourses and calcareous plains/ washes, including the variations:
  - Quartzitic washes and sandy floodplains; and
  - Calcareous outcrops and washes;
- Communities 3 and 4 – *Combretum apiculatum Grewia flavescens – Colophospermum mopane* Woodland, including the physiognomic variations:
  - Closed Woodland;
  - Open Woodland;
  - Closed Woodland Watercourses;
  - Open Woodland Watercourses;
  - Quartzitic Outcrop; and
- Community 5 – *Vachellia tortilis – Cienfuegosia – digitata* old fields.

» Vegetation of the study area conforms to a uniform, but mixed, undifferentiated broadleaf woodland that comprises mostly of deep, highly leached sandy soils. Results of the floristic surveys reflect the proportional and notable prominence of typical woodland constituents such as *Vachellia tortilis, Dichrostachys cinerea* and *Colophospermum mopane.*

The proposed activity implies the loss of natural habitat and no impacts of a beneficial nature on the floristic environment are likely to result. Based on a generic list of impacts associated with this type of development, three categories of impacts are likely to result, namely, direct impacts, indirect impacts and impacts of a cumulative nature.

Table 4: Summary table for impact significance in the botanical environment

Impact	*Significance*	
	Without Mitigation	With mitigation
1. Loss of plant taxa (individuals, stands, populations) of conservation importance (threatened taxa) as well as plant taxa of conservation concern (declining status, provincially protected taxa), including habitat that is regarded highly suitable for the persistence of these species	High (85)	Medium (48)
2. Loss of natural vegetation (physical modifications, removal, damage) including the loss of atypical, sensitive, conservation important habitat types or ecosystems of restricted abundance	High (75)	Medium (48)
3. Local depletion of plant taxa and reduction of phytodiversity	Medium (52)	Medium (39)
4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.	High (60)	Medium (40)
5. Reduced or severely altered ecological functionality (including fire, erosion)	High (80)	Medium (52)
6. Decreased aesthetic appeal of the landscape	High (60)	Medium (55)
7. Introduction of invasive, exotic and encroacher plant species	High (60)	Medium (33)
8. Increased exploitation of natural resources due to increased human presence and resource requirements	High (64)	Low (22)
9. Cumulative exacerbation of existing levels of habitat fragmentation and isolation	High (64)	Medium (36)
10. Cumulative impacts on local/ regional and national conservation targets and obligations	Low (26)	Low (6)

The three project alternatives are regarded as highly similar in layout and estimated footprint sensitivity regarding the botanical receiving environment. Anticipated impacts on the floristic environment, surrounds and region is not expected to vary significantly between the three proposed alternatives; discussions on anticipated impacts are therefore applicable to the three alternative layouts. Despite the similarity in sensitivity aspects, minor (localised) attributes are considered important in the preferability of the proposed alternative layouts. The following order of preferability is presented:

» Option 1 is regarded the preferred option;
» Option 2 is regarded the least preferred option in terms of the floristic environment; and
» Option 3 is regarded as the second preferred alternative in terms of impacts on the floristic environment.

It is the conclusion of this botanical assessment that, despite severe cumulative impacts that can reasonably be expected, the proposed project does not pose and unacceptable and threats to sensitive environs and species on a local scale. It is strongly advised that impacts on the botanical receiving environment should be managed according to the proposed mitigation strategy described in this document, but care should also be taken to identify *ad hoc* impacts which were not necessarily highlighted in this document and administer suitable and appropriate mitigation measures during the life of the project.

Based on results and recommendations presented in this botanical impact assessment, we do regard the project as acceptable, but cautions the use of a dedicated, acceptable and appropriate mitigation strategy to prevent undue and unneccesary impacts within the floristic environment.

XIII EXECUTIVE SUMMARY – FAUNAL ASSESSMENT

The farms Du Toit 563 and Vrienden 589 in the Vhembe District of the Limpopo Province were surveyed for mammals, herpetofauna and invertebrates between 12 and 19 January 2018 with specific focus on potential red data listed inhabitants. Mammals, reptiles and frogs were surveyed with the use of ecological indicators such as tracks, dung, diggings, nests and calls. Visual sightings of both diurnal and nocturnal species (night-time surveys were also included) were also used to identify both small and medium to large mammal species as well as frogs and reptiles. Bats were surveyed with the use of a handheld bat detector and frog's species-specific calls were recorded with the use of a field sound recorder. Carrion-baited infrared camera traps were used to attract and photograph carnivores and other species passing by.

The plant communities described for the study area are considered representative of the macro faunal habitat types. The study area is located within the Q-grid 2229DB. Available information sources listed a total of ninety-five (95) animals for 2229DB, including three red data species. During the site investigation the presence of one hundred and twenty-two (122) animal species were confirmed in the study area, representing twenty-two orders (22) and fifty-five (55) families. Of these 122 species, 111 were recorded on Farm Du Toit and 82 species on Farm Vrienden. The species recorded within the study areas included six red data listed species, namely:

» *Copris cambeforti* Nguyen-Phung, 1988a (Dung Beetle) – Data Deficient;
» *Onthophagus quadrimaculatus* Raffray, 1877 (Dung Beetle) – Data Deficient;
» *Rhinolophus smithersi* Taylor, Stoffberg, Monadjem, 2012 (Smither's Horseshoe Bat) – Near Threatened;
» *Acinonyx jubatus* (Schreber, 1775) (Cheetah) – Vulnerable;
» *Panthera pardus* (Linnaeus, 1758) (Leopard) – Vulnerable; and
» *Parahyaena brunnea* (Thunberg, 1820) (Brown Hyaena) – Near Threatened.

The species inventory results of the field investigation on the farms Du Toit 563 and Vrienden 589 compared well to the known inhabitants of the Q-grid 2229DB, although a total of 27 more species were confirmed for the study areas than are listed for the Q-grid. Groups that were better represented during the field investigation included spiders, dung beetles, frogs and mammals.

The three project alternatives are regarded highly similar in layout and estimated footprint sensitivity regarding the faunal communities and especially the persistence and general presence of conservation important species. The anticipated impacts on the fauna of the study area, surrounds and region is therefore not expected to vary significantly between the three proposed alternatives; discussions on anticipated impacts are therefore applicable to the three alternative layouts.

Table 5: Summary table for impact significance on the faunal components		
Impact	Without Mitigation	With mitigation
1. Loss of fauna species of conservation importance (threatened taxa) and habitat associated with CI species	High (72)	Medium (36)
2. Loss of natural habitat, including essential habitat refugia	High (65)	Medium (55)
3. Depletion of faunal diversity, human/ animal conflict situations, including the introduction of invasive and non-endemic species	Medium (52)	Low (27)
4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.	Medium (48)	Low (27)
5. Indirect impacts on movement/ migration patterns of animals and ecological interaction and processes	High (70)	Medium (40)
6. Exacerbated increases of edge effects of the project areas	Medium (52)	Medium (30)
7. Cumulative losses and degradation of natural habitat	Medium (48)	Medium (30)
8. Cumulative depletion of faunal taxa, assemblages and communities, with specific reference to the conservation important species	Medium (36)	Low (24)

The following key comments are presented:

» Results obtained from this faunal assessment indicate that the persistence of animals, with particular reference to red data taxa, across the landscape in which the study areas are situated, is of such a nature that neither of the proposed development alternatives present a clear and significant threat to any specific species, or specific habitat.

» Expected and likely impacts associated with the proposed alternatives are similar in nature and significance.

» The variation in the spatial arrangement of the appurtenant infrastructure, as per the proposed alternatives, is not expected to result in significant variation in expected and likely impacts on the faunal receiving environment.

» As such, no clear and obvious preferred alternative could be identified that would result in a significant reduction of impacts, compared to other alternatives.

» The faunal component is therefore unlikely to represent a driver for a specific, preferred option as all the alternatives are similar in terms of impact significance within the faunal receiving environment.

XIV EXECUTIVE SUMMARY – AVIFAUNAL ASSESSMENT

An avifaunal survey was conducted on the Farms Farm Du Toit 563 and Farm Vrienden 589. Information provided in this report forms part of a baseline study that was obtained from:

1) relevant literature;
2) personal observations from similar habitat near the study area; and
3) site visits (January 2017 and January 2018).

The following key considerations were identified and noted:

» Various sampling techniques (including bird point counts) were employed to evaluate the bird composition, richness and ecological sensitivity on the study area;

» Two dominant habitat types were identified, which included undifferentiated mixed closed woodland on sandy soils and secondary microphyllous woodland. In addition, six important azonal habitat types were also present: calcareus plans and outcrops, natural depressions and impoundments, seasonal drainage lines, artificial game watering holes, large *Adansonia digitata* canopy constituents and large dead trees. The undifferentiated woodland and microphyllous woodland were identified with high bird species richness, while the natural depressions and impoundments (when inundated) provided habitat for "specialised" bird species (waterbirds and shorebirds);

» A total of 270 bird species were expected to occur, of which 176 species were confirmed during the surveys;

» The avifaunal community on the study area was poorly represented by South African endemics, while the dominant composition is widespread in the region although it consisted of many species with high affinities to the Kalahari-Highveld biome;

» Fourteen (14) threatened and near threatened bird species were expected to be present (with four species confirmed during the surveys). Observed species included the regionally near threatened Kori Bustard (*Ardeotis kori*), critically endangered White-backed Vulture (*Gyps africanus*), endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*) and the vulnerable Black Stork (*Ciconia nigra*);

» The study area was represented by five ill-defined avifaunal assemblages consisting of (1) an association confined to undifferentiated mixed woodland, (2) an association confined to areas with surface water, (3) an association confined to homogenous stands of *Colophospermum mopani*, (4) an association confined to stunted *Colophospermum mopani* along seasonal watercourses, (5) an association confined to natural pans with large *Combretum imberbe* and (6) an association confined to calcrete plains and outcrops;

» The avifaunal importance of the proposed study area for bird species is summarised below:

- Part of the undifferentiated mixed woodland, calcrete plains and microphyllous woodland habitat consisted of an open canopy structure, which provided potential foraging habitat for terrestrial large-bodied bird species (e.g. Kori Bustard - *Ardeotis kori* and Secretarybird *Sagittarius serpentarius*);
- The natural depressions and dams have benefitted the colonisation of "specialised" bird taxa (mainly wader and wading bird species) that were of local importance and contributed towards the regional avifaunal diversity when inundated;
- The natural depressions and dams provided foraging habitat for threatened stork taxa;

- The large *Adansonia digitata* trees provided breeding and roosting habitat for the Brown-headed Parrot (*Poicephalus cryptoxanthus*) which is restricted to the East Coast Biome and reached its western distributional limit on the study area.

An evaluation of the expected and likely impacts on the avifaunal component of the study areas revealed that certain sensitive parts of the study area should be excluded from the proposed development. Furthermore, the application of detailed and site-specific mitigation measures is required to ameliorate significant impacts to an acceptable significance level. The following table presents a summary of the significance of expected and likely impacts on the avifaunal components of the study areas.

Table 6: Summary table for impact significance in the avifaunal environment

Impact	*Power Station*	
	Without Mitigation	With mitigation
1. Loss of sensitive/important bird habitat and subsequent displacement/loss of threatened and near threatened bird species	High (85)	High (65)
2. Loss of natural habitat (physical modifications, removal, damage) containing high avifaunal diversity	High (65)	Medium (55)
3. Loss of azonal, and important habitat types or ecosystems of restricted abundance containing unique bird compositions (on a local scale)	High (60)	Medium (36)
4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc., also including Impacts on habitat types utilised by threatened or near-threatened bird species	Medium (56)	Medium (33)
5. Changes in the community structure due to habitat fragmentation (e.g. roads, loss of closed-canopy woodland) and altered habitat quality	High (70)	Medium (30)
6. Increased "urban sprawl" and exploitation of natural resources due to increased human presence and resource requirements	Medium (42)	Medium (33)
7. Bird collisions with proposed overhead power line	High (80)	Medium (36)
8. Electrocution of large-bodied birds due to the use of inappropriate tower design	High (64)	Medium (39)
9. Additional loss of dispersal corridors owing to habitat alteration	High (64)	High (64)
10. Subsequent habitat changes and changes to the local avifaunal community structure and composition (colonisation by generalists and secondary species)	Medium (36)	Low (20)
11. Urban sprawl based on "job-seeking" opportunities leading to the localised depletion of natural resources and direct persecution of bird taxa	High (80)	Medium (48)

From the analysis of alternatives, in particular when taking bird richness and abundance into account, it would appear that Option 1 is regarded as being more feasible when compared to Option 2 and 3. However, Option 1 is not failsafe from other impacts related to potential pollution run-off and localised fragmentation. In addition, the location of the service road remains perpetual on all three of the proposed Options. To minimize potential impacts of the service road, it is proposed that alternatives be put in place to evaluate an alignment which may have a lower impact on the current environment.

An independent avifaunal impact assessment report should be conducted to evaluate the location of the substation and the powerline infrastructure that would be required for the development, with particular emphasis on the nearby dam located on Du Toit.

XV ACRONYMS & ABBREVIATIONS

Table 7: Acronyms and abbreviations	
BEC	Bathusi Environmental Consulting cc
CBA	Critical Biodiversity Areas
CBD	Convention on Biological Diversity
CITES	Convention of International Trade in Endangered Species
CR	Critically Endangered
DAFF	Department of Fisheries and Forestry
DD	Data Deficient
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
End	Endemic Species
ESA	Ecological Support Areas
IBA	Important Bird Area
IPP	Independent Power Producer
IRP	Integrated Resource Plan
IUCN	International Union for Conservation of Nature
Ha/lsu	Hectares per large stock unit
LC	Least Concern
LCP	Limpopo Conservation Plan (Version 2)
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LEMA	Limpopo Environmental Management Act
mmasl	Mean Meters Above Sea Level
NEMBA	National Environmental Management Biodiversity Act
NEnd	Near Endemic Species
NFA	National Forest Act
NT	Near Threatened
PAN	Protected Area Network
POSA	Plants of Southern Africa
Pr.Sci.Nat.	Professional Natural Scientist (registered at SACNASP)
SABAP	South African Bird Atlas Project
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SEIA	Social and Environmental Impact Assessment
SSC	Species of Special Concern
TOPS	Threatened or Protected Species
TWINSPAN	Two Way Indicator Species Analysis
VU	Vulnerable

XVI GLOSSARY OF TERMS

Table 8: Glossary of Terms	
Ad hoc	Random, non-sequential, opportunistic observations
Antelope	Swift running, deer-like ruminant with smooth hair and upward-pointing horns
Anthropogenic	Human induced
Austral	Southern hemisphere
Avifauna	Birds
Biodiversity	Diversity among and within plant and animal species in an environment
Bovid	A mammal of the cattle family (Bovidae)
Cannibalism	Eating of the flesh of an animal by another animal of the same kind/ species
Carnivore	Flesh eating animal
Commensal	A symbiotic relationship in which one species is benefited while the other is unaffected
Conspecific	Animals or plants belonging to the same species
Disjunct	Disjoined or distinct from one another
Diurnal	During the day
Endemic	Restricted to a certain geographic area
Eurytopic	Able to adapt to a wide range of environmental conditions; widely distributed (used for an animal or plant)
Fossorial	Animals adapted to burrowing
Granivore	Animals that eat seeds as the main part of their diet
Herbivorous	Animals that eat plants
Herpetofauna	Amphibians and Reptiles
Insectivorous	Animals that feed on insects as the main part of their diet
Lepidoptera	Butterflies
Mammal	A warm-blooded vertebrate animal of a class that is distinguished by the possession of hair or fur, females that secrete milk for the nourishment of the young and (typically) the birth of live young
Monitoring	The collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a conservation or management objective
Nomenclature	The devising or choosing of names for things, especially in a science or other discipline
Passerine	Relating to or denoting birds of a large order distinguished by having feet that are adapted for perching, including all songbirds
Phylogenetic	The evolution of a genetically related group of organisms as distinguished from the development of the individual organism
Primate	Animals characterized by large brains relative to other mammals, as well as an increased reliance on stereoscopic vision at the expense of smell, the dominant sensory system in most mammals
Putative species	Species that are assumed to exist, or reputed to have existed
Red Data	A taxon included in the UICN list of threatened species
Rodent	Gnawing mammal of an order that includes rats, mice, squirrels, hamsters, porcupines, and their relatives, distinguished by strong constantly growing incisors and no canine teeth. They constitute the largest order of mammals
Solitary	Animals that spend a majority of their lives without others of their species, with possible exceptions for mating and raising their young
Subterranean	Existing, living under the earth's surface
Sympatric	Animals or plant species or populations occurring within the same or overlapping geographical areas
Territorial	The sociographical area that an animal of a particular species consistently defends against conspecifics (or, occasionally, animals of other species). Animals that defend territories in this way are referred to as territorial. Territoriality is only shown by a minority of species.
Threatened	Species (including animals, plants, fungi, etc.) which are vulnerable to endangerment in the near future. Species that are threatened are sometimes characterised by the population dynamics measure of critical dispensation, a mathematical measure of biomass related to population growth rate

XVII INTRODUCTION

Biodiversity is a series of relationships in a complex web, which is also referred to as 'the web of life'. Our natural environment includes rivers, wetlands, coastlines, mountains, plains, grasslands, woodlands, forests, etc., as well as all the life on earth, such as plants, animals, reptiles, insects, and birds. South Africa is blessed with an exceptionally rich biodiversity; we have the recognition as one of the world's few 'megadiverse' countries. In addition to having an entire floral kingdom, it also includes two globally significant biodiversity 'hot spots' (the Cape and succulent Karoo regions), six Centres of Plant Diversity, two Endemic Bird Areas and the richest temperate flora in the world (Cowling, 2000).

Pressure is continually being exerted on these valuable natural resources of South Africa because of uncontrolled growth of human population. Energy consumption has increased exponentially as well as the drive to extract more economically valuable resources at ever-faster rates. Natural habitats that harbour valuable biodiversity are being lost at increasingly faster rates and over progressively wider areas, while managed lands are undergoing increasing simplification. Projections show that the extinction of species and degradation of ecosystems are likely to continue, and likely accelerate and drastic action is needed to arrest the uncontrolled extinction of species on a global scale caused by modern lifestyles. Many would argue, from spiritual and ethical points of view, that the diversity of life on Earth has intrinsic value, and that it is worth protecting for its own sake.

However, implementing 'biodiversity friendly' practices remains challenging within the entire developmental sphere, especially for smaller companies and peripheral players. This is partly because governments, while perhaps committed on paper to biodiversity, have found it difficult to create the right incentives and apply the necessary regulations in a way that could encourage all players to conserve biodiversity (ICMM, 2004). Achieving a balance while doing this requires better understanding and recognition of conservation and development imperatives by all stakeholders, including governments, business and conservation communities.

Energy is essential for sustainable development. In many countries, including South Africa, economic growth and social needs are resulting in substantially greater energy demands, even taking into account continuing and accelerated energy efficiency improvements. The need for a stable supply of energy across South Africa is one of the most hotly debated topics; from governmental institutions, industries and developers, down to the common household. Althought the electricity demand:supply ration in South Africa has been stable for the recent past, government has indicated the need for new projects to prepare for future energy demands, as outlined in the country's Integrated Resource Plan (IRP). Independent Power Producers (IPP) play a crucial role in the provision of some of the energy requirements through the development and operation of power generation operations. These activities include traditional coal-fired power stations, Open Cycle Gas Turbines (OCGT) as well as hydro-electricity and pumped storage schemes, and alternative sources such as wind generation and solar power plants.

Despite the significant potential for negative impacts on biodiversity, there is a great deal that companies can do to minimize or prevent impacts on our irreplaceable natural resources. There are also many opportunities for companies to enhance biodiversity conservation within their areas of operations. Being proactive in the assessment and management of biodiversity is important not only for new operations but also for those that have been operating for many years, usually under regulatory requirements that were less focused on the protection and enhancement of biodiversity.

In summary, the threats to biodiversity are compelling. Unless they are addressed in a holistic manner, which considers social and economic as well as scientific considerations, the benefits of ecosystem services will be substantially diminished for future generations. Furthermore, the next 50 years could see a further acceleration in the degradation of ecosystem services unless action is taken to reverse current trends.

XVIII PROJECT SYNOPSIS

Mutsho Power (Pty) Ltd (The Client) propose the development of a new coal-fired power station and associated infrastructure. Savannah Environmental (Pty) Ltd has been appointed as the Environmental Consultants responsible for undertaking the Environmental Impact Assessment (EIA) for the Mutsho Power Project. Mutsho Power, having previously considered locating the proposed power plant close to the existing Vele Colliery (in the vicinity of Mapungubwe with its associated sensitivities), identified two properties through a rigorous site selection process, covering more than 135 000 ha north of the Soutpansberg as new possible sites for the proposed project, with fewer sensitivities. The focus areas include the entire surface area of the Farm Du Toit 563 MS and Farm Vrienden 589 MS (excluding the section south of the main dirt road which passes through Farm Vrienden), comprising a total surface area of approximately 1 899 ha.

A minimum footprint of 350 ha is required for the power plant and associated infrastructure. While the physical power generation components require approximately 50 ha, supporting areas for the establishment of coal and other raw material stockpiles, and an ash dump, increase the development footprint.

The project will have a generation capacity of up to 600 MW in line with the DoE's CBIPPP requirements and will make use of Circulated Fluidised Bed (CFB) technology. The project will comprise the following key infrastructure components:

» an Ash dump totalling 120 ha in extent;
» an Ash run-off dam;
» a power plant of 30 ha;
» a plant run-off dam and raw water storage dam;
» a new access road and pipeline servitude;
» a new rail siding; and
» a coal conveyer and ash conveyer.

Based on a detailed integration of interdisciplinary results, three proposed project alternatives were presented, namely:

1. First technically preferred option (Option 1) - the project will be developed entirely on Farm Vrienden (refer **Figure 1**);
2. Second technically preferred option (Option 2) - the project will be developed on Farm Vrienden and portions of Farm Du Toit (refer **Figure 2**); or
3. Third technically preferred option (Option 3) - the project will be developed entirely on Farm Vrienden (alternative layout) (refer **Figure 3**).

The project will utilise coal mined at the Makhado Colliery, to be developed approximately 20 km south-east of the project site, to fuel its operations. Coal will be transported to site either via a new 22 km railway loop, proposed for development between the Makhado Colliery and the existing Huntleigh railway siding, or via road transport and stockpiled on site.

This EIA report will investigate the sensitivity of the receiving environments in terms of the terrestrial biological environment and will inform on the suitability/ preferability of each of the project alternatives. An analysis of the likely and expected impacts on the receiving biological environment will be presented to substantiate recommendations presented in this report.

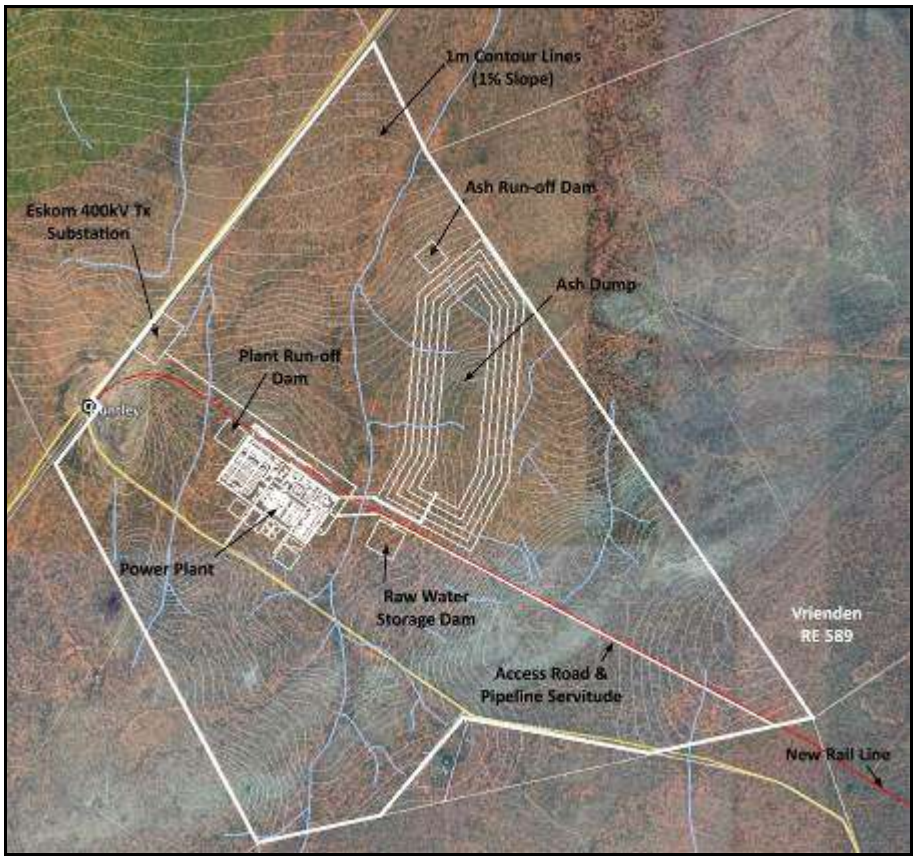


Figure 1: Spatial layout of the first technically preferred option - Farm Vrienden

Section A

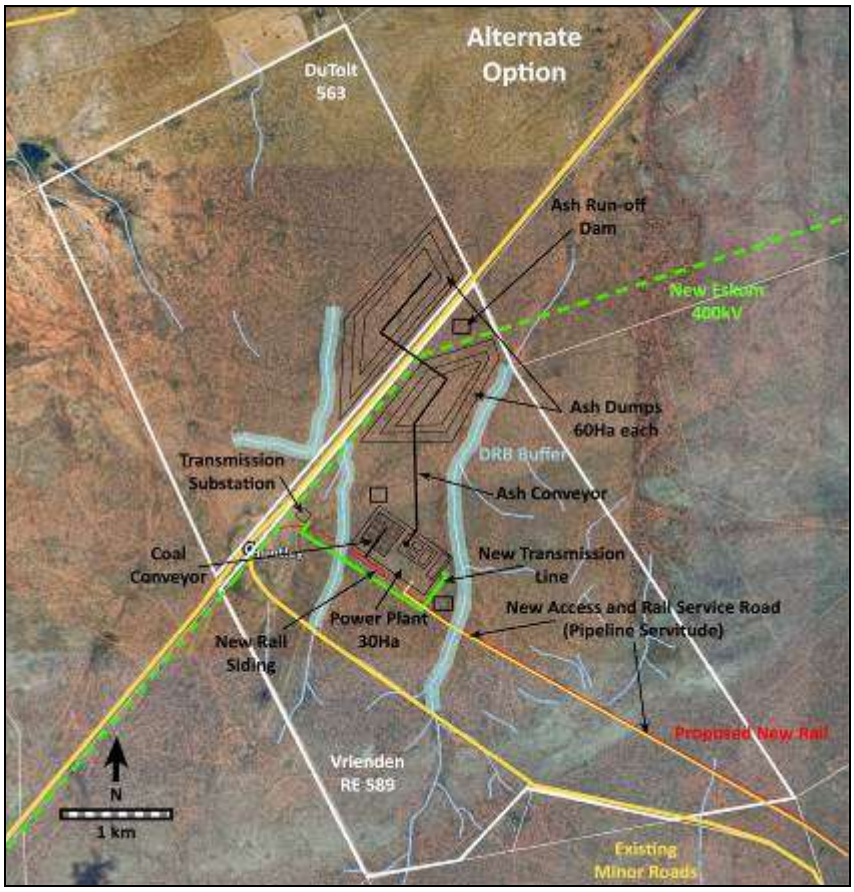


Figure 2: Spatial layout of the second technically preferred option - Farm Vrienden and Farm Du Toit

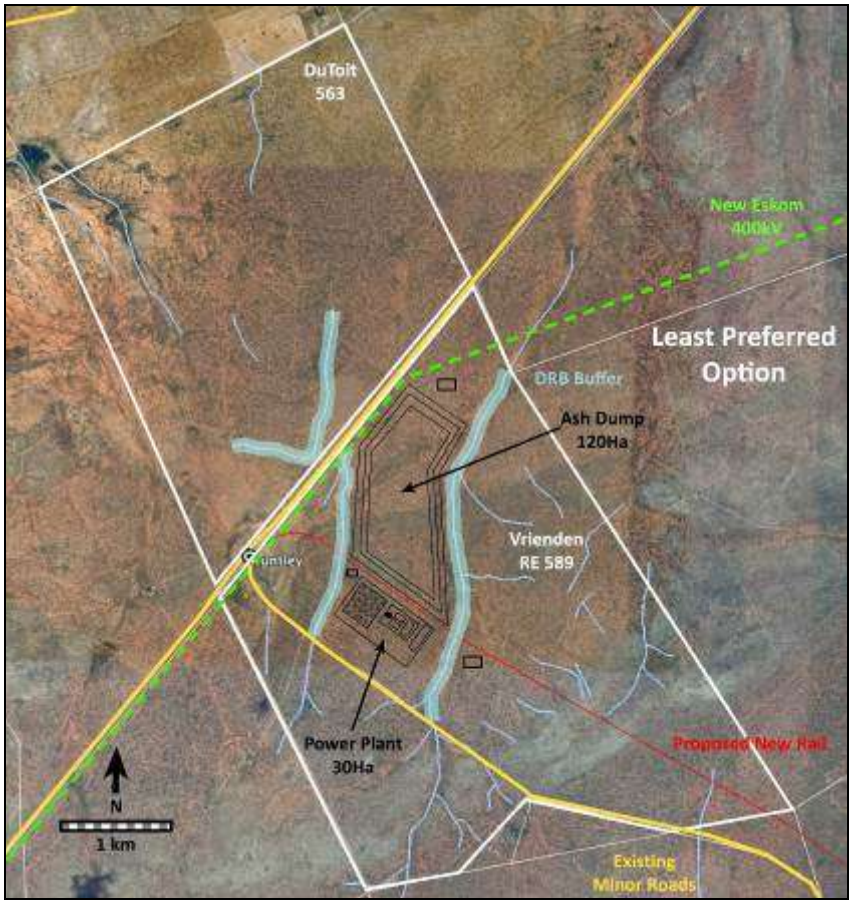


Figure 3: Spatial layout of the third technically preferred option - Farm Vrienden

Section A

XIX PROJECT SITE LOCATIONS

The project sites are situated in the Limpopo Province, located approximately 40 km southwest of Musina and 38 km north of Makhado (Louis Trichardt) in the Musina Municipality. Other nearby settlements include Mopane (5.6 km north east) and Thohodandou (75 km southeast). The sites are accessed from the N1 Toll highway, from the turnoff at the R525 towards Mopane and then on a gravel road south-eastward towards the Huntleigh railway siding.

» Access to Farm Du Toit is at the GPS locality S22.68231° and E29.80907°; and
» Access to Farm Vrienden is at the GPS locality S22.70110° and E29.82633°.

The regional location of the site alternatives is illustrated in **Figure 4**. A Google Earth image of the region is presented in **Figure 5**.

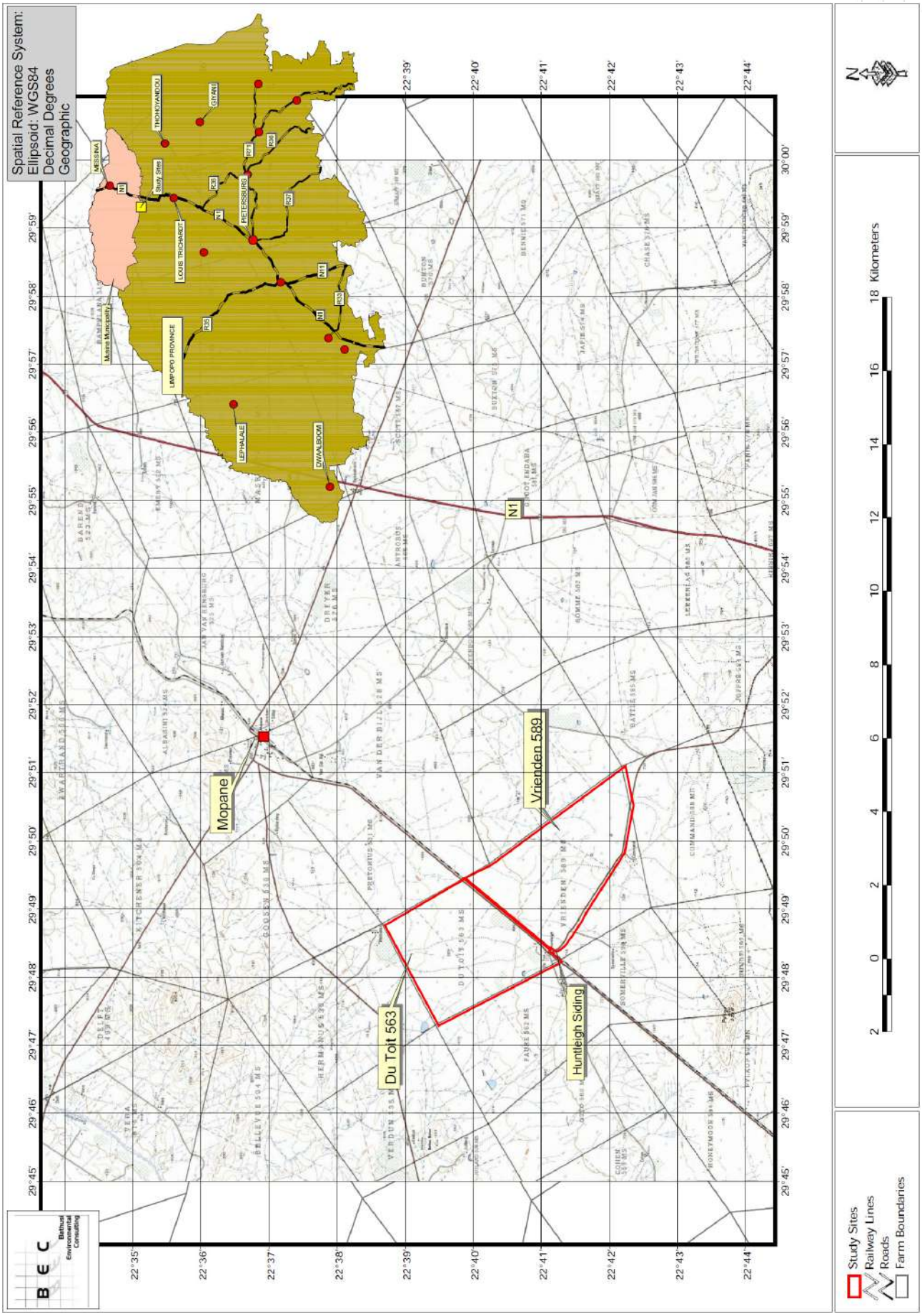


Figure 4: Geographic location of the proposed study sites

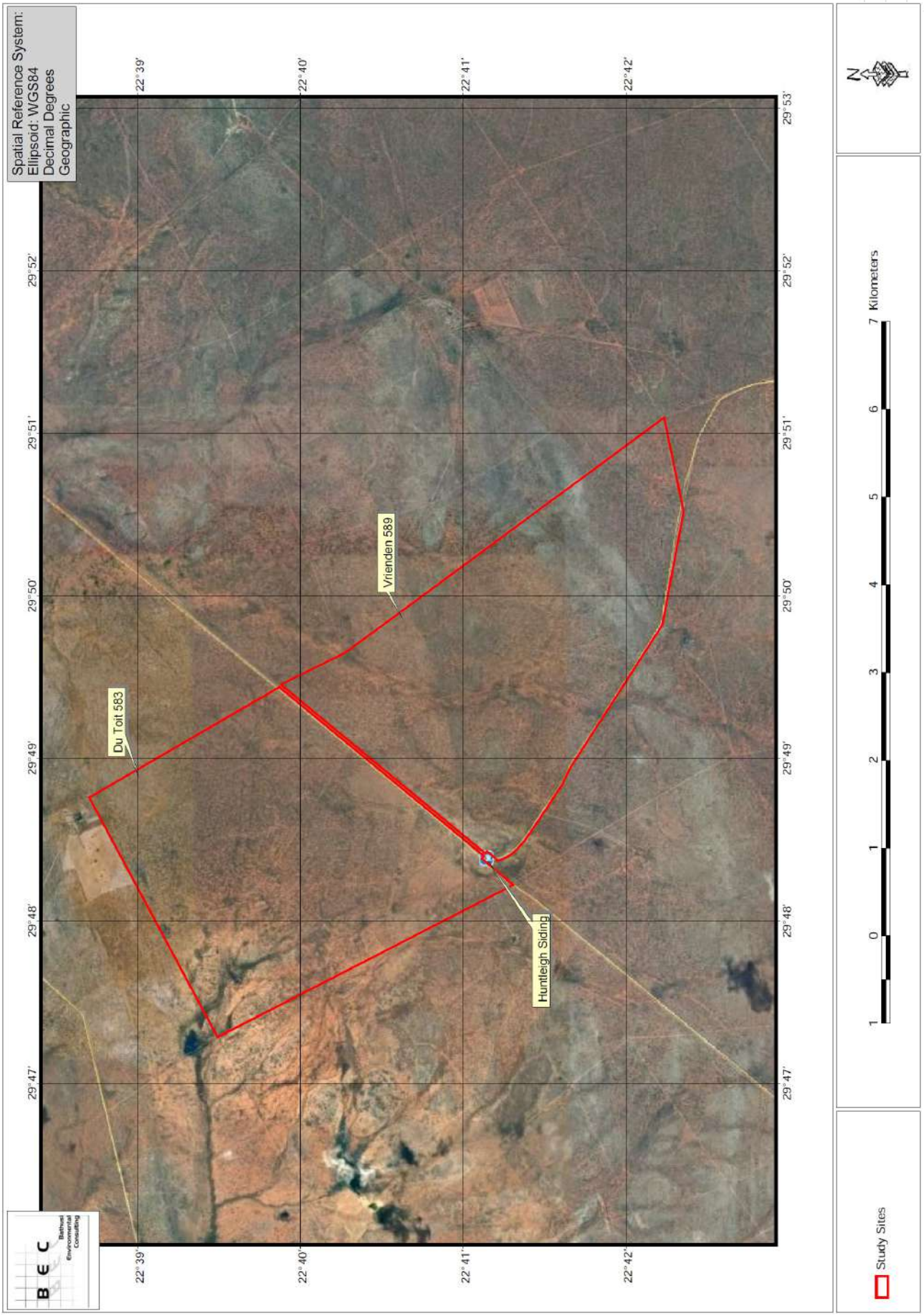


Figure 5: Aerial imagery of the immediate surrounds
Imagery courtesy of www.googleearth.com

SECTION B – BIOPHYSICAL ATTRIBUTES OF THE RECIEVING ENVIRONMENT

Riaan A. J. Robbeson (Pr.Sci.Nat.)

1 LAND COVER & LAND USE OF THE REGION

Land use often determines land cover; it is an important factor contributing to the condition of the land. Different uses have varying effects on the integrity of the land. For this assessment, land cover is loosely categorized into classes that represent natural habitat and land cover categories that originated from habitat degradation and transformation on a local or regional scale. Areas that are characterized by high levels of transformation and habitat degradation are generally more suitable for development purposes as it is unlikely that biodiversity attributes of conservation importance will be present or affected by development. Conversely, areas that are characterized by extensive untransformed and pristine habitat are generally not regarded suitable options for development purposes.

The Musina Municipality comprises approximately 758 000 ha, of which 717 000 ha (94.59 %) remains untransformed (BGIS, 2015), reflecting the observations made in the immediate region of the study sites.

Available satellite imagery and brief site observations indicate that the general region is definitively rural, with extremely little existing anthropogenic developments and transformed environments (refer **Figure 5**. It is therefore a natural assumption that the development of a coal-fired power station and the appurtenant infrastructure will inevitably result in significant increases in human movement, influx and transformative activities within a, largely, natural and untransformed environment, affecting the receiving environment adversely. A preliminary estimation of the expected cumulative impacts on a local and regional scale would suggest that these types of effects would be significant and high, specifically on a spatial and temporal scale. Despite this being regarded a significant and adverse impact, it is not regarded a fatal flaw for the development. Cattle and game farming constitute the major land use activity within the proposed farms and in the surrounds, implying that the area is decidedly untransformed with natural woodland habitat (refer **Figure 6**).

2 DECLARED CONSERVATION AREAS

Currently, the following declared land-based protected areas are situated in regional surrounds of the proposed project sites:

» Baobab Tree Reserve (1 2281 ha);
» Honnet Nature Reserve (1 992 ha);
» Mapungubwe National Park (19 929 ha);
» Nwanedi Nature Reserve (5 660 ha);
» Nzhelehele Nature Reserve (2 164 ha);
» Happy Rest Nature Reserve (2 714 ha);
» Langjan Nature Reserve (4 796 ha); and
» Blouberg Nature Reserve (12 832 ha).

No protected areas are situated within the immediate surrounds of the study sites; the closest being Happy Rest Nature Reserve (30 km southeast), Nzhelehele Nature Reserve (36 km southwest), Baobab Tree Reserve (32 km northeast) and Honnet Nature Reserve (35 km east) (refer **Figure 7**).

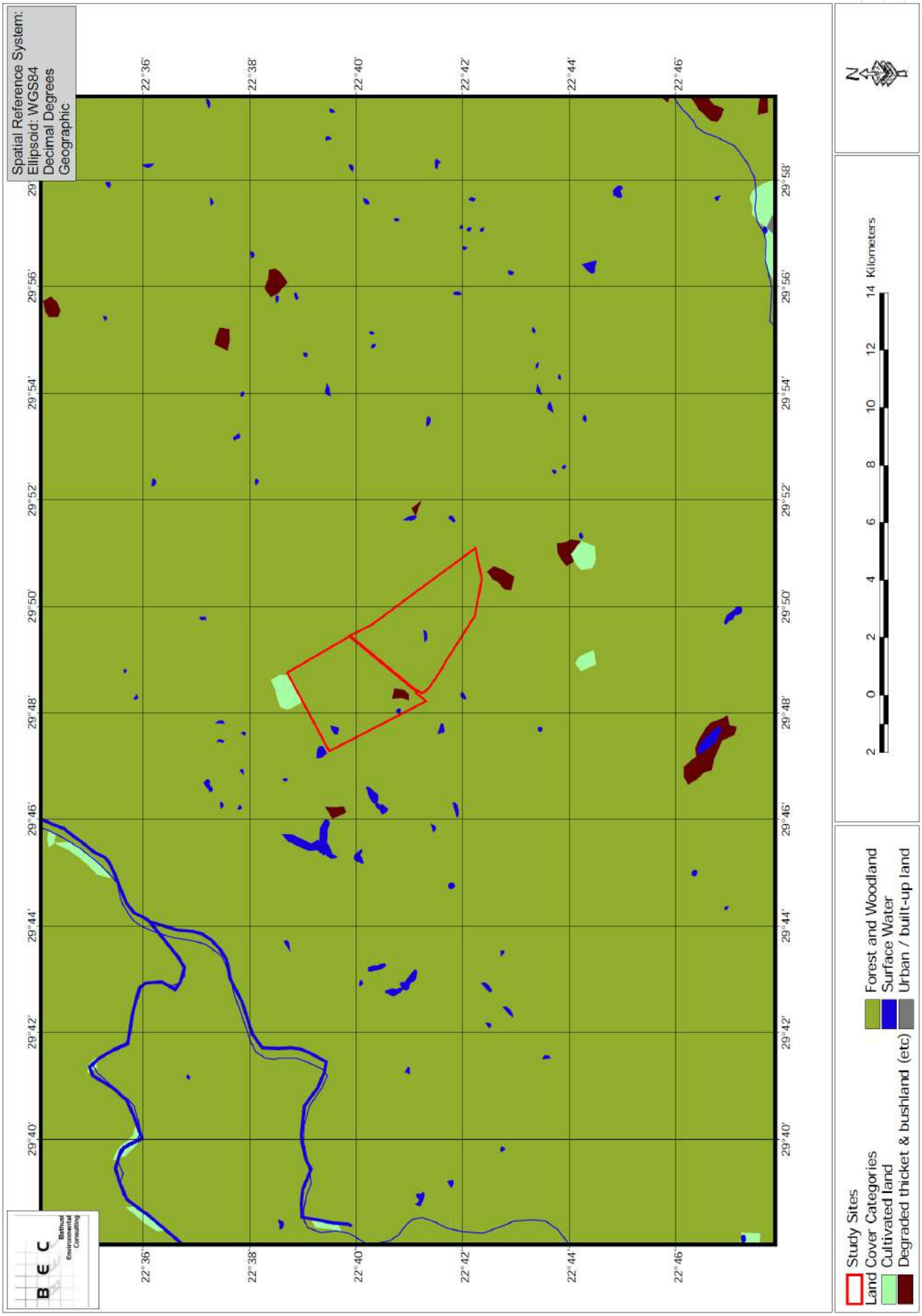


Figure 6: Broad land cover categories of the general surrounds

Section B

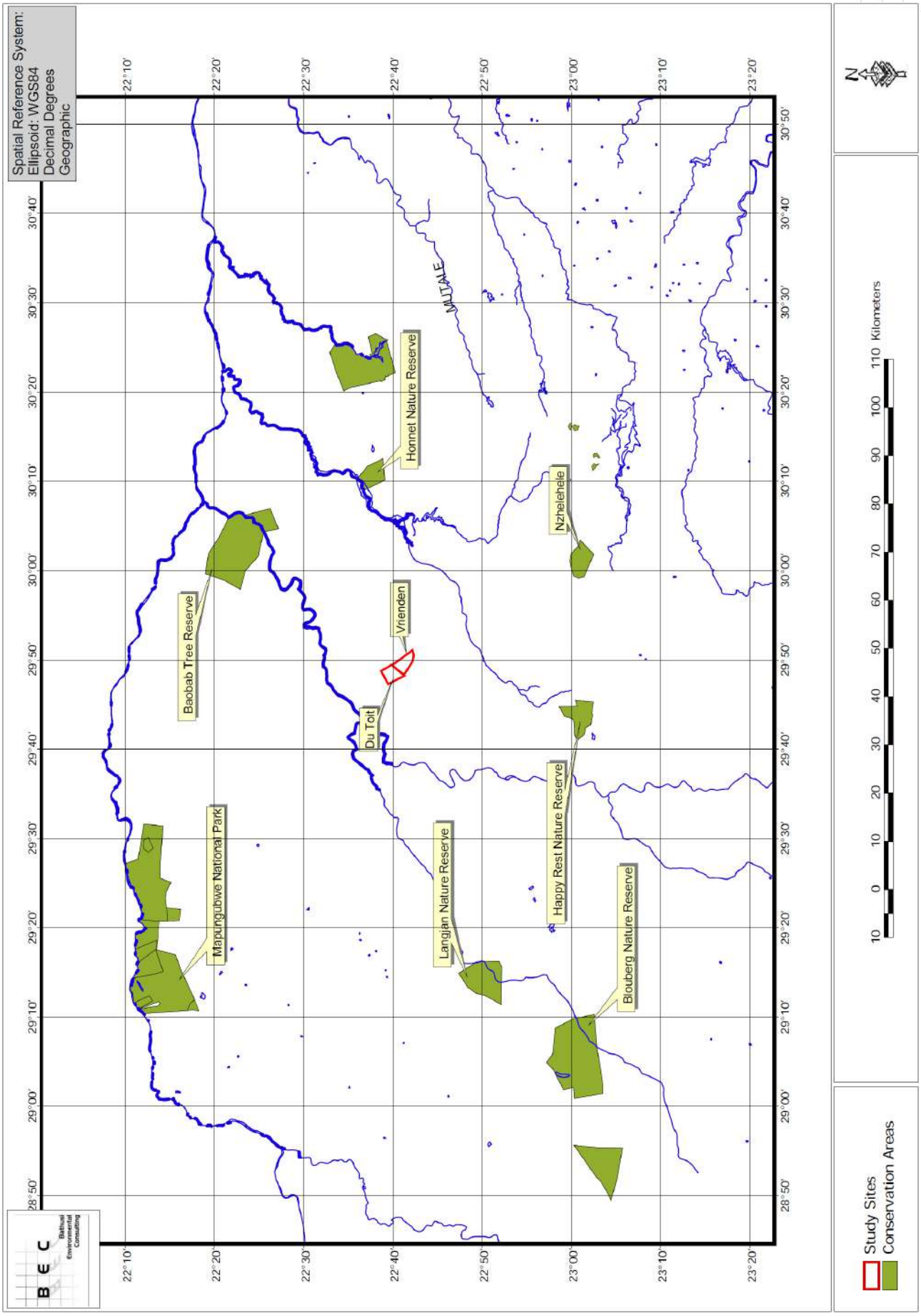


Figure 7: Land based conservation areas in the general surrounds

Section B

3 LAND TYPES & GEOLOGY

Although it is not in the scope of this report to present a detailed description of the soil types, a basic description will suffice for this assessment as the association of habitat types and land types (soils) are often demonstrated for savanna vegetation.

The proposed farms are entirely situated witin the Ah81 land type form. Map units Aa to Ai refer to yellow and red soils without water tables and belonging in one or more of the following soil form: Inanda, Kranskop, Magwa, Hutton, Griffin and Clovelly. The map units refer to land that does not qualify as a plinthic catena and in which one or more of the above soil forms occupy at least 40 % of the area. In red and yellow soils, high base status indicates land with red and yellow soils, each of which covers more than 10 % of the area while dystrophic and/or mesotrophic soils occupy a larger area than high base status red-yellow apedal soils (Land Type Survey Staff, 1987). Specifically, Ah land type indicates red and yellow, freely-drained sandy soils with a high base status and is often calcareous. Soil depth is often restrictive in places and is excessively freely-drained. Dominant forms encountered in this unit include Hutton and Clovelly.

The broad geological characteristics of the area are characterised by being underlain by the Archaean Beit Bridge Complex, except where it is covered by much younger Karoo sandstones and basalts. The Beit Bridge Complex consists of gneisses and metasediments and is structurally very complex. Variable soils from deep red/brown clays, moderately deep, dark, heavy clays to deep, freely drained sandy soils to shallower types including skeletal Glenrosa and Mispah soil forms. Land types mainly Ae, Ah, Fc and Db.

4 SURFACE WATER[1]

Water, salt and processes linked to concentration of both are the major controls of the creation, maintenance and development of peculiar habitats. Habitats formed in and around flowing and stagnant freshwater bodies, experience waterlogging (seasonal or permanent) and flooding (regular, irregular or catastrophic), leading to formation of special soil forms. Invariably, both waterlogged and salt-laden habitats appear as 'special', deviating strongly from the typical surrounding zonal vegetation. They are of azonal character (Mucina & Rutherford, 2006). Water, in conjunction with geology, soil, topography and climate, is responsible for the creation of remarkably many types of habitats. Water chemistry, temperature and temporary changes in both, together with the amount of water (depth of water column), timing of occurrence (regular tides or irregular floods) and speed of its movement (discharge, flow and stagnation) are the major factors shaping the ecology of biotic communities occupying such habitats (Mucina & Rutherford, 2006).

Areas of surface water contribute significantly towards the local and regional biodiversity due to atypical habitat that is present within ecotonal areas. Ecotones (areas or zones of transition between different habitat types) are occupied by species occurring in both the bordering

[1] Please note that it is not the intention of this report to present a detailed account of the wetland and aquatic habitat types of the area; this is addressed in a separate specialist report. However, certain aspects do related to the biodiversity of the study area and general comments pertaining to this attribute are therefore included in this report.

habitats and are generally rich in species due to the confluence of habitats. In addition to daily visitors that utilize the water sources on a frequent basis, some flora and fauna species are specifically adapted to exploit the temporal or seasonal fluctuation in moisture levels in these areas, exhibiting extremely low tolerance levels towards habitat variation. Ecotonal interface areas form narrow bands around areas of surface water and they constitute extremely small portions when calculated on a purely mathematical basis. However, considering the high species richness, these areas are extremely important on a local and regional scale. Rivers also represent important linear migration routes for several fauna species as well as a distribution method for plant seeds.

The study sites are situated within the Limpopo Catchment area, specifically in the A71K Quaternary Catchment Area. While no major rivers are present in the immediate surrounds, the Sand River is situated approximately 8.5 km to the north of the Farm Du Toit and the Mutamba River 12 km south of the Farm Vrienden. BGIS (2015) indicates no RAMSAR sites being present in the Musina Municipality.

The study sites exhibit attributes of periodic flooding with ill- and well-defined drainage lines and floodplains. More specifically, the north-western part of Farm Du Toit comprises a significant floodplain with a defined drainage line in which an artificial impoundment has been constructed. This drainage line flows northwards towards the Sand River, exhibiting atypical vegetation attributes. Similarly, ill-defined flood zones are noted on Farm Vrienden, which will contribute towards habitat diversity on a local scale. The presence and ecological contribution of these attributes, increases the habitat diversity of the farms and, ultimately, the perceived sensitivity. However, none of these attributed could be construed as a fatal flaw to the process.

5 TOPOGRAPHY, RELIEF & SLOPES

Topographical heterogeneity is recognized as a powerful influence contributing to the high biodiversity of southern Africa. Landscapes composed of spatially heterogeneous abiotic conditions provide a greater diversity of potential niches for plants and animals than do homogeneous landscapes. The species richness and biodiversity has been found to be significantly higher in areas of geomorphological heterogeneity. In general, the region is described as 'Extremely Irregular Plains' (ENPAT, 2002). While most of the proposed sites comprise of uniform and flat plains, some low outcrops and ridges are encountered across, particularly, Farm Vrienden. These areas are visually recognisable from aerial imagery and is strongly associated with surfacing of underlying geological formations. Whilst not representing significant topographical features, these features do contribute to habitat diversity on a local scale, although not exhibiting any significant atypical or distinguishing floristic characteristics (refer **Section C**).

6 REGIONAL CONSERVATION PLANNING

The Limpopo Conservation Plan version 2 (LCP) (Desmet 2013) assists with the development of the spatial component of a bioregional plan (*i.e.* map of Critical Biodiversity Areas (CBA) and associated land-use guidelines). Incomplete biodiversity datasets and coarse mapping of biodiversity features impose limitations on this plan, which although they do not restrict the application of the plan, need to be recognized and appropriately accommodated when used:

1. The conservation plan does not replace the need for site assessments, particularly for EIAs. Although it is based on a systematic conservation plan using best available data, this does not remove the need for on -site verification of the identified CBAs. Further, due to incomplete knowledge of the distribution of biodiversity features, it is likely that additional or alternative areas will need to be identified in the future as we gain a better understanding of rare, threatened, cryptic and understudied species;
2. This LCP is designed to be used at a scale of approximately 1:50 000. Although it can be used at a finer scale, this requires specialist interpretation of the specific biodiversity features identified in the systematic biodiversity plan; and
3. Ongoing changes in land-use, i.e. loss of natural habitat and changes in the distribution of biodiversity (*e.g.* in response to climate change), will impact on the identified network of Critical Biodiversity Areas. It is likely that in future additional areas would need to be designated as CBAs to meet biodiversity targets in future iterations of the plan.

Categories employed in the LCP (which are also spatially represented in the general project area), include the following (refer **Figure 8**):

» Critical Biodiversity Areas - Based on the LCP, 40 % of the province is designated as CBAs. These CBAs have been split into CBA 1 and CBA 2, based on selection frequency and the underlying characteristics of the biodiversity features that are being protected (*i.e.* location fixed features such as sites for CR species and flexible ones such as Least Cost Corridors). The majority of the CBAs in the province are CBA 1 (22 %), which can be considered "irreplaceable" in that there is little choice in terms of areas available to meet targets. If CBA 1 areas are not maintained in a natural state, then targets cannot be achieved. CBA 2's is considered "optimal" as there is significant design involved in their identification. CBA 2's comprises 18% of the province, and represent areas where there are spatial options for achieving targets and the selected sites are the ones that best achieve targets within the landscape design objectives of the plan; and

» Ecological Support Areas, spatially represented in Farms Du Toit and Vrienden, cover a further 22 % of the province, of which 16 % are intact natural areas (ESA 1) and 7 % are degraded or areas with no, or very little, natural habitat remaining, which are nevertheless required as they potentially retain some value for supporting ecological processes (ESA 2). Developments within these areas are generally subject to an EIA process that needs to demonstrate that no significant effects will result on remaining areas of natural habitat, or nearby CBAs

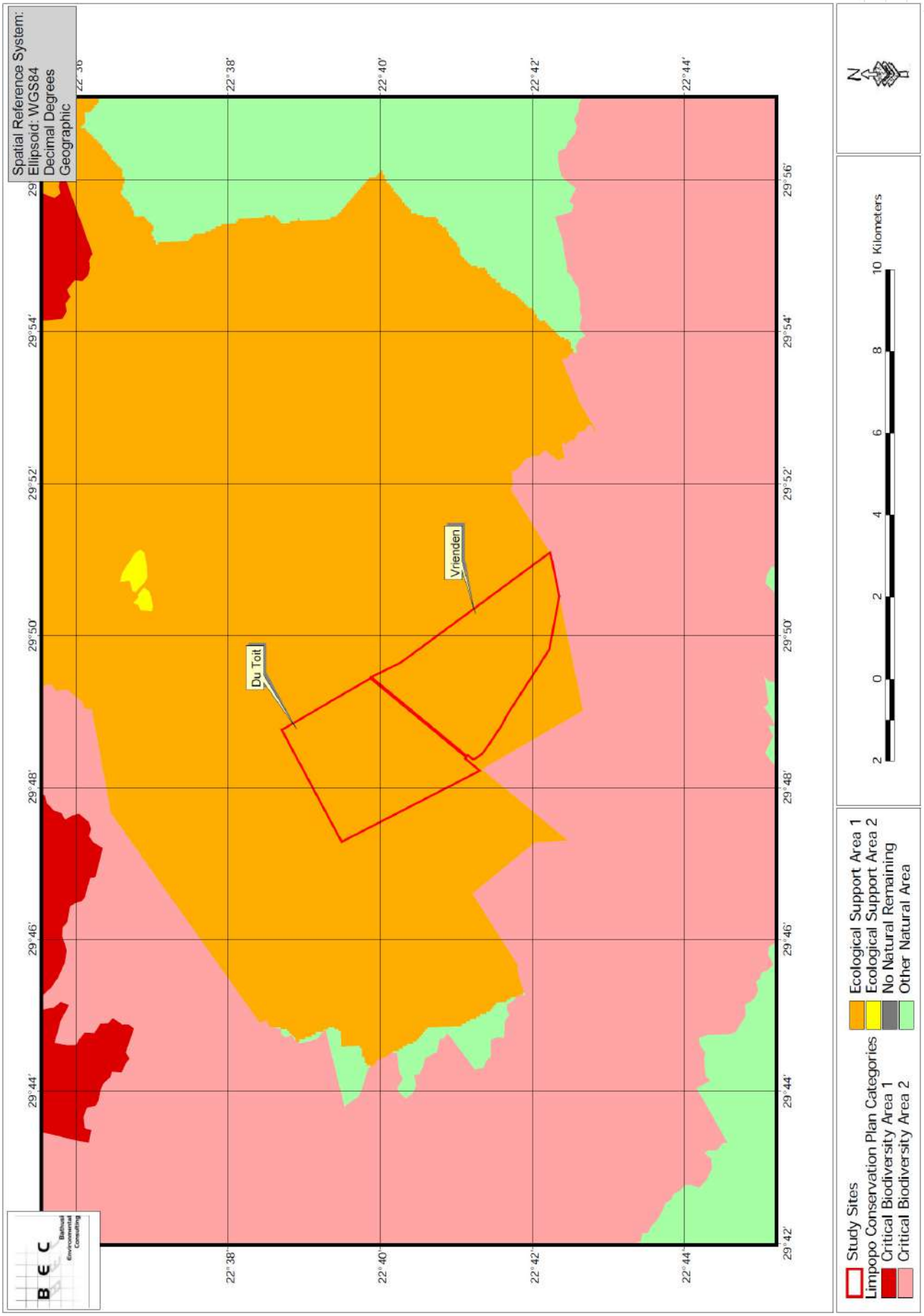


Figure 8: Illustration of regional conservation plan categories on a local scale

7 BACKGROUND TO THE SAVANNA ECOLOGY

The Savanna Biome is the largest biome in southern Africa, covering about 46 % of its area. The term savanna is widely accepted as describing a vegetation type with a well-developed grassy layer and an upper layer of woody plants. Many environmental factors correlate with the distribution of different savanna vegetation types, including landform, climate, soil types, fire and a very specific fauna. South African savannas of nutrient-poor substrates are characteristically broad-leaved and without thorns, while those of nutrient-rich substrates are fine-leaved and thorny. Nutrient-rich savannas have high grass layer productivity and the grasses are acceptable to grazers, resulting in a high grazing capacity (Knobel, 1999).

The diversity of African savanna is exceptional, comprising more than 13,000 plant species, of which 8,000 are savanna endemics. Specifically, dry savannas have more than 3,000. This diversity equals that of the South African grasslands and is exceeded only by the Fynbos Biome (Knobel 1999). Similarly, in respect of animal diversity, savannas are without peer, including approximately 167 mammals (15 % endemism), 532 birds (15 % endemism), 161 reptiles (40 % endemism), 57 amphibians (18 % endemism) and an unknown number of invertebrates (Knobel, 1999). Flagship species include the Starburst Horned Baboon Spider (Ceratogyrus bechuanicus), ground Hornbill (*Bucorvus leadbeateri*), Cape Griffon (*Gyps coprotheres*), Wild dog (*Lycaon pictus*), Short-Eared Trident Bat (*Cloeotis percivali*) and the White Rhino (*Ceratotherium simum*) (EWT, 2002).

Conservation within and of the savanna biome is good in principle, mainly due to the presence of several wildlife reserves. Urbanization is not a threat, perhaps because the hot, dry climate and diseases prominent in the savanna areas have hindered urban development. Much of the area is used for game farming and the importance of tourism and big-game hunting in the conservation areas must not be underestimated. Savannas are the basis of the African wildlife and ecotourism industry and play a major role in the meat industry.

Surprisingly little is known about the vegetation as most studies have been done in nature reserves and game farms, but five major regions are present, three of which are represented in the immediate region of the study sites. Sweet Bushveld occurs on fertile soils in the dry and hot valleys of the Limpopo River and the thorny, small-leaved vegetation is dominated by Acacia species that increase to dense, impenetrable thickets at the expense of the grass layer when overutilized. Mixed Bushveld varies from short, dense bushveld to a rather open tree savanna. On shallow, infertile soils the broad-leaved Red Bushwillow (*Combretum apiculatum*) dominates, whereas on deeper, leached soils the Silver Clusterleaf (*Terminalia sericea*) becomes dominant. The Waterberg moist mountain bushveld is a typical example of moist, infertile savanna. Due to the high proportion of unpalatable grasses, the area has become known as 'sour bushveld'. An interesting phenomenon is the presence of many plant species showing affinities with the flora of the Drakensberg, which indicates an ancient link with this range (Knobel, 1999).

The vegetation that characterizes this area has developed many survival strategies, including the ability to produce tannins that are triggered when the leaves are browsed, the production of toxic sap, the development of thorns or their adaptation to sourveld areas that are not

generally favoured by grazers. The interaction of vegetation, fire and animals play important roles in maintaining savanna ecosystems (Knobel, 1999).

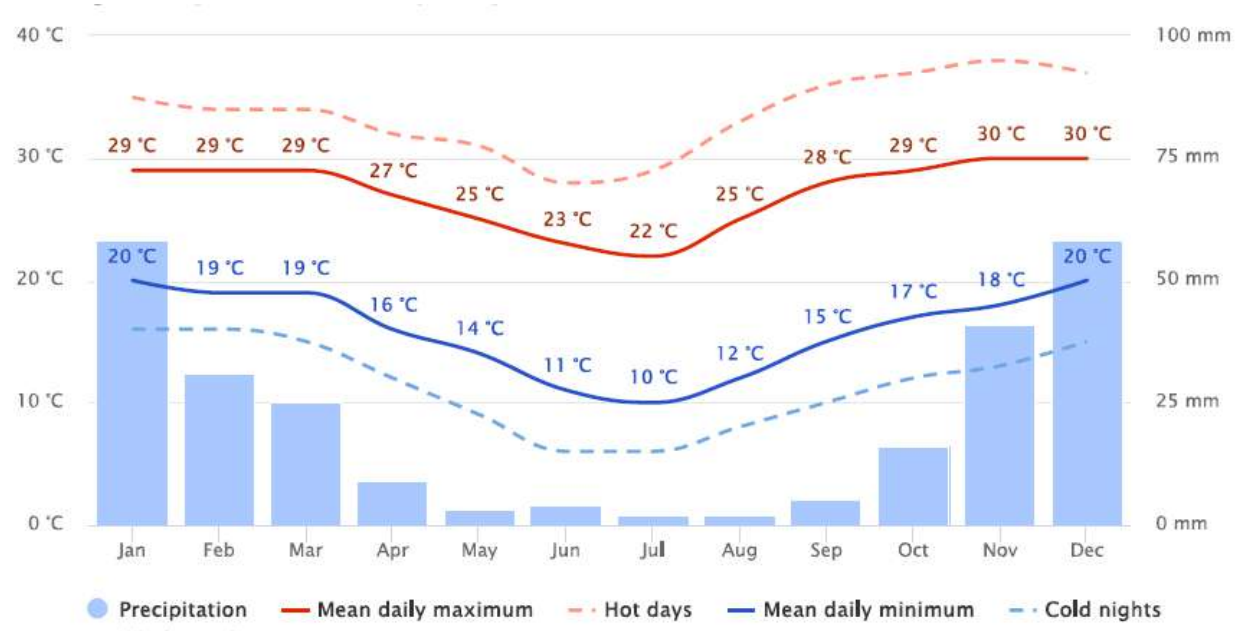
Over thousands of years, the savanna system and the antelope that inhabit them have developed side by side. Grasses, for example, have become well adapted to defoliation, as much a defensive response to constant pressure by grazers as to the regular veld fires that rage through the savanna in the dry seasons. The success of grasses has been a constantly renewed vast reservoir of food upon which large herds of grazers flourish. The woody component is also constantly exploited by many browsers, and with so many herbivores present, the carnivore component of the complex ecological system has also flourished (Knobel, 1999).

The savanna biome is populated by a greater diversity of bird species than any other biome in South Africa. The presence of both woody plants and a well-developed herbaceous layer provides diverse sources of food and shelter for specialist and generalist bird species, including seedeaters, insectivores and diurnal and nocturnal birds of prey abound.

Much of the area is used for game farming and big game hunting, illustrating that utilization and conservation of an area are not mutually exclusive. The savanna biome is the core of the wildlife, ecotourism and meat-production industries. Threats include rapidly expanding development of settlements for impoverished human populations and the associated need for firewood and building materials, diminishing water supply, agriculture and over-grazing (Knobel, 1999).

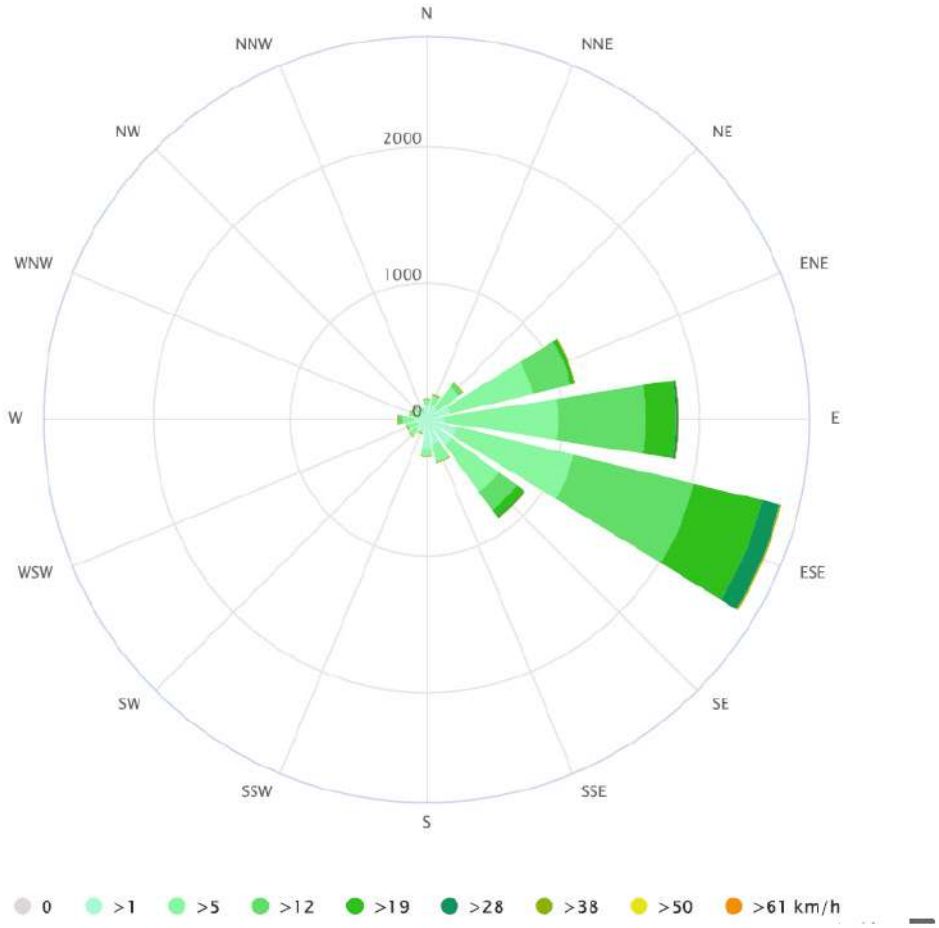
8 BROAD WEATHER STATISTICS

The climatic description for the typical climate in Musina region is BWh (Köppen Climate Classification), implying a Tropical and Subtropical Desert climate (BW – desert $P_{ann} \leq 5\ P_{th}$ &h – hot, $T_{ann} \geq +18°C$).



Graph 1: General climatic statistics for Mopane

courtesy of www.meteoblue.com

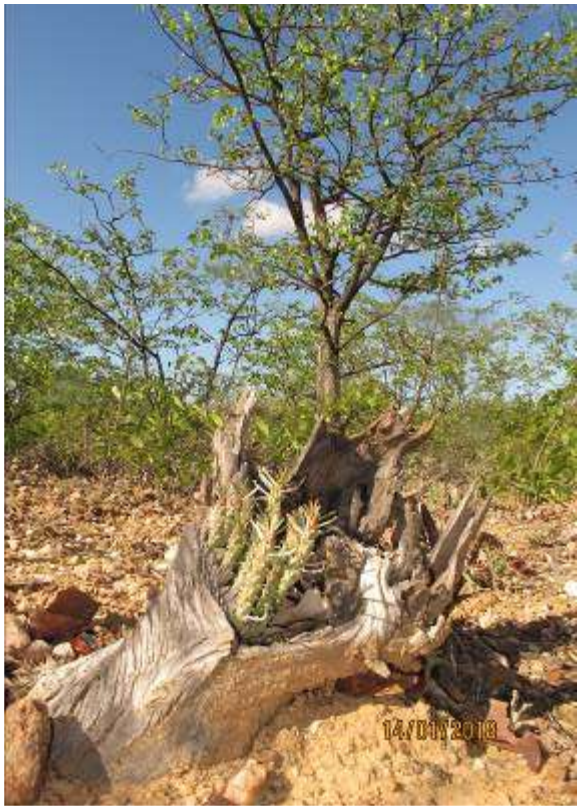


Graph 2: Wind direction and speeds for Mopane
courtesy of www.meteoblue.com

Typical climate for the region includes summer rainfall with very dry winters including the shoulder months of May and September. The mean annual precipitation varies between 300 and 400 mm. The region is normally frost-free, with mean monthly maximum and minimum temperatures between a maximum of 39.9°C and minimum of 0.9°C for November and June, respectively.

SECTION C – BOTANICAL ATTRIBUTES OF THE RECIEVING ENVIRONMENT

Riaan A. J. Robbeson (Pr.Sci.Nat.)



9 ABRIDGED METHOD STATEMENT

Focus areas include the Farm Du Toit 563 and Farm Vrienden 589 (excluding the section south of the main dirt road which passes through Farm Vrienden), comprising a total surface area of approximately 1 899 ha.

9.1 Baseline Survey

A site visit (during 12 - 19 January 2018) was conducted to collate baseline information on the floristic environment. Floristic data was compiled from a total of 58 sample plots that were placed in a stratified random approach across the study areas (refer **Figure 9**).

9.2 Sampling Approach

The number of sample plots to be distributed in a given area depends on various factors, such as the scale of the classification, environmental heterogeneity and the accuracy required for the classification (Bredenkamp 1982). Stratification of sample plots will be based on visual observations made during the initial site investigation as well as aerial imagery. The Zurich-Montpellier approach of phytosociology (Braun-Blanquet 1964) will be followed; this is a standardised and widely used sampling technique for general vegetation surveying in South Africa. During the surveys, all plant species in the sample plots and the cover and/or abundance of each species will be estimated according to the following Braun-Blanquet cover abundance scale:

+ infrequent, with less than one percent cover of total sample plot area
1 frequent, with low cover/ infrequent but with higher cover, 1-5 % cover of the total sample plot area;
2 abundant, with 5-25 % cover of total sample plot area:
  2A >5-12 %
  2B >12-25 %
3 >25-50 % cover of the total sample plot area, irrespective of the number of individuals
4 >50- 75 % cover of the total sample plot area, irrespective of the number of individuals
5 >75 % cover of the total sample plot area, irrespective of the number of individuals.

In addition, a relevant selection of the following biophysical attributes will be recorded within each relevè:

» Altitude- and longitude positions for each relevè - obtained from a GPS;
» Soil characteristics, including colour, clay content, etc;
» Topography (crests, scarps, midslopes, footslopes, valley bottoms, floodplains or drainage lines);
» Altitude, slope and aspect;
» Rockiness, estimated as a percentage;
» Rock size; and
» General observations (including the extent of erosion, utilisation, disturbances of the vegetation management practices, etc).

In addition to species captured within the sample plots, general observations will be made to compile a comprehensive species list that will include taxa that, because of low abundance levels, are unlikely to be captured within the sample areas. Specific reference is made to Red Data plants, which normally do not occur at great densities.

9.3 Phytodiversity Measurements

Phytodiversity is a measure of the number and variety of plants within a given area. Three main indices are used to indicate floristic species richness and diversity in the sampled areas, namely:

» Species richness (Alpha diversity) refers to the number of species represented in a set or collection of individuals in each of the releveès. It is a simple count of species, and it does not consider the abundance of the species or their relative abundance distributions;
» EstimateS analyses are implemented to present an estimation of the expected species richness of the areas, based on collated data from the surveys;
» The Shannon-Weiner diversity index presents an opinion on how species are distributed in an ecosystem or a community, taking cognisance of the species richness and relative abundance of each species in a community. Making use of the Shannon-Weiner values, the Evenness Index compares releveès by controlling for the number of species found within the communities; and
» The Simpsons Diversity Index quantifies the biodiversity of a habitat or relevè. It considers the number of species present (species richness), as well as the abundance of each species (Evenness).

9.4 Data Processing

The combined floristic and faunal data sets will be subjected to the Two-Way INdicator SPecies ANalysis technique (TWINSPAN) (Hill 1979) and subsequently refined by Braun-Blanquet procedures. TWINSPAN will be applied to derive a first approximation of the vegetation units. These classifications will be further refined by the application of Braun-Blanquet procedures to determine the plant communities. A phytosociological table showing the vegetation lines will be used to compile a synoptic table of the datasets. A synoptic table summarizes and confirms the vegetation types/ habitat types and variations. Relevant descriptions will follow from the data analysis, based on the presence/ absence and abundance of taxa.

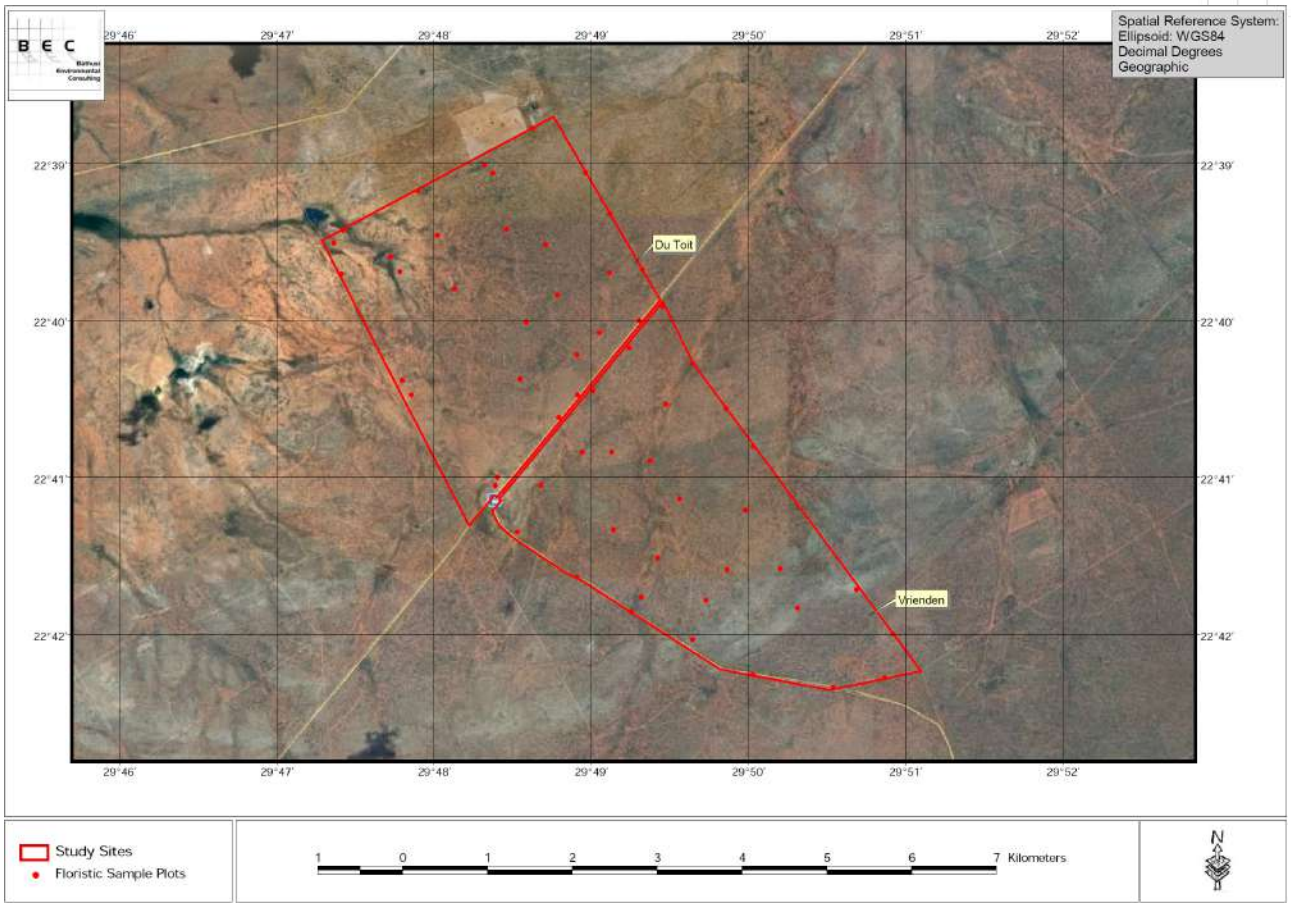


Figure 9: Spatial position of 58 floristic sample plots within the study area

10 REGIONAL FLORISTIC ATTRIBUTES

10.1 Regional Floristic Traits

The study area corresponds to the Savanna Biome and more particularly to the Central Bushveld Bioregion as defined by Mucina & Rutherford (2006), comprising an ecological type known as the Musina Mopane Bushveld (refer **Figure 10**). This unit is geographically situated in the Limpopo Province on undulating plains from around Baines Drift and Alldays in the west, remaining north of the Soutpansberg and south of the Limpopo River (but also occurring to the north in Zimbabwe), through Musina and Tshipise to Malongavlakte, Masisi and Banyini Pan in the east. Altitude ranges between 300 m (in the eastern Limpopo Valley) to 800 m.

Vegetation and landscape features of this type comprises undulating to very irregular plains, with some hills. In the western section, open woodland to moderately closed shrubveld dominated by *Colophospermum*[2] *mopane* on clayey bottomlands and *Combretum apiculatum* on hills. In the eastern section on basalt, moderately closed to open shrubveld is dominated by *Colophospermum mopane* and *Terminalia prunioides*. On areas with deep sandy soils, moderately open savanna dominated by *Colophospermum mopane*, *T. sericea*, *Grewia flava* and *Combretum apiculatum*. Field layer well developed (especially on the basalt), open during the dry season; the herbaceous layer is poorly developed in areas with dense cover of *Colophospermum mopane* shrubs, for example, north of Alldays bordering the Limpopo floodplain.

[2] Possible name change to *Hardwickia*, to be confirmed

The high palatability of the graminoid composition and the geographic position of the study area makes this vegetation type very suitable for game and livestock (mainly cattle) farming practices. The conservation status is set at Least Threatened; only 2 % is statutorily conserved mainly in the Mapungubwe National Park as well as in Nwanedi and Honnet Nature Reserves. Additionally, about 1 % is conserved in the Baobab Tree Reserve. Roughly, 3 % is transformed, mainly by cultivation. This unit is the most diverse Mopane veld type in South Africa. The Musina region has the highest species richness—also relative to *Colophospermum mopane*-dominated areas in Namibia and the Save River Valley in Zimbabwe (F. Siebert et al. 2003). The relationship of this unit with the adjacent and often fragmented parts of Limpopo Ridge Bushveld is spatially complex. It is very dependent on scale and has not been fully captured on the map.

Important taxa for this unit include|:

Tall Trees:	*Senegalia nigrescens, Adansonia digitata,* and *Sclerocarya birrea* subsp*. caffra*.
Small Trees:	*Colophospermum mopane, Combretum apiculatum, Senegalia senegal* var*. leiorhachis, Vachellia tortilis* subsp*. heteracantha, Boscia albitrunca, B. foetida subsp. rehmanniana, Commiphora glandulosa, C. tenuipetiolata, C. viminea, Sterculia rogersii, Terminalia prunioides, T. sericea,* and *Ximenia americana*.
Tall Shrubs:	*Grewia flava, Sesamothamnus lugardii, Commiphora pyracanthoides, Gardenia volkensii, Grewia bicolor, Maerua parvifolia, Rhigozum zambesiacum,* and *Tephrosia polystachya*.
Low Shrubs:	*Acalypha indica, Aptosimum lineare, Barleria senensis, Dicoma tomentosa, Felicia clavipilosa* subsp*. transvaalensis, Gossypium herbaceum* subsp*. africanum, Hermannia glanduligera, Neuracanthus africanus, Pechuel-Loeschea leubnitziae, Ptycholobium contortum,* and *Seddera suffruticosa*.
Succulent Shrub:	*Hoodia currorii* subsp*. lugardii*.
Herbaceous Climber:	*Momordica balsamina*.
Graminoids:	*Schmidtia pappophoroides, Aristida adscensionis, A. congesta, Bothriochloa insculpta, Brachiaria deflexa, Cenchrus ciliaris, Digitaria eriantha* subsp*. eriantha, Enneapogon cenchroides, Eragrostis lehmanniana, E. pallens, Fingerhuthia africana, Heteropogon contortus, Sporobolus nitens, Stipagrostis hirtigluma* subsp*. patula, S. uniplumis, Tetrapogon tenellus,* and *Urochloa mosambicensis*.
Herbs:	*Acrotome inflata, Becium filamentosum, Harpagophytum procumbens* subsp*. transvaalense, Heliotropium steudneri, Hermbstaedtia odorata,* and *Oxygonum delagoense*.
Succulent Herbs:	*Stapelia gettliffei* and *S. kwebensis*.

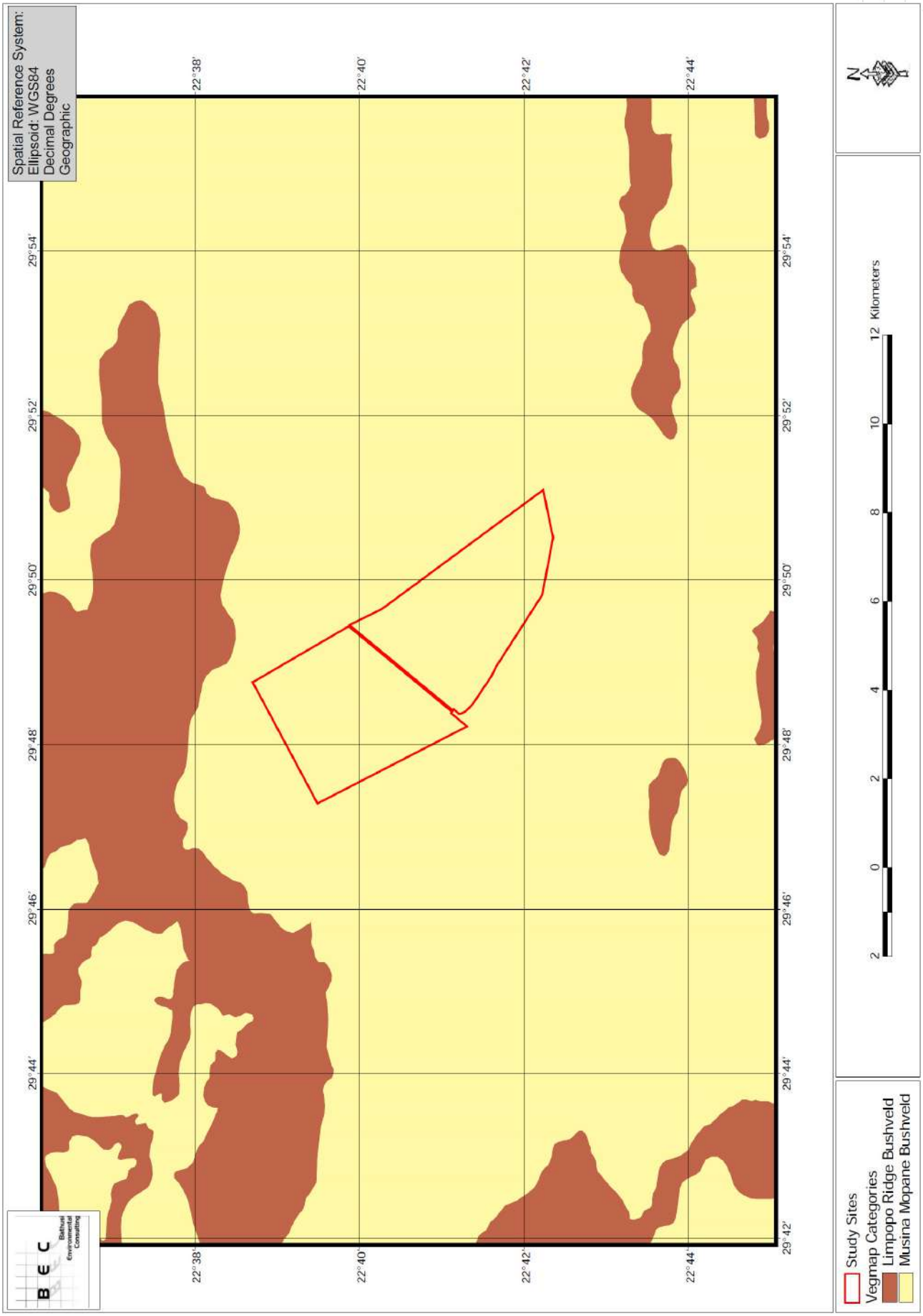


Figure 10: Vegmap categories of the surrounding region

10.2 Regional Phytodiversity

The SANBI database was consulted to provide a brief account of the known regional phytodiversity; the presence of 59 plant species within the ¼-degree grid (2229DB) has been recorded, reflecting a poor knowledge of the floristic diversity of the area in general. Detailed assessments during the EIA phase of the project will afford the opportunity to contribute to the floristic knowledge of the region by submission of sampling records to SANBI.

10.3 Plants of Conservation Importance

The assessment of plants of conservation concern and importance is based on the following legislative sets:

» Union for Conservation of Nature;
» National Forests Act of 1998; and
» Limpopo Environmental Management Act (Act no 7 of 2003).

South Africa's Red List system is based on the IUCN Red List Categories and Criteria Version 3.1 (finalized in 2001), amended to include additional categories to indicate species that are of local conservation concern (refer **Figure 11**). The IUCN Red List system is designed to detect risk of extinction. Species that are at risk of extinction, also known as threatened or endangered species are those that are classified in the categories Critically Endangered (CR), Endangered (EN) and Vulnerable (VU).

The **absence** of conservation important taxa from the regional sampling records reflects on a high paucity of accurate floristic data for the region rather than a true lack of plants of conservation importance from the region. Taking cognisance of the status and availability of habitat within the site and surrounds, the possibility that plant species of conservation importance would persist within the region cannot be discounted at this stage of the process. This paucity of accurate floristic data is confirmed by results of the surveys that confirmed the presence of several plant species of conservation concern. It is therefore likely that, provided ideal climatic conditions, plants of conservation importance would persist within the region. Although not within the scope of this investigation, several seasonal surveys will be needed to confirm (or refute) the statement.

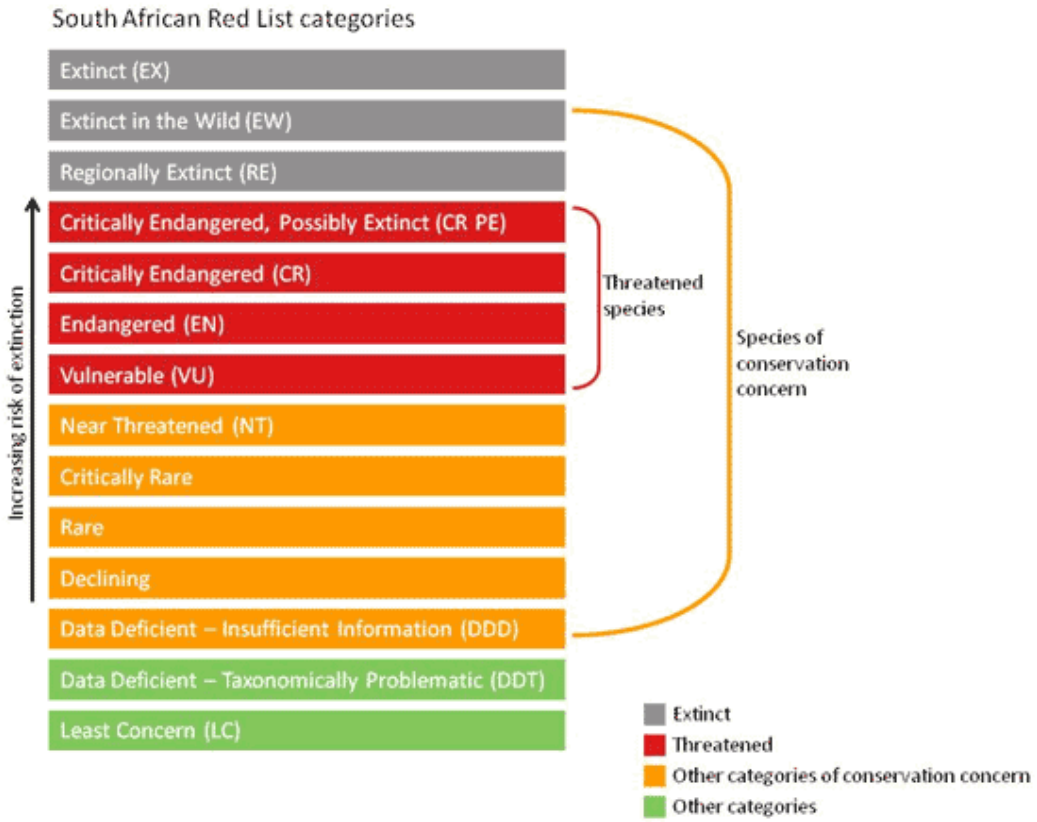


Figure 11: South African Red List Categories (courtesy of SANBI)

10.3.1 2018 Survey Results

⇒ **Union for Conservation of Nature (IUCN)**

No plant species with IUCN status were recorded during the brief survey effort. However, taking cognisance of the habitat variability and existing status of the environment, the likelihood of plants of conservation concern persisting within the study area cannot be excluded. Although not within the scope of this investigation, several seasonal surveys will be needed to confirm (or refute) the statement as challenging climatic and seasonal conditions might imply that Red Data species are not prevalent on annual and seasonal repetitive basis. It is also known that some species flowers during the austral winter period and a summer survey is not likely to establish th presence of these particular species. Ideally, particularly since the vegetation of this region is generally accepted to be summer prevalent, a walkdown of the development footprint should be done prior to the commencement of the construction activities to allow for the implementation of mitigation strategies.

⇒ **National Forests Act of 1998**

In terms of the National Forests Act of 1998, certain tree species can be identified and declared as protected. All trees occurring in natural forests are also protected in terms of the Act. Protective actions take place within the framework of the Act as well as national policy and guidelines. Trees are protected for a variety of reasons, and some species require strict protection while others require control over harvesting and utilization. In terms of the National Forests Act of 1998, protected tree species may not be "cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold, except under license granted by the Department of Water Affairs and

Forestry (or a delegated authority)". It is therefore necessary to conduct a survey that will determine the number and relevant details pertaining to protected tree species on the property for the submission of relevant permit applications to authorities prior to the disturbance of these individuals (refer **Appendix 3**). **Table 9** presents a list of protected trees that have been recorded within the study sites.

The localised presence of massive *Adansonia digitata* is regarded an important consideration; every opportunity was taken to georeference the presence of these individuals within the properties. Several individuals with an estimate circumference in excess of 15 m were recorded.

Table 9: Protected trees recorded in the study area (NFA, 1998)

Binomial Name	*Family*	*Status*
Adansonia digitata L.	Malvaceae	Protected Tree (National Forest Act, 1998)
Boscia albitrunca (Burch.) Gilg & Gilg-Ben.	Capparaceae	Protected Tree (National Forest Act, 1998)
Combretum imberbe Wawra	Combretaceae	Protected Tree (National Forest Act, 1998)
Sclerocarya birrea (A.Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro	Anacardiaceae	Protected Tree (National Forest Act, 1998)

10.3.2 The age of Adansonia digitata trees

Several *Adansonia digitata* individuals with significant physical dimensions were recorded within the study areas. Although it is extremely likely that more of these individuals will be present (which should be determined through a final walkdown of the proposed site prior to construction commencing), the location of some are indicated in **Figure 14.**

As other tree species, the estimation of age of an individual by counting growth rings in the main stem of Baobabs is not possible; growth rings are problematic to observe and counted in certain areas of the trunk of old baobabs and because of the presence of large internal hollows. These massive hollows can be observed within some of the individuals that occur within the study area on the two farms. Hence, the only accurate method for aging baobabs is radiocarbon dating of wood samples collected from their trunk. Up to the present, the oldest dated African baobab is Grootboom, a very large specimen that collapsed recently in Namibia and was investigated by accelerator mass spectrometry (AMS). According to the dating results, its calibrated age was at least 1 275 yr (Patrut et al. 2007). Recently, a radiocarbon dating of Makulu Makete (South Africa) indicated a calibrated age of approximately 1 000 years. Samples taken indicated that the conventional growth rate of the trunk, estimated by the radial increase, declined gradually over its life cycle. However, the growth rate expressed more adequately by the cross-sectional area increase and by the volume increase accelerated up to the age of 650 yr and remained almost constant over the past 450 yr (Patrut, et. al. 2007).

Forming an integral part of the ecological infrastructure of the local region, this tree exhibits significant contributions, including foraging and roosting habitat for bats, mammals, birds, and invertebrates. Taking cognisance of the popular and scientific opinions on the age that this species can achieve, it is estimated that most of the large *Adansonia* individuals on the farms could be adjudged older than 500 years, with the largest ones close to 1 000 years (i.e. on Farm Vrienden).

Although this species is abundantly encountered throughout the study area, location of these large individuals is regarded important in terms of the placement of the footprint and impacts on these individuals should be avoided.

⇒ **Limpopo Environmental Management Act (Act no 7 of 2003)**

The LEMA provides for the consolidation and amendment of the environmental management legislation of, or assigned to the Province, and to provide for matters incidental thereto. In particular, Schedule 11 (Specially protected plants) and Schedule 12 (Protected plants) have relevance to this section. **Table 10** provides a list of protected plant taxa that have been recorded during the brief site investigation.

Table 10: Protected plants (LEMA) recorded during the surveys

Taxon	*Family*	*Status*
Adansonia digitata L.	Malvaceae	Protected plant, Schedule 12 (LEMA)
Adenium multiflorum Klotzsch	Apocynaceae	Protected plant, Schedule 12 (LEMA)
Hoodia currorii (Hook.) Decne. subsp. *lugardii* (N.E.Br.) Bruyns	Apocynaceae	Protected plant, Schedule 12 (LEMA)

10.4 Recorded Phytodiversity (2018)

Phytodiversity is a measure of the number and variety of plants within a given area. Three main indices are used to indicate floristic species richness and diversity in the sampled areas, namely:

» Species richness (Alpha diversity) refers to the number of species represented in a set or collection of individuals in each of the releveès. It is a simple count of species, and it does not consider the abundance of the species or their relative abundance distributions. EstimateS analysis presents an estimation of the expected species richness of the areas, based on collated data from the 2018 surveys;

» The Shannon-Weiner diversity index presents an opinion on how species are distributed in an ecosystem or a community, taking cognisance of the species richness and relative abundance of each species in a community. Making use of the Shannon-Weiner values, the Evenness Index compares releveès by controlling for the number of species found within the communities; and

» The Simpsons Diversity Index quantifies the biodiversity of a habitat or relevè. It considers the number of species present (species richness), as well as the abundance of each species (Evenness).

10.4.1 Species Richness – Alpha Diversity

The survey yielded an Alpha Diversity of only **120 plant taxa**, which, although relatively poor, is regarded as representative of the floristic diversity on a regional scale, particularly in view of the typical species poor attribute that is associated with Mopane veld. Climatic constraints (drought) attributed considerably to the relatively low alpha diversity; specifically, growth forms such as graminoids, forbs and herbs were either extremely problematic to identify correctly and displayed a diversity that is lower than would be anticipated under more ideal conditions.

A list of the recorded plant species, together with their growth forms, medicinal/ traditional uses and colloquial names is presented in **Appendix 1**. A basic synopsis of the growth forms recorded in the study area reflects the major physiognomic variations that are present in the study area (refer **Table 11**). A prominent woodland physiognomy is typically dominated by a relatively diverse stratum, comprising of 50 species (small trees, shrubs, trees (41.7 %). Climatic conditions precluded the compilation of a comprehensive inventory of the herbaceous layer. Similarly, a poor compliment of grasses was recorded with only 19 species (15.8 %).

Table 11: Growth forms recorded in the study area

Growth Form	*Number*	*Percentage*
Climbers	5	4.2%
Dwarf shrubs	13	10.8%
Forbs	15	12.5%
Geophytes	3	2.5%
Grasses	19	15.8%
Herbs	1	0.8%
Parasites	1	0.8%
Prostrate herbs	7	5.8%
Shrubs	13	10.8%
Small trees	17	14.2%
Succulents	6	5.0%
Trees	20	16.7%
Total	**120**	

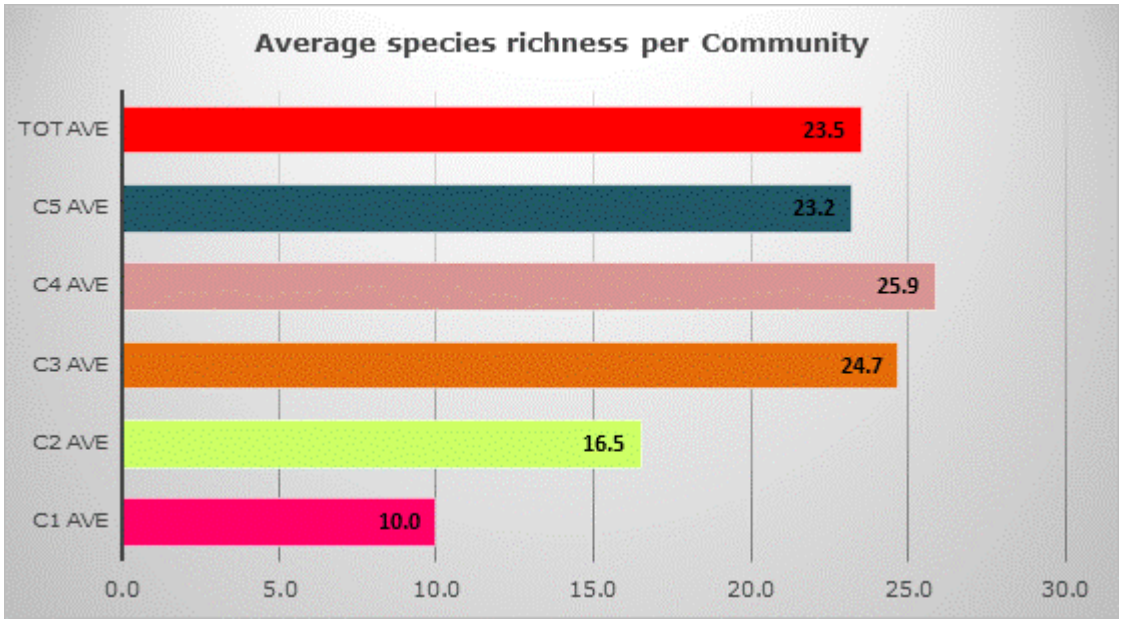
The diversity of plants within the study area is represented by only 34 plant families (refer **Table 12**), dominated by Poaceae (graminoids, 19 species, 15.8% %) and Fabaceae (legume family, 18 species, 15.0 %) and Malvaceae (13 species, 10.8 %).

Table 12: Plant families recorded in the study area

Family	*Number*	*Percentage*
Acanthaceae	6	5.0%
Amaranthaceae	3	2.5%
Anacardiaceae	2	1.7%
Apocynaceae	3	2.5%
Asteraceae	7	5.8%
Bignoniaceae	2	1.7%
Boraginaceae	3	2.5%
Brassicaceae	1	0.8%
Burseraceae	7	5.8%
Caesalpiniaceae	2	1.7%
Capparaceae	3	2.5%
Celastraceae	1	0.8%
Combretaceae	3	2.5%
Convolvulaceae	2	1.7%
Cucurbitaceae	1	0.8%
Euphorbiaceae	4	3.3%
Fabaceae	18	15.0%
Lamiaceae	1	0.8%
Liliaceae	3	2.5%
Loganiaceae	1	0.8%
Loranthaceae	1	0.8%
Malvaceae	13	10.8%
Molluginaceae	1	0.8%

Table 12: Plant families recorded in the study area		
Family	*Number*	*Percentage*
Olacaceae	1	0.8%
Pedaliaceae	2	1.7%
Poaceae	19	15.8%
Rhamnaceae	1	0.8%
Scrophulariaceae	1	0.8%
Simaroubaceae	1	0.8%
Sterculiaceae	2	1.7%
Tiliaceae	1	0.8%
Velloziaceae	1	0.8%
Vitaceae	2	1.7%
Zygophyllaceae	1	0.8%

The average number of species recorded in releveès during the survey period is 23.5 per sampling bout (std. dev. = ±6.0). The lowest total was 6 (Rel 19), with 33 (Rel 1) the highest number of individuals (refer **Graph 4**.[3] Alpha richness results of respective Twinspan communities are illustrated in **Graph 3**, revealing a poor species diversity associated with atypical habitat types and a uniform diversity of species (also reflecting structural homogeneity) across the typical arid broadleaf savanna of the sites.



Graph 3: Average species richness per Community

10.4.2 Estimate-S Analysis

While Alpha Diversity provides an indication of the total number of species that were recorded within a certain area (community or habitat) and along several repetitions (relevèes/ sampling bouts), it does not provide any information on how well each of the species is represented in the sampled area. Species diversity is a measure of both the number of species (species richness) and the relative contribution of each of these species to the total number of individuals in a community (evenness). Evenness is also an important characteristic that is used to assess the status of an area/ community or habitat. Pristine areas are generally

[3] Colour coding of sample releveès is set according to TWINSPAN communities, refer Section 10.5

characterised by a high evenness with several co-dominant species. Forms of degradation or human related impacts generally affect the abundance levels of species, with poor quality species increasing while sensitive species will decrease in abundance or disappear altogether. This effect is easily observed in areas where high grazing pressure is sustained; poor quality species dominate the species composition and physiognomy and good quality grasses and forbs that are mostly associated with pristine conditions generally disappear.

EstimateS (Colwell, 2006) was used to appraise the collated data. It is designed to determine the accuracy and comprehensiveness of the sampling procedure and, given the collated data, also provide an estimation of the number of species that should be present in the habitat. Species abundance values were replaced by presence/ absence indications prior to the analysis. Results are illustrated in **Graph 5**.

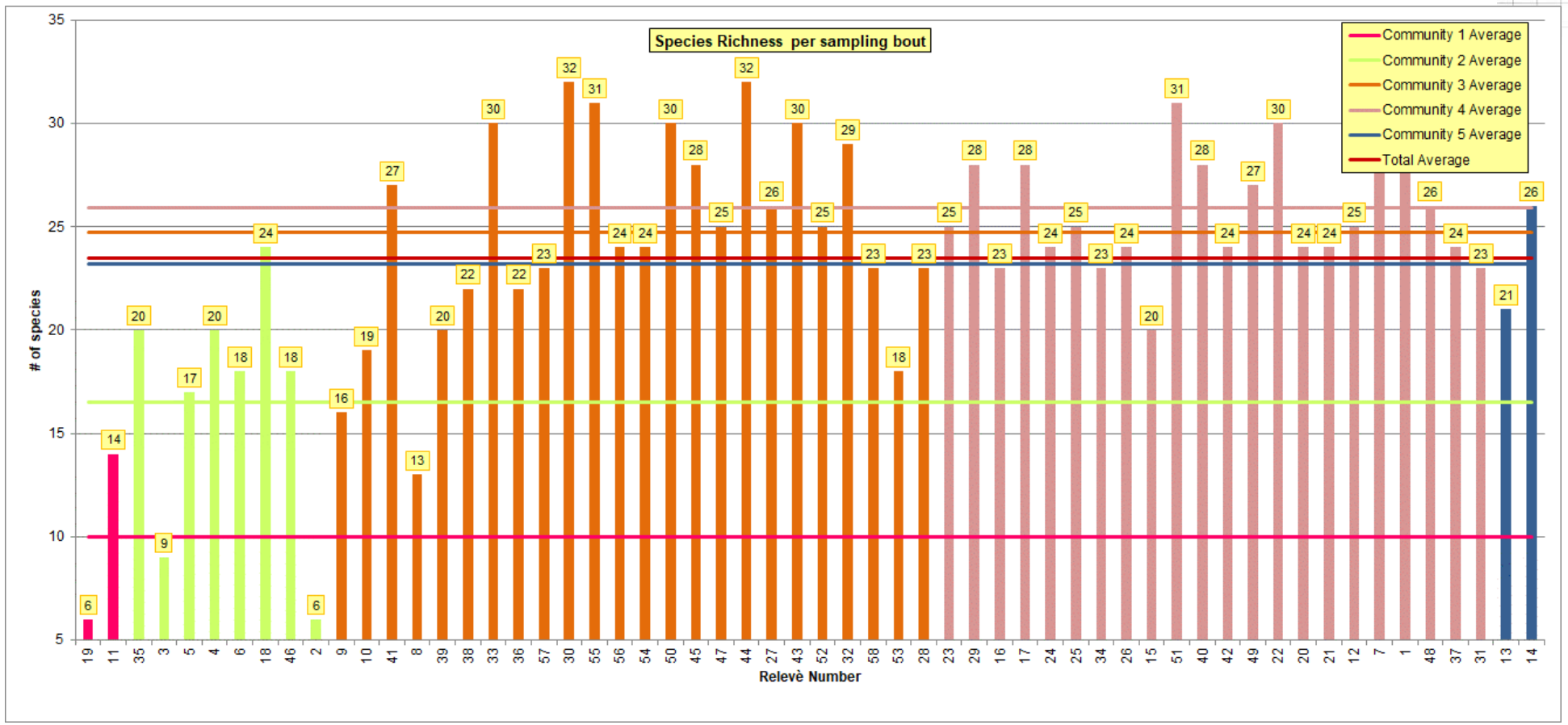
Comments

The X-axis represents the number of times the study area was sampled. The Y-axis represents species richness, or simply the number of species present or estimated. The bootstrap analysis of the observed species revealed the following aspects:

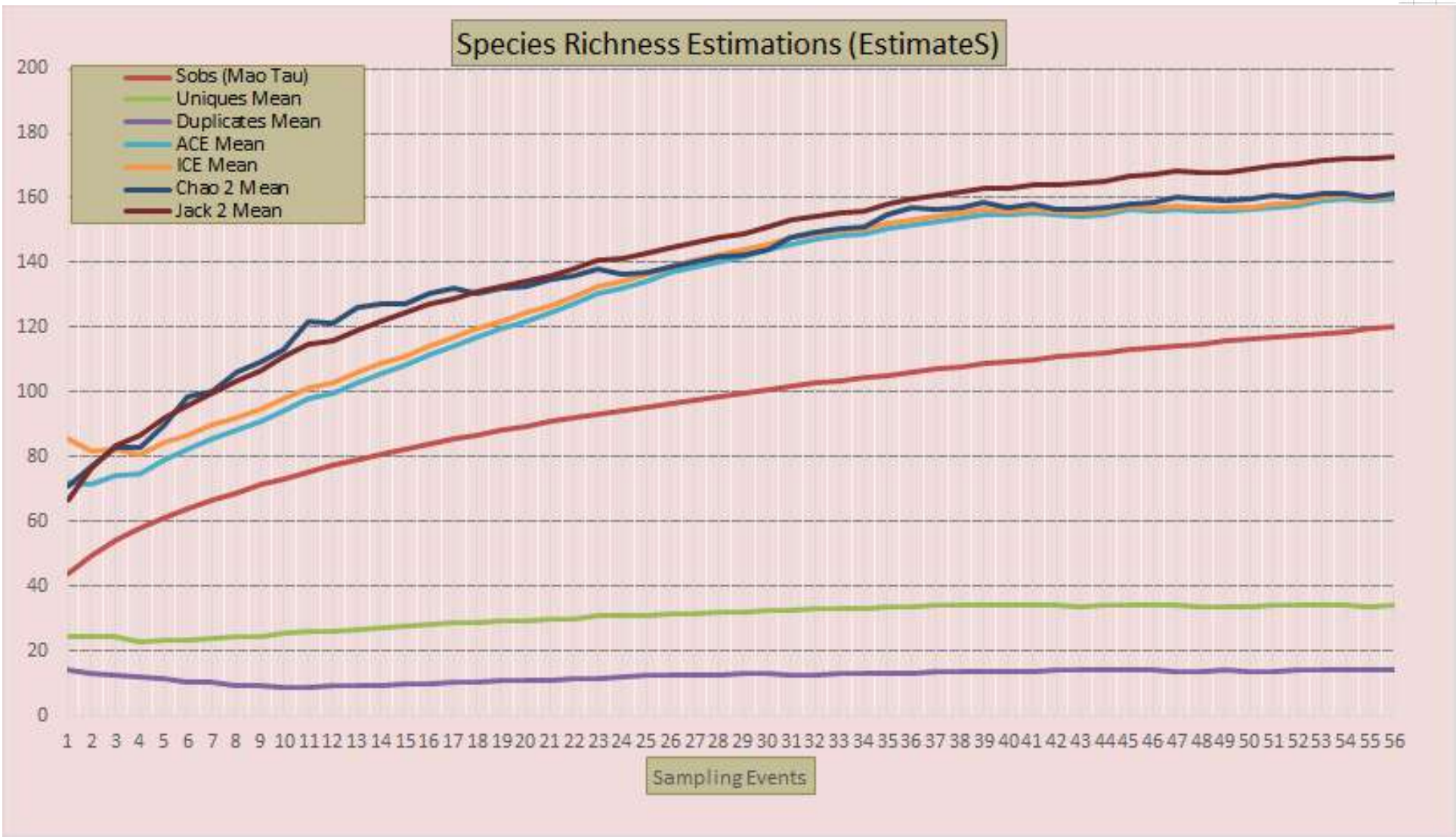
» Sobs (# of species observed) – The number of species is beginning to asymptote (levelling off), although not completely. If the same species are being sampled throughout the sampling bouts, it is expected that the Sobs indicator will asymptote completely. In this particular case, the numbers continue to increase with each additional sampling event, albeit slightly. It is therefore expected that, with additional sampling, the number of species identified within the study region will increase further, although not significantly.

» Uniques/ Duplicates - The ratio of uniques to duplicates represents a comparison of the number of species that occurred once in the pooled sample plots to those that occurred twice. Simply put, if the number of uniques keeps on increasing, the expectation is that many new species are likely to be recorded. However, if the number of duplicates increases (usually when the uniques and duplicates lines cross), the sampling process is producing more of the same species instead of new ones. Evidence from **Graph 5** indicates that the ratio remains the same, i.e. there is only a small difference between the number of uniques and duplicates, indicating that further sampling is not expected to produce significant numbers of additional new species.

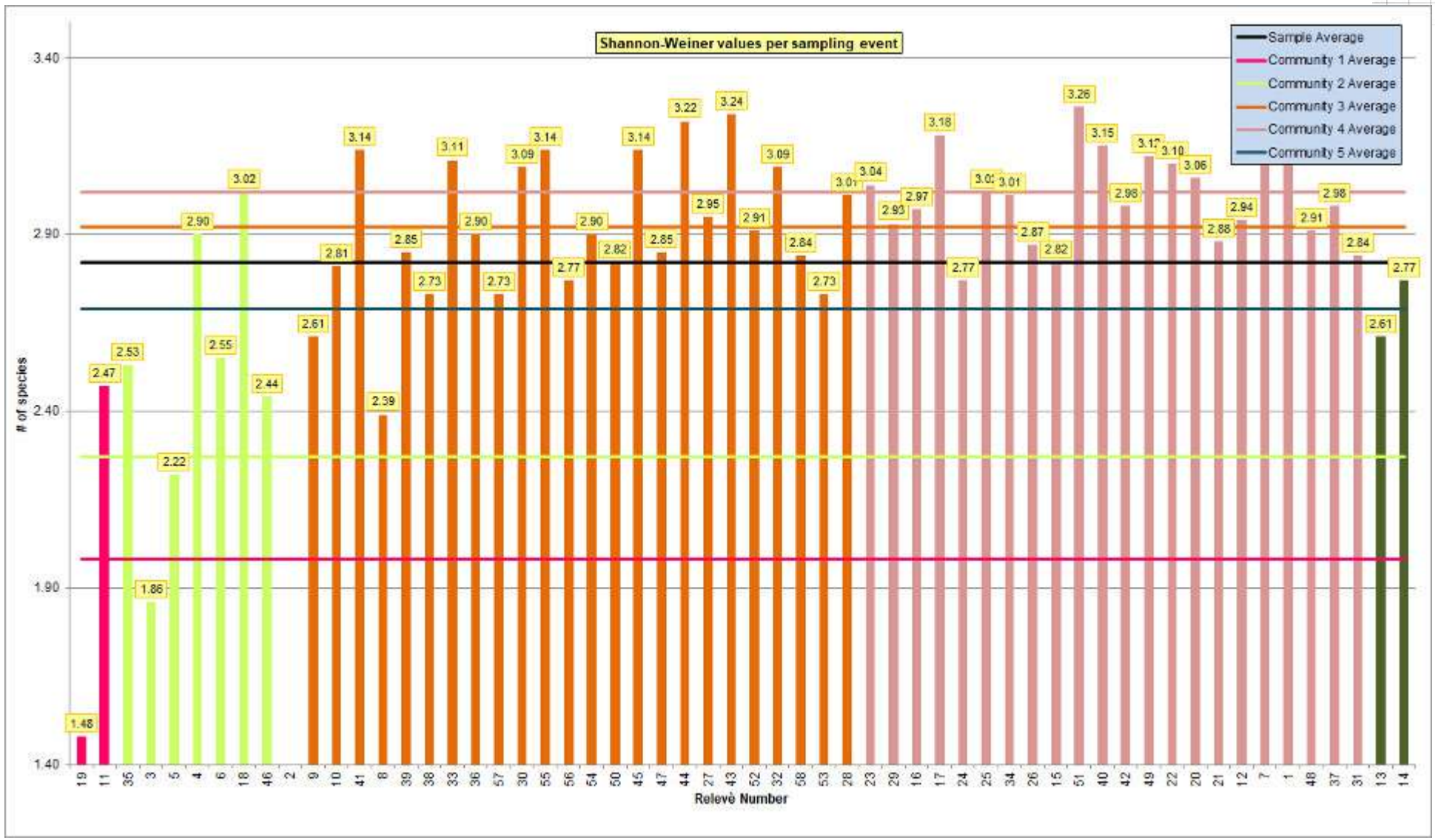
» Estimator Calculators – the variety of estimator (bootstrap) calculators (ACE, ICE, Chao, Jack) used in the analysis provides predictions of the estimated number of species that could be expected given the sampling bouts. These estimators generate predictions based largely on the total number of species found given a certain number of pooled samples and the ratio of uniques to duplicates found within the pooled sample. The actual number of species recorded during the sampling process is 120, while the predictors estimate a species richness of between 160 and 173 species, which confirms the climatic constraints that were mentioned.



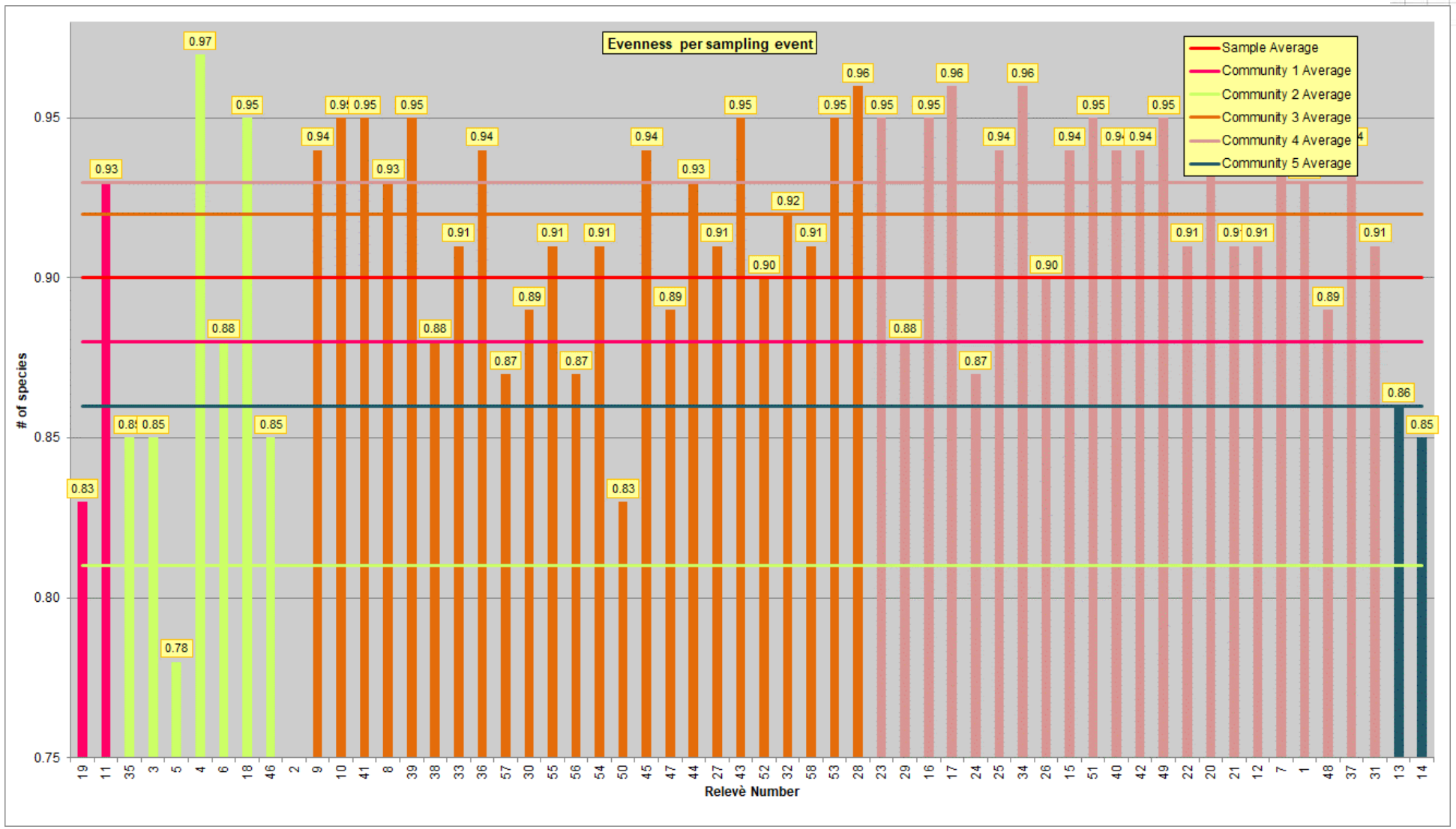
Graph 4: Alpha species richness per sampling bout



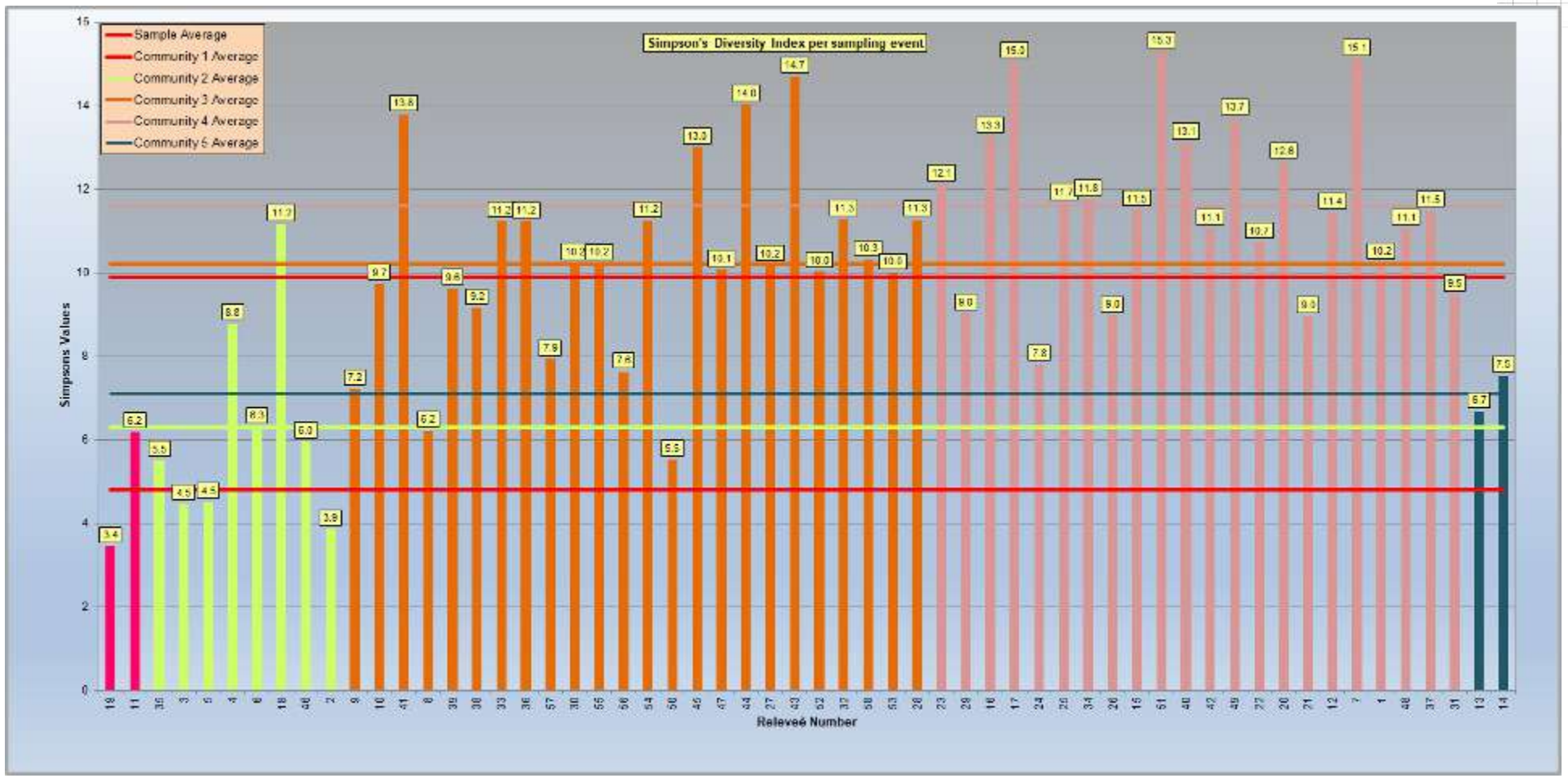
Graph 5: Estimate S analysis of predicted species richness



Graph 6: Shannon Weiner values per sampling event (presented in community clusters)



Graph 7: Evenness values per sampling event (presented in community clusters)



Graph 8: Simpsons Diversity Index values per sampling event (presented in community clusters)

10.4.3 Shannon-Weiner Index (H')

The Shannon-Weiner diversity index (H') looks at how species are distributed in an ecosystem or a community. This index therefore considers both the species richness and the relative abundance of each species in a community to determine the uncertainty that an individual picked at random will be of a given species. H is calculated with the following formula, where p_i is the proportion of species belonging to the *i*th type of letter in the string of interest. In ecology, p_i is often the proportion of individuals belonging to the *i*th species in the dataset of interest:

$$H' = -\sum_{i=1}^{R} p_i \log p_i$$

Biologically realistic H' values range from 0 (only one species is present with no uncertainty as to what species each individual will be) to about 4.5 (high uncertainty as species are relatively evenly distributed). In general, it is thought that more disturbed and less stable environments should have lower H' values. The index is maximized when all species have the same number of species. Sampling bouts that display a high discrepancy between the numbers of individuals that inhabit a community will logically therefore display a low index value.

For this particular dataset, the average Braun-Blanquet values were used to calculate the index, as follows:

+ 1 %;
1 3 %;
2A 9 %;
2B 18 %;
3 38 %; and
4 63 %.

Comments
Results are illustrated in **Graph 6** (colour precedence and order of releveès are set according to TWINSPAN results, refer **Section 12)**.

Values range between a minimum of 0.62 (rel. 2, 6 species) and a maximum of 3.30 (rel 7, 31 species) (average 2.82, std. dev. = ±0.44), indicating a moderately low diversity of species within the study area. This correlates well with historic knowledge of the area on a local as well as regional scale. Traditionally the area, also with reference to the Savanna Biome, is not known to exhibit high local floristic diversity values, mainly because of homogenous biophysical attributes. However, considered on a regional scale, the diversity of the Savanna Biome approximates that of the Grassland Biome.

10.4.4 Evenness Index

Evenness (E) is an index that makes the H' values (Shannon-Weiner) comparable between releveès by controlling for the number of species found within the communities. H'max represents the highest possible value if you have a given number of species in a community

(216 in this case) and each of the species was equally represented in the community. Therefore:

H'max = ln(S) (where S = total # of species)

H'max = ln(216)

H'max = 5.3752

Evenness for each of the releveès is therefore calculated by the following formula:

E = H' / H'max

Evenness values of respective releveès are illustrated in **Graph 7**

Comments

An average of 0.90 (std. dev. = ± 0.08) is calculated for the dataset. Areas that are slightly deteriorated, or where anthropogenic effects caused a disturbance in the species composition and abundance values (Community 5), the Evenness were characterised by high values. Areas where the flora is characterised by a low species diversity, the calculated Evenness values were moderate. Closed woodland habitat (Community 3) were characterised by high Evenness values, compared to Open woodland (Community 4) where the Evenness values were considerably lower, providing evidence of the disproportionate distribution of species abundance in the Open woodland areas that reflects a slightly deteriorated status, probably because of elevated and persistent grazing pressure.

10.4.5 Simpson's Diversity Index

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It considers the number of species present (species richness), as well as the abundance of each species (evenness). Simpson's Index (D) measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). The following formula is used to calculate Simpson's Index:

$$D = \frac{1}{\sum_{i=1}^{s} p_i^2}$$

With this index, 0 represents infinite diversity and 1 no diversity. That is, the bigger the value of D, the lower the diversity.

a) Simpson's Index of Diversity: 1 - D

The value of D, as calculated above is neither intuitive nor logical, so to counter this problem, D is often subtracted from 1. The value of this index still ranges between 0 and 1, but now, the greater the value, the greater the sample diversity.

b) Simpson's Reciprocal Index 1/D

Another way of overcoming the problem of the counter-intuitive nature of Simpson's Index is to take the reciprocal of the Index (1/D). The value of this index starts with 1 as the lowest possible figure. This figure would represent a community containing only one species. A higher calculated value therefore indicates a greater diversity. The maximum value is the

number of species (or other category being used) in the sample. For example, if there are five species in the sample, then the maximum value is 5.

Comments

Results are illustrated in **Graph 8**. Values ranges in a fairly narrow width, with an average of 9.92 for the entire sampling event; indicating a low of 3.4 in the ephemeral pan habitat and high averages of 10.2 and 11.6 for the typical open and closed woodland habitat types. The standard deviation for the sample set is ±2.96. The narrow width of Simpson's values across the sample set also correlates to the largely homogenous nature of the flora of the study sites, with strong deviations indicated by atypical and anthropogenically affected areas.

Table 13: Summary of Diversity Indices, indicating community averages

Community	*Species Richness*	*Shannon Weiner Index*	*Evenness Index*	*Simpson's Index*
SAMPLE AVERAGE	**23.5**	**2.82**	**0.86**	**9.9**
C1 – *Comb imb – Phyl ret* pans	10.0	1.98	0.88	4.8
C2 – *Vach gra – Bosc foe* watercourses & calcareous plains	16.5	2.27	0.81	6.3
C3 – *Comb api – Grew fle* open woodland	24.7	2.92	0.82	10.2
C4 – *Comb api – Grew fle* closed woodland	25.9	3.02	0.92	11.6
C5 – *Vach tor – Cien dig* old fields	23.2	2.69	0.93	7.1

10.5 Plants with traditional and medicinal uses/ properties

Table 14 provides an annotated list of plants recorded within the study sites with traditional and medicinal uses.

Table 14: Plants with traditional medicinal values and uses recorded in the study area

Binomial name	*Status/ Traditional values*	*Colloquial name*
Boscia albitrunca (Burch.) Gilg & Gilg-Ben.	Protected Tree (National Forest Act, 1998), important fodder, traditional uses, traditional medicinal uses	Sheperd's Tree (e), Witgat (a), Matoppie (a), Mohlopi (ns)
Boscia foetida Schinz subsp. *rehmanniana* (Pestal.) Toelken	Medicinal uses, browsing value	Bushveld Shepherd Tree (e), Stinkwitgat (a), Mopipi (ns)
Cadaba aphylla (Thunb.) Wild	Medicinal properties, potentially poisonous	Desert Spray (e), Bobbejaanarm (a)
Cassia abbreviata Oliv. subsp. *beareana* (Holmes) Brenan	Least Concern, traditional medicinal uses	Sjambok pod (e), Sambokpeul (a), Molepelepe (tw)
Ceratotheca triloba (Bernh.) Hook.f.	Medicinal properties	Wild Foxglove (e), Vingerhoedblom (a)
Colophospermum mopane (J.Kirk ex Benth.) J.Kirk ex J.Léonard	Traditional medicinal uses, traditional uses, pods browsed by game, host plant for moth larvae *Gonimbrasia belina* (Mopane worm)	Mopane (e), Mopane (a), Mopane (tw)
Combretum apiculatum Sond. subsp. *apiculatum*	Traditional medicinal uses, seeds possibly poisonous but consumed by Brown-headed Parrots, leaves eaten by game, firewood	Red bushwillow (e), Rooibos (a), Mogoeleri (ss)
Combretum imberbe Wawra	Protected Tree (National Forest Act, 1998), firewood, medicinal uses	Leadwood (e), Hardekool (a), Motswiri (tw), Mudzwiri (v)
Commiphora africana (A.Rich.) Engl.	Water source, medicinal uses, edible roots, traditional uses	Hairy corkwood (e), Harige kanniedood (a), Iminyela (z)
Commiphora pyracanthoides Engl.	Edible parts, traditional uses	Common corkwood (e), Gewone kanniedood (a) Iminyela (z)
Commiphora schimperi (O.Berg) Engl.	Traditional uses, browsed by game and cattle	Glossy-leaved Corkwood (e), Blinkblaar-kanniedood (a), Serôka (tw)
Commiphora viminea Burtt Davy	Traditional uses, browsed by game and cattle	Zebra-bark Corkwood (e), Zebrabas-kanniedood (a), Mutonyombidi (v)
Corchorus asplenifolius Burch.	Traditional and medicinal uses, edible parts	Gusha (e), Geel varingblaartjie (a),

Table 14: Plants with traditional medicinal values and uses recorded in the study area

Binomial name	*Status/ Traditional values*	*Colloquial name*
Cordia monoica Roxb.	Edible fruit, traditional medicinal uses.	Sandpaper Saucer-berry (e), Snotbessie (a)
Grewia bicolor Juss. var. *bicolor*	Medicinal uses, edible parts, highly variable	White-leaved Raisin (e), Witrosyntjie (a)
Grewia flava DC.	Edible parts, weaving, traditional uses, declared indicator of encroachment	Velvet Raisin (e), Fluweelrosyntjiebos (a)
Grewia flavescens Juss.	Edible parts, beer brewing	Bushman Raisin (e), Kruisbessie (a)
Grewia monticola Sond.	Edible parts, traditional uses, important browsing	Silver raisin (e), Vaal rosyntjiebos (a)
Grewia villosa Willd. var. *villosa*	Traditional medicinal uses, edible fruit	Mallow raisin (e), Malvarosyntjie (a), Mupuna (v)
Gymnosporia buxifolia	Traditional uses	Common spike-thorn (e), Gewone pendoring (a)
Hoodia currorii (Hook.) Decne. subsp. *lugardii* (N.E.Br.) Bruyns	Protected Species (LEMA), traditional uses, traditional medicinal uses	Ghaap (a)
Kirkia acuminata	Emergency water source	White Kirkia (e), Witsering (a), Modumêla (tw)
Kleinia longiflora DC.	Traditional uses	Sjambokbos (a)
Litogyne gariepina	Traditional uses	Dwarf Sage (e), Blougifbossie (a)
Maerua angolensis DC. subsp. *angolensis*	Fruit potentially poisonous, host plant for the butterfly family Pieridae (Whites)	Bushveld Bead-bean (e), Knoppiesboontjieboom (a), Mogôgwane (tw)
Momordica balsamina L.	Edible parts, medicinal uses	Balsam Pear (e), Laloentjie (a), Balsam Peer (a)
Mundulea sericea (Willd.) A.Chev.	Medicinal uses, traditional uses	Cork Bush (e), Visgif (a), Kurk boom (a)
Pechuel-Loeschea leubnitziae (Kuntze) O.Hoffm.	Browsed by game under extreme conditions, potentially poisonous parts	Stinkbush (e), Stinkbossie (a)
Phyllanthus reticulatus Poir.	Fruit potentially poisonous, eaten by birds and game, traditional medicinal uses	Potato-bush (e), Aartappelbos (a)
Sansevieria aethiopica Thunb.	Medicinal properties, weaving, garden plants	Bowstring hemp (e), Wildewortel (a)
Sarcostemma viminale (L.) R.Br. subsp. *viminale*	Medicinal uses, potentially poisonous	Viny milkweed (e), Melktou (a)
Schkuhria pinnata (Lam.) Cabrera	Medicinal uses, weed (S. America), common weed	Dwarf Marigold (e), Bitterbossie (a)
Sclerocarya birrea (A.Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro	Protected Tree (National Forest Act, 1998), edible parts, traditional uses	Marula (e), Maroela (a)
Senegalia mellifera (Vahl) Seigler & Ebinger subsp. *detinens* (Burch.) Kyal. & Boatwr.	Declared indicator of enchroachment, medicinal uses, poison source	Black Thorn (e), Swarthaak (a)
Senna italica	Medicinal uses	Wild senna (e), Elandsertjie (a)
Sterculia rogersii N.E.Br.	Least Concern, traditional uses, edible seeds	Star-chestnut (e), Sterkastaiing (a), Mukakate (v)
Terminalia prunioides M.A.Lawson	Traditional uses	Purple-pod Cluster-leaf (e), Sterkbas (a), Nshashantsawu (ts)
Tribulus terrestris L.	Medicinal uses	Common Dubbeltjie (e), Gewone Dubbeltjie (a)
Vachellia karroo (Hayne) Banfi & Gallaso	Edible parts, dyes and tans, medicinal uses, traditional medicine, firewood	Sweet thorn (e), Soetdoring (a), Umnga-mpunzi (x)
Vachellia tortilis (Forssk.) Gallaso & Banfi subsp. *heteracantha* (Burch.) Kyal. & Boatwr.	Medicinal uses (bark)	Curly-pod Acacia (e), Haak-en-steek (a), Isishoba (z)
Xerophyta humilis (Baker) T.Durand & Schinz	Medicinal uses	Reenmetertjies
Ximenia americana L. var. *microphylla* Welw. ex Oliv.	Medicinal uses, often parasitic, edible fruit, traditional uses	Blue sourplum (e), Blousuurpruim (a)
Ziziphus mucronata Willd. subsp. *mucronata*	Edible parts, traditional medicinal uses, traditional uses	Buffalo-thorn (e), Blinkblaar-wag-'n-bietjie (a)

11 VEGETATION DEVELOPMENT DRIVERS

Development of typical savanna vegetation is generally a result of complex interacting driving forces that include climatic-, geological (soil), topographical- and moisture gradients typical of the savanna regions of southern Africa. The study area and the general surrounds are characterized by low levels of transformation that caused the sterilisation of extensive areas of natural woodland habitat and the vegetation of the two farms is generally a reflection of these regional development drivers. However, minor floristic differences are noted between the respective farms that assumed to have been caused by long-term and persistent differences in farming practices and methods (i.e. livestock farming vs game farming) as well as the application of different grazing strategies (intensive vs. lower grazing pressure) that attributes for the minor divergence in floristic patterns noted between the farms. Despite these variables, the typical woodland vegetation strongly reflects regional attributes (Musina Mopane Bushveld, refer **Section 10.1**). Although not proven to be floristically distinct in the Twinspan analysis of this brief assessment, these variations are nonetheless regarded important units on a local and regional scale, contributing to the ecological infrastructure and functionality of the region and are therefore described as physiognomic variations within the typical woodland habitat.

The vegetation therefore reflects a largely homogenous composition of (particularly) the woody and shrub stratum, despite biophysical variabilities of habitat. Even with the obvious and apparent physiognomic variations such as the calcareous plains, water courses, etc. only minor compositional variability resulted.

For this reason, the decision was taken to present the Twinspan classification, that would largely group physiognomic variations into large and homogenous communities, as the principal classification, but to present the physiognomic variations (although not distilled from the formal phytosociological table) as variations of the principal communities. Ultimately, and to a large degree, the floristic sensitivity that is ascribed to the variations and communities are determined by the unique nature and existing status (PES) of habitat and variations presented by the communities, as well as the confirmed association (or likelihood thereof) of Red Data plant species persisting within specific units. No specific affiliation was identified, and the floristic sensitivities are unlikely to vary significantly beyond the Twinspan categorisation. However, where minor variations were recorded, such as in the case of the calcareous plains of Vrienden, which was included by Twinspan together with watercourses of Du Toit, the ascribed sensitivity was adjusted to reflect the unique and sensitive nature thereof.

Development of vegetation patterns in certain areas appears to be driven by severe flooding events that is coupled by significant rainstorms, causing minor surface erosion and the exposure of subsurface soils. Secondary attributes are ascribed to the effect of long-term management and grazing patterns.

12 TWINSPAN RESULTS

Subjecting data to a TWINSPAN classification, a major community was recognised that accounts for the typical savanna woodland vegetation. Minor communities were recognised that accounts for ephemeral pans, anthropogenically transformed woodland (old fields) and emergence of calcareous washes and plains that is a typical and natural occurrence in the immediate region. Cut-levels of the TWINSPAN classification were achieved as follows (refer **Graph 9, Table 15**):

1. Cut level 1 separated typical terrestrial woodland from ephemeral pans, calcareous washes and plains and eroded woodland areas;
2. Cut level 2.1 separated typical terrestrial woodland from anthropogenically altered woodland (historic clearance events);
3. Cut level 2.2 separated natural ephemeral pans from calcareous washes and plains and eroded woodland areas;
4. Cut level 3.1 separated typical terrestrial woodland from quartzitic outcrops (due to absence of species); and
5. Cut level 4 separated typical terrestrial closed woodland from typical terrestrial open woodland

Four aspects are noted in this regard:

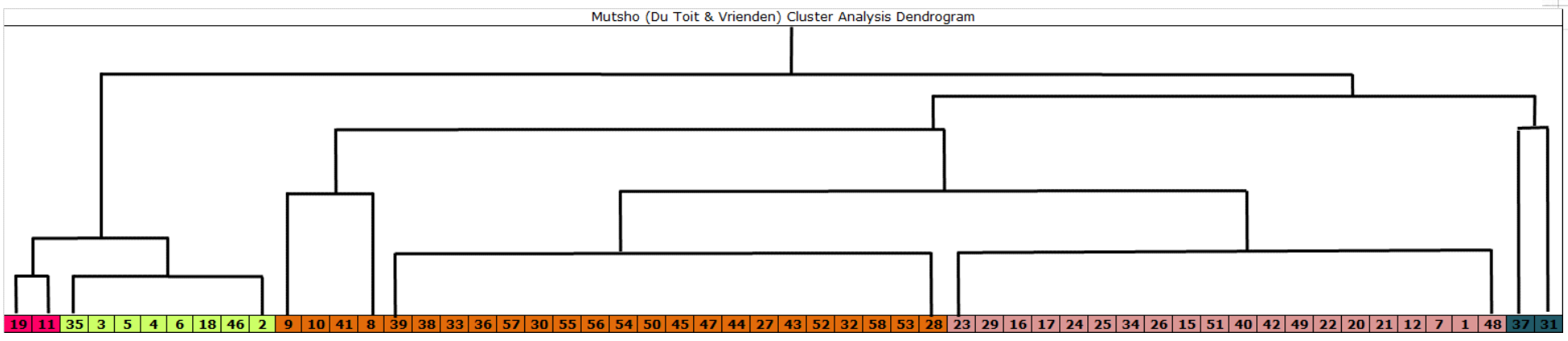
» Other, smaller variations are recognised from a visual interpretation of the physiognomy (aerial photographs). As these variations were not confirmed by the TWINSPAN results, the species composition indicated a similarity to relevant communities;

» Considering lower cut-levels, smaller variations are recognised from TWINSPAN results, but because of the characteristic species of these units comprising of low abundance forbs and low fidelity species types, these units become nonsensical and they do not translate to identifiable, distinctive and mappable units. Most often, these variations is a reflection of management and grazing patterns on a local scale;

» In the absence of detailed soil analysis and wetland delineation procedures, the mapping of units is based on a visual interpretation of the physiognomy as well as the interpretation of the TWINSPAN results. As soils and hydromorphic attributes are generally considered the driving forces behind vegetation development, the delineation of units would be more accurate should it be based on these actual borders; and

» In addition to the classified communities, other macro-habitat types were recognised, but due to a transformed and degraded state, were generally excluded from the surveys, but are illustrated on the accompanying vegetation map. These include:

  * Degraded woodland; and
  * Transformed habitat, including linear infrastructure, mining areas, industrial areas.



Graph 9: Cluster Analysis Dendrogram for the TWINSPAN analysis

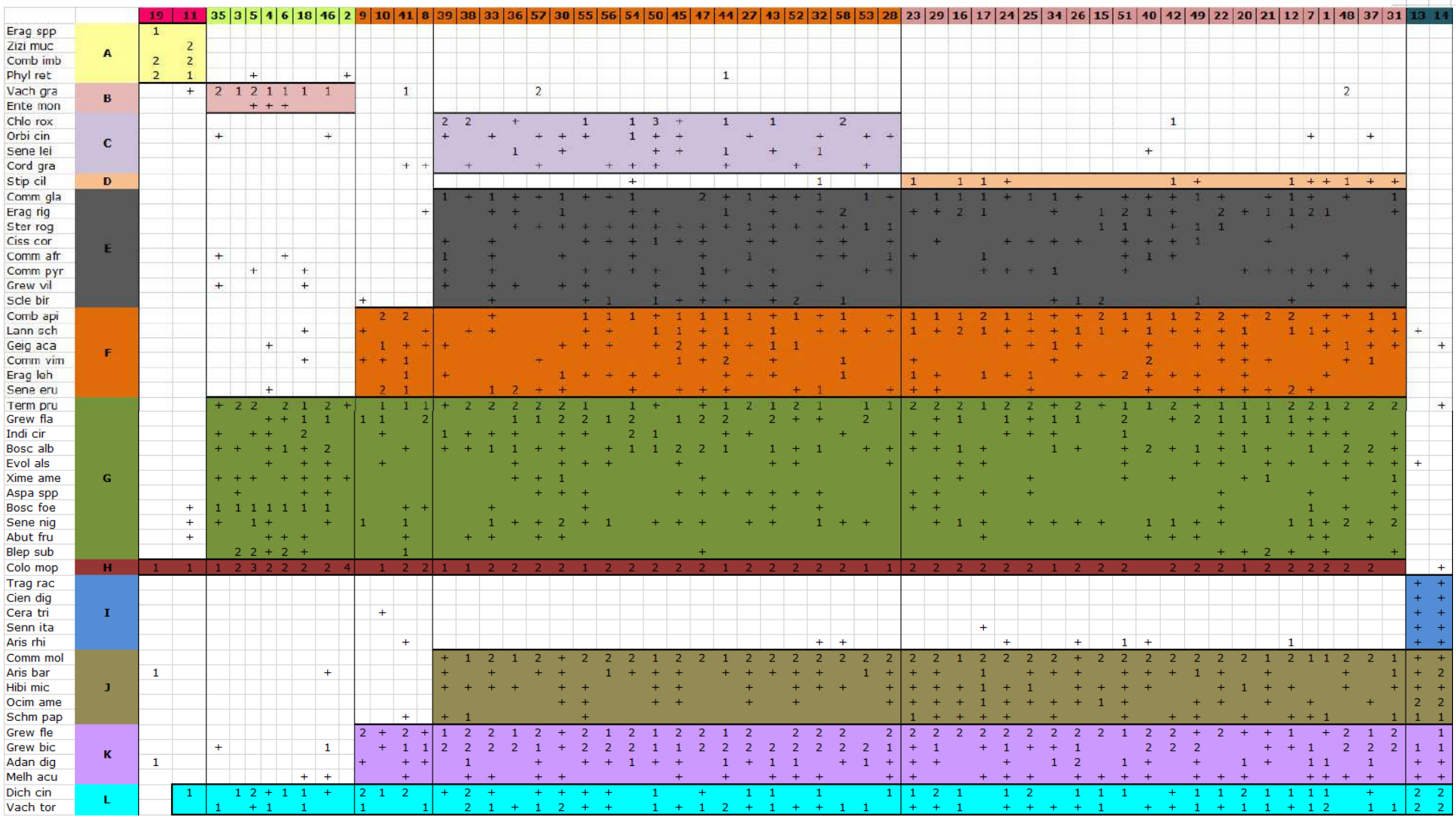


Table 15: TWINSPAN classification results for dataset

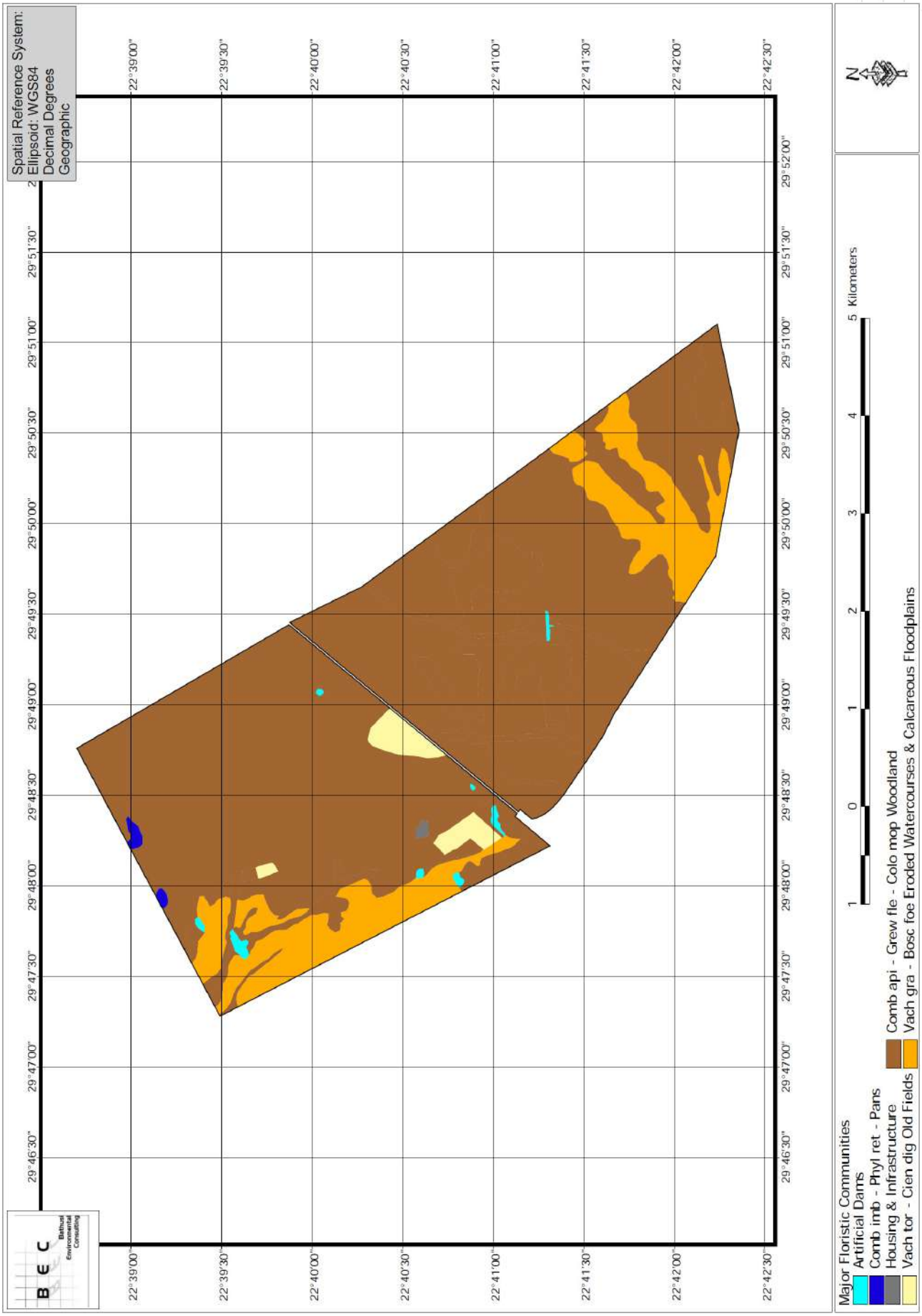


Figure 12: Floristic units of the study sites (Twinspan Communities)

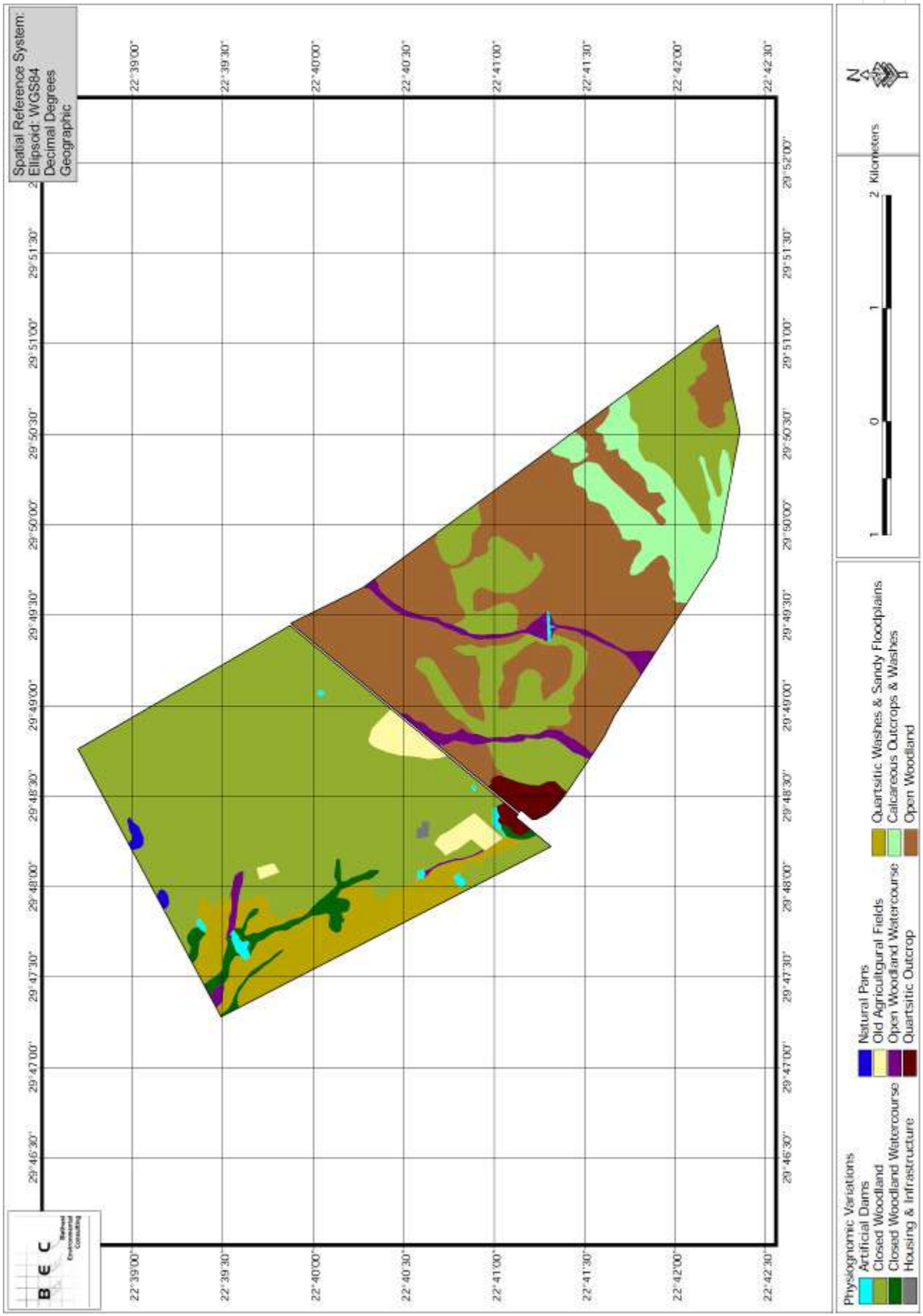


Figure 13: Physiognomic variations of the study sites

13 FLORISTIC COMMUNITIES AND VARIATIONS

The broad vegetation of the sites is recognised as the *Colophospermum mopane – Vachellia tortilis* woodland that is typical of the region and representative of the regional ecological type. The following communities and variations were recognised from the TWINSPAN classification:

» Community 1 – *Combretum imberbe – Phyllanthus reticulatus* ephemeral pans;
» Community 2 - *Vachellia grandicornuta – Boscia foetida* eroded watercourses and calcareous plains/ washes, including the variations:
  - Quartzitic washes and sandy floodplains; and
  - Calcareous outcrops and washes;
» Communities 3 and 4 – *Combretum apiculatum Grewia flavescens – Colophospermum mopane* Woodland, including the physiognomic variations:
  - Closed Woodland;
  - Open Woodland;
  - Closed Woodland Watercourses;
  - Open Woodland Watercourses;
  - Quartzitic Outcrop; and
» Community 5 – *Vachellia tortilis – Cienfuegosia – digitata* old fields.

Additionally, the following habitat types were also recognised, although not captured in the analysis:

» Artificial dams; and
» Housing and farm infrastructure.

The broad communities are illustrated on **Figure 12**, while the physiognomic variations are illustrated in **Figure 13**

Vegetation of the study area conforms to a uniform, but mixed, undifferentiated broadleaf woodland that comprises mostly of deep, highly leached sandy soils. Results of the floristic surveys reflect the proportional and notable prominence of typical woodland constituents such as *Vachellia tortilis, Dichrostachys cinerea* and *Colophospermum mopane.* However, apart from minor and isolated variations that occur as embedded units within this broadleaf woodland, other typical tree constituents include species such as *Terminalia prunioides, Grewia flava, G. flavescens, Boscia albitrunca, Ximenia americana, Senegalia nigrescens, Adansonia digitata* and various *Commiphora* species. The herbaceous layer is a poor compliment to the vegetation, exhibiting significant signs of the recent drought[4]. Although manifesting as a sparse layer, herbaceous species that were recorded include the grasses *Stipagrostis uniplumis, Schmidtia pappophoroides, Eragrostis lehmanniana, Aristida congesta* subsp. *barbicollis* and the forbs cf. *Melhania acuminata, Ocimum americanum, Hibiscus micranthus, Blepharis subvolubilis, Evolvulus alsinoides* and *Geigeria acaulis.*

[4] Due to the significant variability and poor status of the herbaceous stratum, the major distinctions of floristic units were based on the woody components of the habitat types. It was reasonably expected that the inclusion of poorly distributed herbaceous components into the classification will result in the identification of non-sensical and unrepresentable floristic units.

13.1 *Combretum imberbe – Phyllanthus reticulatus* ephemeral pans

Unique and atypical ephemeral pans are situated in the northern part of the farm Du Toit as embedded units within the typical and normal woodland. These areas are strongly characterised by the presence of the tree *Combretum imberbe* and the shrub *Phyllanthus reticulatus*. *Combretum imberbe* is typically associated with clayey soils within areas where these soils are temporarily inundated, such as within these ephemeral pans. The absence of this tree from most of the artificial impoundments (dams) provides evidence of the natural status and historic origin of the ephemeral pans, as opposed to the artificial nature of the impoundments. The absence of water courses that contribute to the influx of water into these features is an important distinguishing attribute between these features, with artificial impoundments typically encountered within water courses.

The atypical nature of these features as well as the protected status of the dominant tree constituents within these areas ultimately renders these features highly sensitive. Fringes of these features comprises the typical woodland vegetation and typical woodland trees such as *Vachellia* species, *Commiphora* species, *Colophospermum mopane, Terminalia prunioides,* etc. are typically encountered along the fringes. The physical features of these areas conform to open areas with scattered, large Leadwood trees within the pan and dense woodland vegetation along the perimeter.

An appraisal of the diversity characteristics of these areas revealed a low Alpha diversity of only 10 species, compared to the 23.5 average of the study areas. This diversity is likely to be much higher during periods of inundation when opportunistic species will abound in the moist soil conditions.

As these features are periodically inundated by seasonal rain events, they will undoubtedly represent incredibly important parts of the local and regional ecological infrastructure in terms of faunal species that are likely to utilise the available habitat. As water is retained within these features well after local drainage lines and water courses have run dry, it represents an important source of water for animals. It therefore constitutes critical aspects of the ecological infrastructure and ecological functionality of the immediate region, as results of the faunal and avifaunal assessments have also indicated, and a high ecological sensitivity is therefore ascribed to this community.

13.2 *Vachellia grandicornuta – Boscia foetida* eroded watercourses and calcareous plains/ washes

Twinspan Cut level 2 distinguished the eroded watercourses (seasonal drainage lines) and sandy woodland plains of Farm Du Toit and the calcareous plains of Farm Vrienden based on the presence of the microphyllous species *Vachellia grandicornuta*, but mostly because of the absence of species groups C, E, F and K. The absence of most of the *Commiphora* and *Grewia* species as well as other woody constituents that are typically associated with surrounding terrestrial woodland, coupled with a poorly developed herbaceous stratum provide some evidence of the challenging nature that emphasises the biophysical conditions within this community.

Although not recognised as a 'strong' community within the Twinspan table, visual characteristics distinguishes between this community and surrounding woodlands as well as between physiognomic variations included in this community. Notable woody constituents that are frequently encountered in this unit include *Boscia foetida, Dichrostachys cinerea, Terminalia prunioides* and *Colophospermum mopane.* Peculiarly, and probably a reference to the challenging soil conditions that characterises this community, the protected tree *Adansonia digitata* is generally absent from these parts.

Soils encountered in these parts exhibit poor and shallow characteristics, hence the herbaceous layer constitute a poor component of the floristic composition with only hardy shrubs, such as *Indigofera circinata, Abutilon fruticosa* and *Blepharis subvolubilis* persistently occurring within these areas. Typically, the species richness of these areas is low; only 16.5 species were, on average, encountered in the sample plots, compared to the 23.5 average of the study areas.

A peculiar phytosociological affinity is demonstrated between the two variations that are grouped in this community, which is best explained by the characteristic woody small tree *Vachellia grandicornuta* being the only common species between these variations and being largely absent from other communities. Topographical variations that characterise the two variations of this community ranges from lowland watercourses of Farm Du Toit and the elevated calcareous plains of Farm Vrienden. Similarly, soils vary significantly between the variations with sandy, reddish soils with occasional quartzitic washes characterising areas on Farm Du Toit and shallow calcareous, stony washes indicative of Farm Vrienden, similarly providing little evidence of biophysical attributes that might reasonably clarify the apparent analogous vegetation of these two variations. Physiognomic variations recognised in this community include:

» Quartzitic washes and sandy floodplains encountered in the western part of Farm Du Toit constitute areas that are periodically subjected to significant surface flow subsequent to periodic/ seasonal rain events that caused surface erosion in most areas and localised/ shallow gulley erosion. Resultantly, the herbaceous stratum is poor and extensive areas of open/ bare soils are encountered. Soil conditions also vary widely between hard soils with evidence of surface erosion, sandy substrate (assumedly imported during periods of surface flow) and areas of extensive quartzitic washes where stony and rocky soils predominate. The nature of this variation appears to conform to a (slightly) deteriorated woodland, based on the absence of a prominent and diverse woody layer and a species poor herbaceous stratum. Resultantly, the floristic sensitivity ascribed to this unit is regarded medium. The succulent *Euphorbia limpopoana* was recorded in this variation.

» Calcareous outcrops and washes encountered on Farm Vrienden constitute parts of the site where calcareous soils with subsurface stones and rocks predominate. These areas are visually recognisable from aerial imagery (refer **Figure 5**). Due to the topographical elevated nature of this variation, water generally does not accumulate, and moisture content of the soils are generally lower than the surrounding sandy woodland plains. Poor species richness of this physiognomic variation that resulted in the affiliation with the quartzitic plains of Farm Du Toit, appears to be a natural attribute and not the result of habitat deterioration. Because of the (slightly) atypical nature of this variation and the contribution to the ecological infrastructure on a local scale, the floristic sensitivity of this

variation is regarded medium-high. The protected species *Hoodia currorii* was recorded within this unit.

13.3 *Combretum apiculatum Grewia flavescens – Colophospermum mopane* Woodland

Communities 3 and 4 are characterised as the (regional) typical undifferentiated arid broadleaf woodland, with minor physiognomic variability that, although not necessarily recognised from the Twinspan classification of the dataset, can be attributed to anthropogenic intervention as well as minor biophysical variability in topography, soils, etc. Communities 3 and 4 are included in this phytosociological affiliation because of high compositional similarity and few differentiating species between the two communities, notably Species groups C and D. It is broadly characterised by Species group F and is distinguished from other communities by the absence of Species groups A, B and I. It should be noted that these groups do not constitute species with high fidelity values, which reflect the homogenous nature of the local and regional woodland habitat, also considering the variability in physiognomic variations that are encountered within these communities.

The two communities are structurally differentiated because of a notable variance in crown cover exhibited by the woody canopy, roughly divided between closed woodland of Farm Du Toit and open woodland encountered on Farm Vrienden, although some areas of Farm Vrienden also exhibit areas of closed woodland. The assumption is that long-term grazing strategies, overgrazing (Farm Vrienden) and dissimilar management strategies led to minor differences in structural aspects of the typical woodland of these farms. Structurally, the closed woodland of Farm Du Toit appears taller compared to the woodland constituents of Farm Vrienden.

The woody stratum is relatively diverse, comprising of a notable compliment of *Commiphora* species, *Grewia* species, *Sterculia rogersii, Combretum apiculatum, Lannea schweinfurthii, Senegalia* species, *Terminalia prunioides* and *Colophospermum mopane*, as well as the occasional *Kirkia acuminata* and *Adansonia digitata.* The variability of the woody cover contributes to the recognition of the following physiognomic variations:

» Closed Woodland that comprise the majority of Farm Du Toit and portions of Farm Vrienden exhibit a dominant and dense woody canopy, comprising of the typical woodland constituents, but also a relatively well developed herbaceous stratum; assumedly because of the protection that the woody layer provides against grazers. Vertical variability is also noted with the average extent of trees slightly higher compared to the Open Woodland. The historic exclusion of fire as a management application, could possibly also provide an explanation of the densification of the typical woodland of this variation. Twinspan differentiated between Open and Closed Woodland only on Cut level 4, the presence of Species group D (*Stipagrostis uniplumis*) indicating a differentiation between this and the Open Woodland areas as well as the absence of Species group C. The typical woodland nature of this variation, with adequate representation within the general and regional surrounds ultimately renders the floristic sensitivity of this unit medium.

» Open Woodland is typically encountered on Farm Vrienden and is (assumed) the result of intensive and persistent high grazing pressure, but possibly also a result of recent porific

events, which could also provide an explanation of the apparent lower average height of the typical woodland of this variation. This variation is differentiated by Twinspan only on Cut level 4, characterised by Species Group C, consisting mainly of *Chloris roxburghiana, Orbivestus cinerascens, Senegalia senegal* subsp. *leiorhachis* and *Cordia grandicalyx.* Despite minor deterioration of these woodland portions, the nature and status of these parts generally reflect a medium floristic sensitivity.

» Closed Woodland Watercourses are typically tall and dense, dominated by a compliment of typical woodland constituents or mono-specific *Colophospermum mopane* closed woodland stands. Relics of *Schotia brachypetala, Xanthocercis zambesiaca* and *Peltophorum africanum* were also observed during previous surveys. These features are also typically associated with artificial impoundments and along watercourses where water might accumulate for extended periods of time. Physically these areas conform to narrow bands with the fringes along the seasonal water courses exhibiting vertical heterogeneity and typical terrestrial woodland habitat composition and structure, which probably provides some indication of why Twinspan failed to differentiate these areas from the typical woodland habitat. More detailed sampling, within smaller sample plots will likely result in the recognition of a phytosociological distinct unit. Despite the association with watercourses, no floristic attribute of sensitivity was recorded within these areas and a medium sensitivity is ascribed.

» Open Woodland Watercourses manifest as eroded channels or open plains with sandy substrate streambeds and is generally recognised from a poor woodland compliment within the ill-defined streambeds. However, fringes of these features are typical of the surrounding woodland habitat with the typical compliment of trees and shrubs, which possibly provides some indication of why Twinspan failed to differentiate these areas from the typical woodland habitat. The highly ephemeral nature of these features also likely explains the failure to develop an atypical woodland composition or cover (as with the Closed Woodland Watercourse variation). Despite the association with watercourses, no floristic attribute of sensitivity was recorded within these areas and a medium sensitivity is ascribed.

» Quartzitic Outcrop - Twinspan differentiated (Cut level 3) the Quartzitic Outcrop that is geographically situated in the north-western part of Farm Vrienden. Although a physical and topographically recognisable unit, it does not exhibit notable or dominant characteristic species; roughly separated from the surrounding woodland communities by the absence of Species groups C, D, E and J. Biophysical attributes of the soils indicate prominent outcrops and the general absence of deep sandy soils, which comprise some of the notable woodland constituents, such as *Commiphora glandulosa, Sterculia rogersii, C. pyracanthoides, C. africana, C. mollis, Sclerocarya birrea* and *Ximenia americana.* The atypical nature of this habitat type, despite a moderate similarity to surrounding broadleaf habitat, and the contribution to habitat variability on a local and regional scale, ultimately renders the floristic sensitivity of this unit medium-high.

13.4 *Vachellia tortilis – Cienfuegosia – digitata* old fields

A few small, open fields are spatially situated within Farm Du Toit; these areas are the result of historic land clearing activities (for unknown reasons as arable agriculture is unlikely). These areas constitute open plains that have been recolonised by secondary and short sclerophyllous woody constituents, such as *Vachellia tortilis* and *Dichrostachys cinerea*, and is characterised by the presence of Species group I and the absence of most of the typical woodland constituents that is associated with the surrounding broadleaf woodland habitat. The early successional status of the various sites varies according to the timeline of clearance activities, exhibited by the dominance of the *Vachellia tortilis* and *Dichrostachys cinerea.* The devastation that accompanies significant changes to the woody canopy is demonstrated by the prominence of weed species and annual grasses, including cf. *Ocimum americanum, Aristida* species and other forbs that generally indicate poor habitat conditions.

Despite the presence of some individuals of *Adansonia digitata,* no elevated floristic sensitivity aspect or sensitivity attribute was recorded, and a medium-low sensitivity is therefore ascribed to these parts.

13.5 Artificial dams

Impoundments are generally encountered as embedded areas within the temporary watercourses. These features were constructed as attempts to increase the availability of water for animal use and generally vary in size based on the nature of the temporary water course. The fringing vegetation strongly reflects surrounding woodland habitat, but increased abundance of *Vachellia tortilis* is generally noted. Based on the artificial nature, and despite the minor contribution to the ecological functionality in terms of animal presence and abundance, a moderate floristic sensitivity is ascribed.

13.6 Farming Infrastructure

Housing and farming infrastructure of Farm Du Toit is highlighted as a separate anthropogenic variation. A low floristic sensitivity is ascribed as the nature of the unit is artificial.

13.7 Photographic examples of various habitat types and pertinent aspects

Photo 1: Typical undifferentiated broadleaf woodland habitat (Farm Du Toit, closed woodland), note poor compliment of grasses and forbs

Photo 2: Typical undifferentiated broadleaf woodland habitat (Farm Vrienden, open woodland), note poor compliment of grasses and forbs

Photo 3: Example of an artificial dam (Farm Du Toit)

Photo 4: Example of a closed woodland watercourse dominated by *Colophospermum mopane*

Photo 5: Typical habitat of quartzitic plains and washes

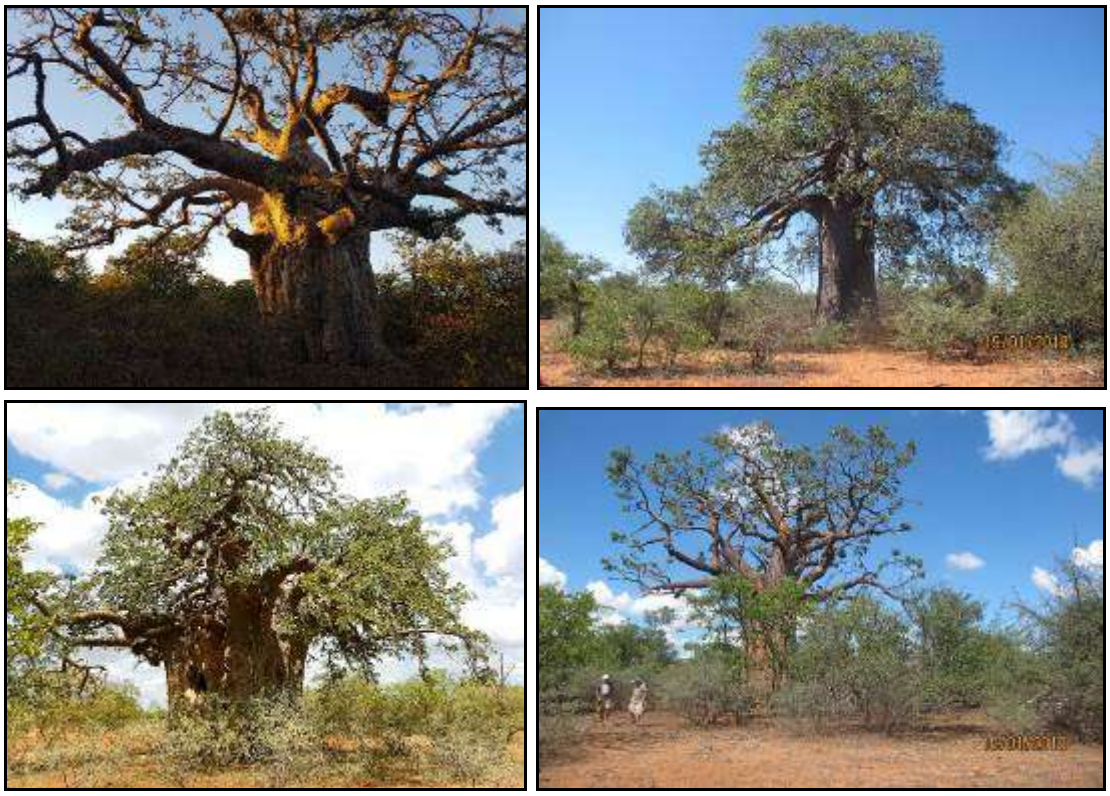
Photo 6: Typical open woodland habitat within eroded watercourses and sandy plains

Photo 7: Example of sclerophyllous vegetation of old fields, note absence of typical broadleaf species

Photo 8: Typical habitat within the calcareous plains and washes

Photo 9: Typical habitat within the calcareous plains and washes

Photo 10: Typical habitat within the quartzitic outcrop of Farm Vrienden



Photos 11-14: Examples of some large *Adansonia digitata* individuals

Photo 15: Example of a temporary watercourse, note loose and sandy soils within streambed

Photo 16: cf. *Euphorbia* cf. *limpopoana*

Photo 17: *Sesamnothamnus luggardii*

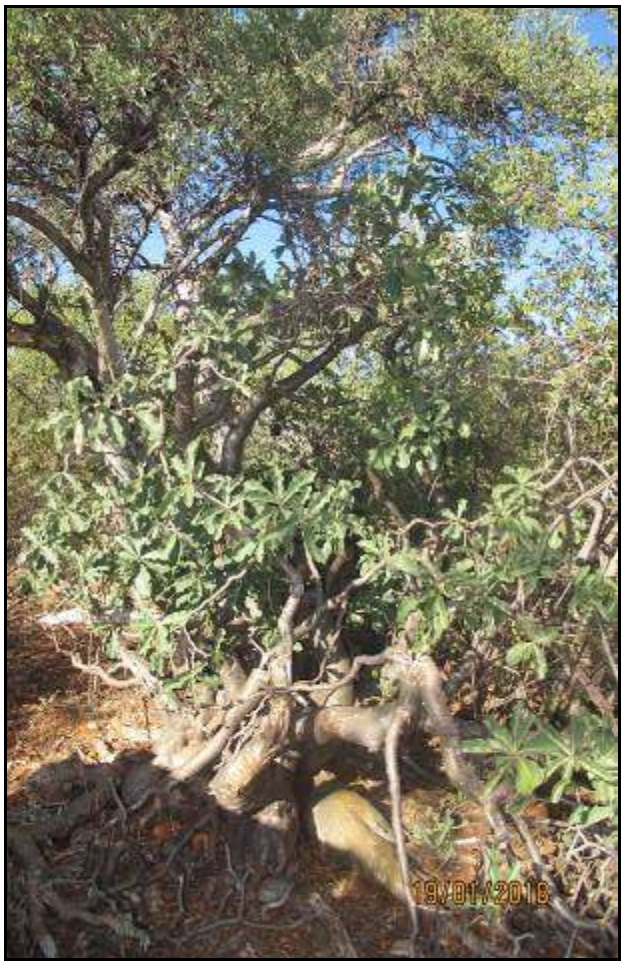


Photo 18: An *Adenium multiflorum* individual

Photo 19: A *Hoodia currorii* individual

14 FLORISTIC SENSITIVITY

For existing protected areas and species, the floristic importance ascribed to certain areas is obvious and simplistic. Most countries will have differentiated the biodiversity importance of their protected areas (national or local) as part of their designation. Conversely, outside of protected areas, but within areas that are clearly of value for biodiversity, the evaluation of importance is more complex and vague. It is important to note that the absence of protected status should never be interpreted as low biodiversity importance; many areas of international importance for biodiversity lie outside of protected areas. The challenge is to include a suitable range of criteria to determine whether the site is of local, regional, national or international importance. Although no universal standard exists, some of the common criteria include the following:

» **Species/habitat richness:** In general, the greater the diversity of habitats or species in an area, the more valuable the area is. Habitat diversity within an ecosystem can also be very valuable. Habitat mosaics are extremely valuable, as some species that depend on different types of habitat may live in the transition zone between the habitats.
» **Species endemism:** Endemic species typically occur in areas where populations of a given species have been isolated for sufficiently long to evolve distinctive species-specific characteristics, which prevent out-breeding with other species populations.
» **Keystone species:** A keystone species is one that exerts great influence on an ecosystem relative to its abundance or total biomass. For example, a keystone predator may prevent its prey from overrunning an ecosystem. Other keystone species act as 'ecosystem engineers' and transfer nutrients between ecosystems.
» **Rarity:** The concept of rarity can apply to ecosystems and habitats as well as to species. Rarity is regarded as a measure of susceptibility to extinction, and the concept is expressed in a variety of terms such as vulnerable, rare, threatened or endangered.
» **Size of the habitat:** The size of a natural area is generally considered as important. It must be big enough to be viable, which relates to the resistance of ecosystems and habitats to activities at the margins, loss of species and colonization of unwanted species. Habitat connectivity is also of related importance and refers to the extent of linkages between areas of natural habitat – high levels of connectivity between different habitats or patches of the same habitat are desirable.
» **Population size:** For example, in international bird conservation, it has become established practice to regard 1 per cent of a species' total population as significant in terms of protective requirements. For some large predators, it is important to know that an area is large enough to encompass the home range of several individuals and allow them to persist successfully.
» **Fragility:** This refers to the sensitivity of a particular ecosystem or habitat to human-induced or natural environmental changes and its resilience to such changes.
» **Value of ecosystem services:** The critical importance of ecosystem services is widely appreciated.

A basic and subjective evaluation of the respective habitat types, communities (also including the various physiognomic variations that were recognised) were compiled to present an opinion on the floristic sensitivity of the receiving environment. For the purpose of this assessment, habitat sensitivity is categorised as follows:

Low No natural habitat remaining; this category is represented by developed/ transformed areas, nodal and linear infrastructure, areas of agriculture or cultivation, areas where exotic species dominate exclusively, mining land (particularly surface mining), etc. The possibility of these areas reverting to a natural state is impossible, even with the application of detailed and expensive rehabilitation activities. Similarly, the likelihood of plant species of conservation importance occurring in these areas is regarded negligent.

Medium – low All areas where the natural habitat has been degraded, with the important distinction that the vegetation has not been decimated and a measure of the original vegetation remain, albeit dominated by secondary climax species. The likelihood of plant species of conservation importance occurring in these areas is regarded low. These areas also occur as highly fragmented and isolated patches, typical to cultivated fields, areas that have been subjected to clearing activities and areas subjected to severe grazing pressure. The species composition of these areas is typically low and is frequently dominated by a low number of species, or invasive plants.

Medium Indigenous natural habitat that comprehend habitat with a high diversity, but characterised by moderate to high levels of degradation, fragmentation and habitat isolation. Also includes areas where flora species of conservation importance could potentially occur, but habitat is regarded marginal;

Medium – high Indigenous natural vegetation that comprehend a combination of the following attributes:

- The presence of habitat that is suitable for the presence of these species;
- Areas that are characterised by a high/ moderate-high intrinsic floristic diversity;
- Areas characterised by moderate to low levels of habitat fragmentation and isolation;
- Regional vegetation types that are included in the lower conservation categories, particularly prime examples of these vegetation types;
- Low to moderate levels of habitat transformation;
- A moderate to high ability to respond to disturbance factors;

It may also include areas that are classified as protected habitat, but that are of a moderate status;

High Indigenous natural vegetation that comprehend for a combination of the following attributes:

» The presence of plant species of conservation importance, particularly threatened categories (Critically Endangered, Endangered, Vulnerable);
» Areas where 'threatened' plants are known to occur, or habitat that is highly suitable for the presence of these species;
» Regional vegetation types that are included in the 'threatened' categories (Critically Endangered, Endangered, Vulnerable), particularly prime examples of these vegetation types;
» Habitat types are protected by national or provincial legislation (Lake Areas Act, National Forest Act, draft Ecosystem List of NEM:BA, Mountain Catchment Areas Act, Ridges Development Guideline, Integrated Coastal Zone Management Act, etc.);

» Areas that have an intrinsic high floristic diversity (species richness, unique ecosystems), with particular reference to Centres of Endemism;

These areas are also characterised by low transformation and habitat isolation levels and contribute significantly on a local and regional scale in the ecological functionality of nearby and dependent ecosystems, with particular reference to catchment areas, pollination and migration corridors, genetic resources. A major reason for the high conservation status of these areas is the low ability to respond to disturbances (low plasticity and elasticity characteristics).

General floristic sensitivity estimations are illustrated in **Figure 14**. Additional aspects that are taken into consideration include surrounding habitat sensitivity, conservation potential, fragmentation and habitat isolation factors.

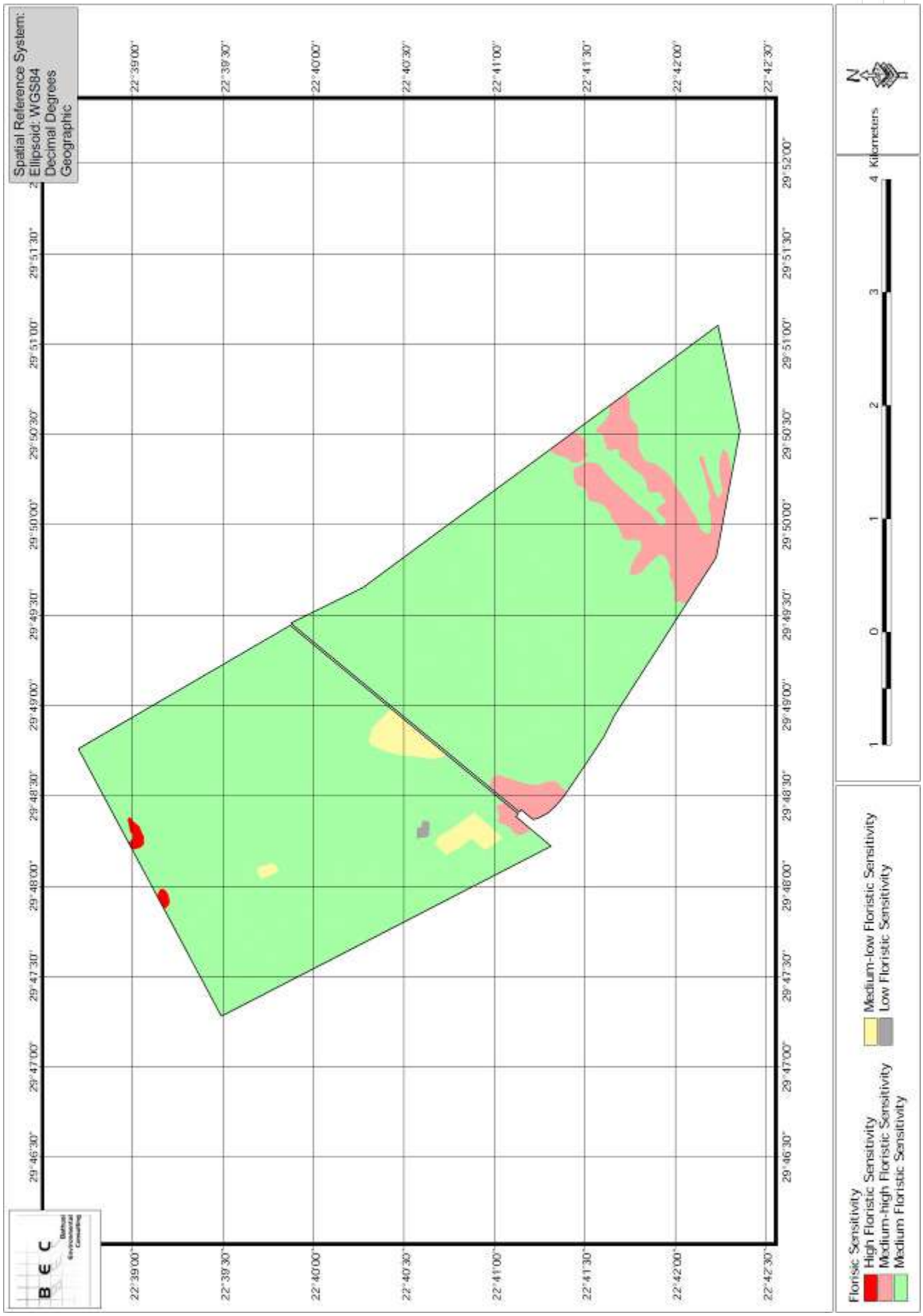


Figure 14: Floristic Sensitivity of the study sites

Section C

15 POTENTIAL AND LIKELY IMPACTS ON THE FLORISTIC RECEIVING ENVIRONMENT

The proposed activity implies the loss of natural habitat and no impacts of a beneficial nature on the floristic environment are likely to result. Based on a generic list of impacts associated with this type of development, three categories of impacts are likely to result, namely, direct impacts, indirect impacts and impacts of a cumulative nature.

15.1 Nature of Potential and Likely Impacts – Direct and Indirect Impacts

The largest extent of impacts within the floristic environment is likely to result due to direct (physical) effects of land clearing activities and losses of vegetation. Direct impacts include any effect on the vegetation, including locally endemic species, populations or individual species of conservation importance, as well as on overall species richness, diversity and abundance. These effects include impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of conservation consideration. Impacts on sensitive, restricted or protected habitat types are included in this category, but only on a local scale. These impacts are mostly measurable and easy to assess, as the effects thereof are immediately visible and can be determined to an acceptable level of certainty. Impacts of a direct nature include the following:

1. Loss of plant taxa (individuals, stands, populations) of conservation importance (threatened taxa) as well as plant taxa of conservation concern (declining status, provincially protected taxa), including habitat that is regarded highly suitable for the persistence of these species;
2. Loss of natural vegetation (physical modifications, removal, damage) including the loss of atypical, sensitive, conservation important habitat types or ecosystems of restricted abundance; and
3. Local depletion of plant taxa and reduction of phytodiversity.

In contrast, indirect impacts are not always immediately evident and can consequently not be measured at a specific moment in time; the extent of the effect is frequently at a scale that is larger than the actual site of impact, but usually restricted to a local scale (and not regional). A measure of estimation, extrapolation, or interpretation, is therefore required to evaluate the significance of these impacts and is usually a factor of the sensitivity of the receiving surrounding environment. This type of impact typically results in adverse effects or deterioration of surrounding areas due to uncontrolled, development related activities. In addition, the ecological functionality of the immediate and surrounding area could be adversely affected by development, with particular reference to the ecological interaction between plants and animals. The aesthetic appeal of the region, although a subjective and highly debatable attribute, is regarded a potential receiver of landscape changes through the addition of industrial developments, ashing facilities, linear infrastructures, etc. Lastly, one of the most important impacts of indirect measures is represented by the alteration of floristic characteristics of the surrounding areas through the introduction and proliferation of plants with an exotic nature or encroachment characteristics. Impacts of an indirect nature include the following:

4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.;
5. Reduced or severely altered ecological functionality (including fire, erosion);
6. Decreased aesthetic appeal of the landscape;
7. Introduction of invasive, exotic and encroacher plant species; and
8. Increased exploitation of natural resources due to increased human presence and resource requirements.

15.1.1 Quantification of Direct and Indirect Impacts on the Floristic Environment

Please note that the quantification of impacts on the floristic receiving environment considers the development and operation of the proposed power plant in its entirety. Relevant comments will be made concerning perceived preferability of the respective footprints, as per **Section XVIII.**

Table 16: Quantification of impacts of the Power Plant on the floristic environment

Nature of impact:	1. Loss of plant taxa (individuals, stands, populations) of conservation importance (threatened taxa) as well as plant taxa of conservation concern (declining status, provincially protected taxa), including habitat that is regarded highly suitable for the persistence of these species	
	Without mitigation	***With mitigation***
Extent	Local (2)	Site only (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Very high (10)	Moderate (6)
Probability	Definite (5)	Highly probable (4)
Significance	***High (85)***	***Medium (48)***
Status (positive or negative)	Negative	
Reversibility	Irreversible, although smaller individuals and localised plants can be restored to nearby, suitable habitat	
Irreplaceable loss of resources?	Yes, the loss of conservation important plants, which are generally strongly associated with the habitat	
Can impacts be mitigated?	Yes, to some extent. Unavoidable impacts on protected trees/ conservation important plants will occur because of land clearance activities within the footprint; success of mitigation measures is extremely limited and will be restricted to localised events of relocation of certain individuals. Relocation of large *Adansonia* individuals will be hugely expensive and unlikely successful, reasonable success has been achieved with smaller individuals	
Mitigation Measures:	Extent of impact likely to restricted to site/ development footprint only with minimal impacts outside development footprint. Selected species and individuals should be rescued and replanted at suitable localities, with specific reference to required landscaping and rehabilitation of development areas. Permitting requirements need to be met prior to destruction of any protected/ conservation important plant species.	
Residual Impacts:	Sterilised landscapes with no propensity for species of conservation concern, decline in population sizes and numbers, continual decline in habitat availability, exacerbated pressure on conservation important and protected plant species	
Nature of impact:	2. Loss of natural vegetation (physical modifications, removal, damage) including the loss of atypical, sensitive, conservation important habitat types or ecosystems of restricted abundance	
	Without mitigation	With mitigation
Extent	Local (2)	Site only (1)
Duration	Permanent (5)	Permanent (5)

Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Highly probable (4)
Significance	**High (75)**	**Medium (48)**
Status (positive or negative)	Negative	
Reversibility	Irreversible, rehabilitation procedures are generally unable to restore vegetation to the previous status	
Irreplaceable loss of resources?	Yes, to some extent. Regional vegetation (due to low transformation and fragmentataion levels) is abundantly represented and characterised by minor habitat diversity. Main threat is presented by the cumulative losses caused by associated developments, linear infrastructures, settlements, increase in human population with associated impacts on ecology	
Can impacts be mitigated?	Yes, to some extent, the development of the proposed power station will cause unavoidable losses and associated impacts on the receiving floristic environment. Implementation of generic mitigation measures will prevent (mostly) direct impacts on surrounding areas and habitat and rehabilitation of altered landscapes will restores some form of vegetation after cessation of the activity, although not entirely similar to the original vegetation	
Mitigation Measures:	Restrict losses of natural vegetation to footprints, avoid peripheral or unnecessary losses of natural vegetation, ensure proper rehabilitation and landscaping practices, ensure nodal developments by grouping development's structures, avoid the uncontrolled spread of infrastructure. Ensure that appurtenant infrastructure and developments are effected with minimal exacerbation of existing impacts, i.e. nodal developments	
Residual Impacts:	Decreased aesthetic appeal, loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat	
Nature of impact:	3. Local depletion of plant taxa and reduction of phytodiversity	
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Moderate (6)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (52)**	**Medium (39)**
Status (positive or negative)	Negative	
Reversibility	Unsure; natural successional processes could potentially account for some recovery	
Irreplaceable loss of resources?	Yes, decimation of localised species might include species of conservation concern, localised areas of high phytodiversity and importance	
Can impacts be mitigated?	Yes, to some extent, rehabilitation procedures during and susbsequent to the activity will restore the presence of some species, although not to previous status and abundance	
Mitigation Measures:	Restrict footprints to preferred development areas, avoid areas of higher floristic sensitivity. Avoid peripheral or unnecessary losses of natural vegetation, ensure proper rehabilitation and landscaping practices, ensure nodal developments by grouping developments structures, avoid the uncontrolled spread of infrastructure; access roads, power lines, conveyor lines, etc.	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat	
Nature of impact:	4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.	
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Long term (4)	Long term (4)

Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Highly probable (4)
Significance	**High (60)**	**Medium (40)**
Status (positive or negative)	Negative	
Reversibility	Moderately reversible; the nature of impacts is such that activities on the development site can be adapted to avoid impacts in surrounding areas, restrict human movement and development footprint through generic mitigation measures, implement biodiversity monitoring and audit programmes to evaluate and ensure compliance	
Irreplaceable loss of resources?	Yes, to some extent as impacts on conservation important species that persist in adjacent habitat could result	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Ensure compliance to EMP, avoid unnecessary impacts within adjacent habitat, prevent unwanted spread of physical impacts outside footprint areas, implement generic monitoring and audit programme aimed at identifying and preventing the uncontrolled spread of impacts into adjacent areas of natural habitat	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat, decrease in habitat quality	
Nature of impact:	5. Reduced or severely altered ecological functionality (including fire, erosion)	
	Without mitigation	With mitigation
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Highly probable (4)
Significance	**High (80)**	**Medium (52)**
Status (positive or negative)	Negative	
Reversibility	Low reversibility; development of the power station may cause irreversible and unavoidable impacts within surrounding natural areas. Evidence from similar developments proved that a decrease in ecological functionality of surrounding areas is unavoidable, but the implementation of dedicated management and subsequent rehabilitation procedures will restore habitat and common/ typical ecological functionality to some extent, although not to the same level as untransformed and natural (existing) habitat	
Irreplaceable loss of resources?	Yes, loss and deterioration of remaining natural habitat will likely cause irreversible impacts on a local scale, impacts will likely include adverse effects on conservation important species and habitat, with reference to isolated and linear habitat types	
Can impacts be mitigated?	Yes, to some extent with the implementation of a dedicated management plan and rehabilitation procedures	
Mitigation Measures:	Limit development to footprint area, avoid impacts in adjacent habitat, implement biodiversity monitoring programmes, alien and invasive management programmes. Although outside the scope of this assessment, uncontrolled anthropogenic encroachment should be prevented and mitigated through worker programmes, settlement developments, etc.	
Residual Impacts:	Fragmented, isolated portions of natural habitat, sterile landscapes, increased anthropogenic pressures on natural resources	
Nature of impact:	6. Decreased aesthetic appeal of the landscape	
	Without mitigation	With mitigation
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (60)**	**Medium (55)**
Status (positive or negative)	Negative	

Reversibility	Irreversible
Irreplaceable loss of resources?	Yes
Can impacts be mitigated?	Yes, to some extent. The use of locally indigenous vegetation, taking cognisance of the visual impact assessement recommendations, dedicated landscaping programmes and rehabilitation programmes will avoid the high visibility of the proposed development from vast distances
Mitigation Measures:	Implement biodiversity monitoring programmes, alien and invasive management programmes, early detection and eradication programmes, prevent/ control anthropogenic encroachment to avoid exacerbation of habitat transformation and cumulative impacts. Ensure appropriate restoration and rehabilitation programmes by using locally indigenous species, litter and refuse control programmes, particularly around human abodes and transportation routes
Residual Impacts:	Degraded landscapes, loss of aesthetic appeal, poor species diversity, loss of 'sense of place', visual impacts, light pollution, etc.

Nature of impact:	7. Introduction of invasive, exotic and encroacher plant species	
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**High (60)**	**Medium (33)**
Status (positive or negative)	Negative	
Reversibility	Irreversible (mostly)	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	Yes. The immediate and dedicated implementation of an Alien and Invasive management programme	
Mitigation Measures:	Implement early detection and control measures as part of Alien and Invasive Management Plan, development and implementation of biodiversity monitoring plan, rehabilitation and landscaping that aims to simulate the surrounding environment, use of locally indigenous species,	
Residual Impacts:	Deterioration of remaining natural habitat, decreased aesthetic appeal, loss of phytodiversity	

Nature of impact:	8. Increased exploitation of natural resources due to increased human presence and resource requirements	
	Without mitigation	With mitigation
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Low (4)
Probability	Highly probable (4)	Improbable (2)
Significance	**High (64)**	**22**
Status (positive or negative)	Negative	
Reversibility	Irreversible, particularly since exploitation of resources are generally aimed at restricted environments and species	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	Public awareness programmes, implementation of biodiversity monitoring protocols, search and rescue operations, landscaping programmes making use of locally indigenous species from the development footprint. Prevent personnel from entering adjacent properties and remaining natural land in the immediate surrounds	
Residual Impacts:	Decreased floristic diversity and aesthetic, potential increase in threat status to certain taxa, exacerbated losses of phytodiversity, changes to local flora patterns	

15.2 Nature of Potential and Likely Cumulative Impacts

Cumulative impact, in relation to an activity, means the pas, current and reasonable foreseeable future impact of an activity, considerd together with the impact of activities associated with that activbity that in itself may not be significan, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities. The role of the cumulative assessment is to test if such impacs are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section will address whether the constructin of the proposed development will result in:

» Unacceptable risk;
» Unacceptable loss;
» Complete or whole-scale changes to the environment or sense of place; or
» Unacceptable increase in impact.

Impacts of a cumulative nature places direct and indirect impacts of this project into a regional and national context, particularly in view of similar or resultant developments and activities in the region. These impacts cause adverse effects on the local and regional conservation status of plant taxa and protected habitat types as well as local and regional fragmentation levels. These impacts are notoriously problematic to control or prevent and frequently require huge financial commitments to mitigate. Impacts of a cumulative nature typically include the following:

8) Exacerbation of existing levels of habitat fragmentation and isolation; and
9) Cumulative impacts on local/ regional and national conservation targets and obligations.

15.2.1 Quantification of Cumulative Impacts on the Floristic Environment

Table 17: Quantification of cumulative impacts of the Power Plant on the floristic environment

Nature:	9. Exacerbation of existing levels of habitat fragmentation and isolation (Loss of natural habitat outside the development footprint caused by peripheral developments such as local townships, increased density of road and other linear infrastructures, increased anthropogenic encroachment and exploitation of natural resources, loss of aesthetic appeal and 'sense of place', habitat fragmentation and degradation)	
	Cumulative Contribution of Proposed Project	Cumulative Impact without Proposed Project
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**High (64)**	**Medium (36)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Loss of resources?	Yes, considered a regional impact	
Can impacts be mitigated?	Yes, but extremely limited success	
Confidence in findings	High	
Mitigation Measures:	These impacts are generally addressed on other platforms, such as regional councils and authority involvement and generally lies outside the scope of this particularly project.	

Nature:	10. Cumulative impacts on local/ regional and national conservation targets and obligations (Loss of natural habitat, habitat fragmentation and degradation, loss of phytodiversity, decreased aesthetic appeal)	
	Cumulative Contribution of Proposed Project	Cumulative Impact without Proposed Project
Extent	National (4)	Local (2)
Duration	Permanent (5)	Local (2)
Magnitude	Low (4)	Minor (2)
Probability	Improbable (2)	Very improbable (1)
Significance	**26**	**6**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Loss of resources?	Yes, all anthropogenci developments result in sterile habitat and devastation of natural vegetation, causing linear and nodal losses of habitat, disruption of continuous habitat, increased fragmentation and isolation of natural habitat	
Can impacts be mitigated?	Yes, but wit extremely little success	
Confidence in findings	High	
Mitigation Measures:	Generic mitigation measures, containment, prevention of spread of cumulative impacts, possible development of a Offset Programme/ conservation programme	

15.3 Summary of Impact Quantification on the Floristic Environment

Table 18: Summary table for impact significance in the botanical environment

Impact	*Significance*	
	Without Mitigation	With mitigation
1. Loss of plant taxa (individuals, stands, populations) of conservation importance (threatened taxa) as well as plant taxa of conservation concern (declining status, provincially protected taxa), including habitat that is regarded highly suitable for the persistence of these species	High (85)	Medium (48)
2. Loss of natural vegetation (physical modifications, removal, damage) including the loss of atypical, sensitive, conservation important habitat types or ecosystems of restricted abundance	High (75)	Medium (48)
3. Local depletion of plant taxa and reduction of phytodiversity	Medium (52)	Medium (39)
4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.	High (60)	Medium (40)
5. Reduced or severely altered ecological functionality (including fire, erosion)	High (80)	Medium (52)
6. Decreased aesthetic appeal of the landscape	High (60)	Medium (55)
7. Introduction of invasive, exotic and encroacher plant species	High (60)	Medium (33)
8. Increased exploitation of natural resources due to increased human presence and resource requirements	High (64)	Low (22)
9. Cumulative exacerbation of existing levels of habitat fragmentation and isolation	High (64)	Medium (36)
10. Cumulative impacts on local/ regional and national conservation targets and obligations	Low (26)	Low (6)

16 ANALYSIS OF PROPOSED PROJECT ALTERNATIVES

Three alternatives in terms of the proposed infrastructure layout are proposed, which are presented in **Figures 15, 16 and 17** superimposed on the floristic sensitivity of the receiving environment. Alternatives differ from each other in terms of the spatial arrangement of the infrastructure, with most of the footprints located on Farm Vrienden, while one of the options (c. second preferred option) having 60 ha of the proposed ash dump also on Farm Du Toit

The respective project alternatives are briefly evaluated in terms of the expected impact on floristic sensitivity units that were identified as part of this assessment and will mostly relate to the expected effects of direct impacts (refer **Section 15**). The evaluation of the estimated suitability of the respective impacts also took brief notice of the location of large *Adansonia digitata* individuals.

The homogeneity of the receiving environment largely determines that none of the project alternatives are spatially situated within areas of particularly high floristic sensitivity, apart from the proposed access road and pipeline servitude which remains as a constant for all the alternatives, which will adversely affect floristic habitat of medium-high sensitivity. Taking cognisance of less pertinent floristic and biophysical attributes of the receiving environment, comments are presented on the feasibility of the respective project alternatives. The proposed placement of the Eskom 400 kV substation should be reconsidered as it is placed immediately adjacent to the Quartzitic outcrop that is deemed to exhibit floristic sensitivity attributes of medium-high sensitivity. A suitable buffer zone (approximately 100 m) should be allowed for this feature.

It should be noted that the significance of most of the impacts are impossible to negate simply by means of the spatial placement of the proposed development; it is simply an undisputed fact that impacts such as loss of natural vegetation, depletion of phytodiversity, decreased aesthetic appeal, local and regional cumulative impacts relating to habitat fragmentation, etc., will occur irrespective of site variations. Consideration is therefore given to site-specific aspects, such as the location of plant individuals of local importance, local fragmentation factors, habitat variability on a local scale, etc.

16.1 Alternative 1

The positioning of the proposed development entirely within the boundaries of the Farm Vrienden is regarded a beneficial aspect in terms of ecological fragmentation and habitat isolation. Although only minor variability was recorded between the typical terrestrial woodland habitat of the two farms, limiting the impacts to only one of the farms is regarded a more suitable alternative as the road and railway line between the properties will act as an artificial buffer. Furthermore, preventing the spread of the proposed development across the road will somewhat lessen the impact of indirect spread of impacts, such as habitat deterioration, spread of unwanted species, peripheral impacts, as the road and railway line presents a 'boundary' to the development. Taking cognisance of the location of plants of local importance, it is estimated that 2 large *Adansonia* individuals will be directly affected. The avoidance of these individuals in the final layout is strongly advised.

Concerns regarding this option include the drainage patterns of the immediate region as it corresponds to seasonal water courses that could contribute to pollution of downstream habitat. This option is regarded as the preferred option from a botanical perspective.

16.2 Alternative 2

As the habitat diversity (with reference to atypical and physiognomic variations) is higher on Farm Du Toit, the placement of part of the development footprint on this property is expected to result in marginally higher impacts. These direct impacts will be exacerbated by an increase in effects that will contribute to exacerbated habitat fragmentation. It is considered more ideal to limit the footprint of the proposed development to a single property, not allowing it to be situated on both sides of the road. The length of the conveyor between the power station and the ash dump is also a negative consideration.

Impacts on plants of interest indicate that at least three significant *Adansonia* individuals will be affected by this option as these are situated within the development footprint. This alternative is therefore regarded as the least preferred option in terms of the floristic environment.

16.3 Alternative 3

As with Alternative 1, limiting the placement of the footprint to a single property is regarded beneficial and will largely limit most of the impacts to some extent. However, the spatial placement of the ash dump in this alternative implies direct losses of at least 2 large individuals of *Adansonia*. The avoidance of these floristic features in the final layout is strongly advised. The placement of the ash dump adjacent to the road also implies significant effect on the aesthetic appearance of the natural environment. Floristic habitat affected by this alternative comprises of moderate sensitivities and no aspect of elevated floristic importance will be affected adversely.

Concerns regarding this option include the drainage patterns of the immediate region as it corresponds to seasonal water courses that could contributed to pollution of downstream habitat. This option is therefore regarded as the second preferred alternative in terms of impacts on the floristic environment.

16.4 Synthesis

The three project alternatives are regarded to be highly similar in layout and estimated footprint sensitivity regarding the botanical receiving environment. Anticipated impacts on the floristic environment, surrounds and region are not expected to vary significantly between the three proposed alternatives; discussions on anticipated impacts are therefore applicable to the three alternative layouts. Despite the similarity in sensitivity aspects, minor (localised) attributes are considered important in the preferability of the proposed alternative layouts. The following order of preferability is presented:

» Option 1 is regarded the preferred option in terms of the floristic environment;
» Option 2 is regarded the least preferred option in terms of the floristic environment; and
» Option 3 is regarded as the second preferred alternative in terms of impacts on the floristic environment.

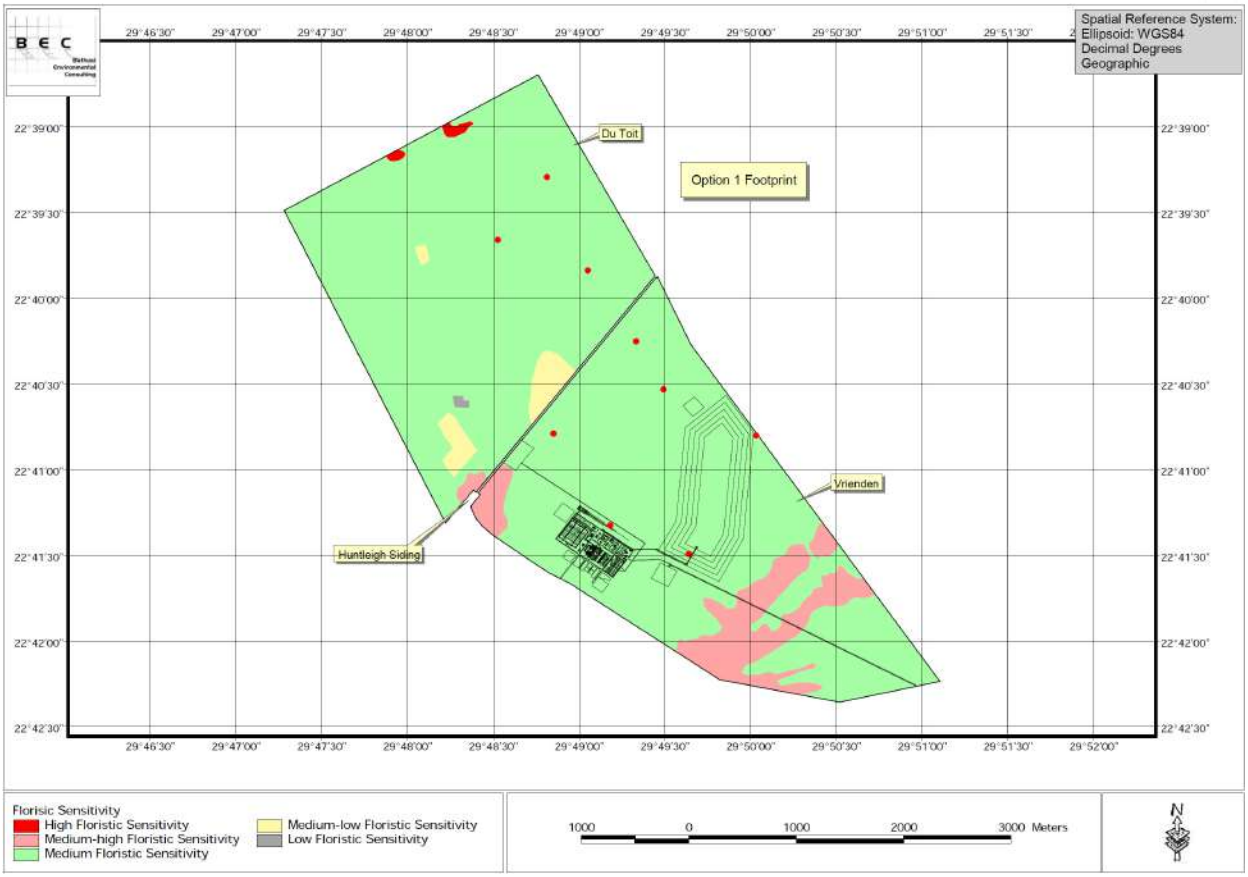


Figure 15: Spatial position of Alternative 1 in relation to floristic sensitivity

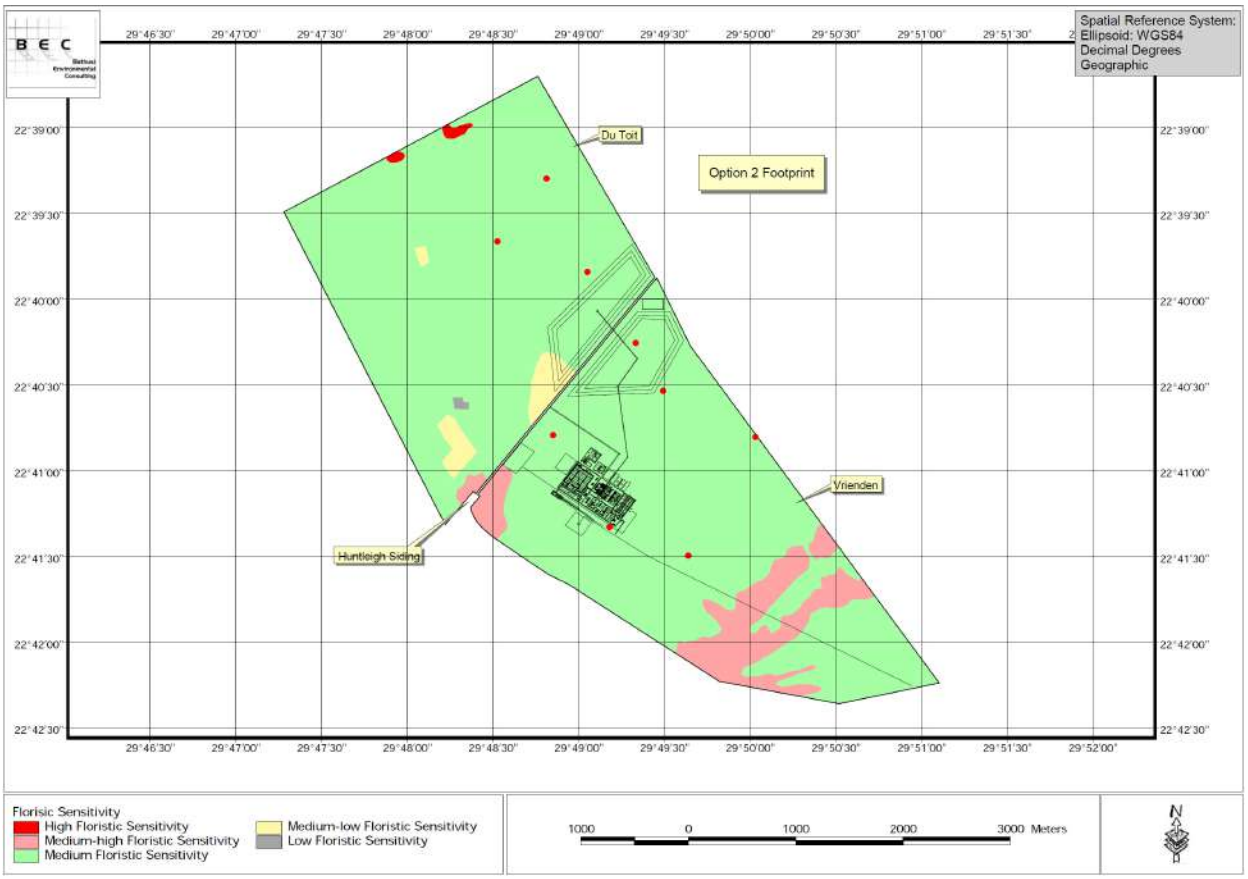


Figure 16: Spatial position of Alternative 2 in relation to floristic sensitivity

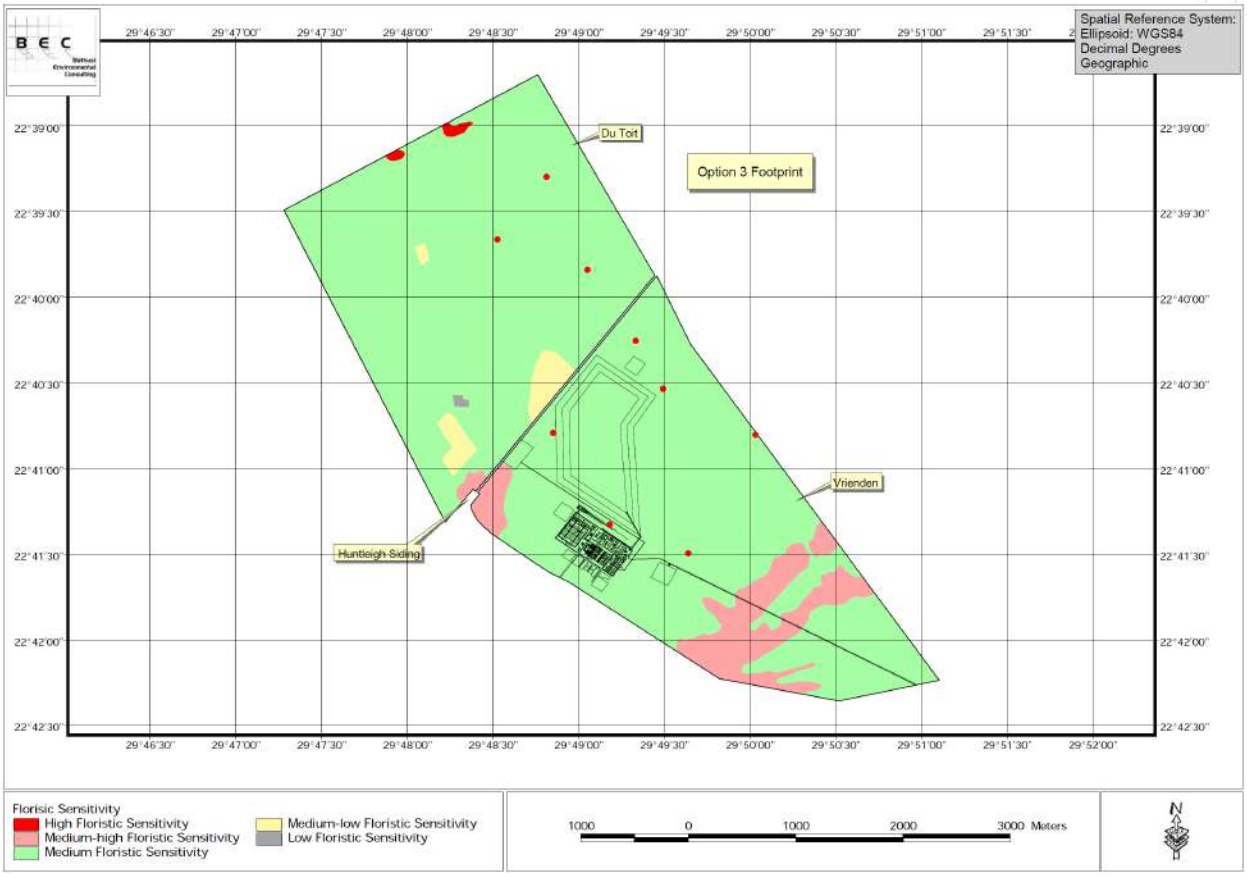


Figure 17: Spatial position of Alternative 3 in relation to floristic sensitivity

17 MITIGATION

The mitigation of negative impacts on biodiversity and ecosystem services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the area being affected. Mitigation requires proactive planning that is enabled by following the mitigation hierarchy, illustrated in **Figure 18**. Its application, is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity, where:

Avoiding or preventing impacts – refers to considering options in project location, siting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services, and people. This is the best option but is not always possible if development/ construction is to take place. However, there are areas where the environmental and social constraints are too high, and development should not take place. Such areas are best identified early in the development life cycle, so that impacts can be avoided, and authorisations refused. In the case of areas where environmental constraints might be limiting, this includes some ecosystems, habitats, ecological corridors, or areas that provide essential ecosystem services and are of such significant conservation value or importance that their loss cannot be compensated for (i.e. there is no substitute). In such areas, it is unlikely to be possible or appropriate to rely on the latter steps in the mitigation hierarchy (e.g. rehabilitating or offsetting impacts) to provide effective remedy for impacts on biodiversity or ecosystem services. Information about the location of many such areas is available, often making it possible to avoid them.

Minimising impacts – refers to considering alternatives in the project location, siting, scale, layout, technology and phasing that would minimise impacts on biodiversity and ecosystem services. Even in areas where the environmental and social constraints are not particularly high for develpoment to proceed/take place every effort should still be made to minimise impacts.

Rehabilitate impacts – refers to the rehabilitation of areas where impacts were unavoidable, and measures are taken to return impacted areas to a condition ecologically similar to their 'pre-development natural state' or an agreed land use after closure. Although rehabilitation is important and necessary, unfortunately even with significant resources and effort, rehabilitation is a limited process that usually falls short of replicating the diversity and complexity of a natural system. Instead, rehabilitation helps to restore some resemblance of ecological functioning in an impacted landscape, to avoid on-going negative impacts, and/or to provide some sort of aesthetic fix for a landscape. Rehabilitation should occur concurrently or progressively with the proposed activity, and/or on cessation of the activity.

Offset impacts –refers to compensating for remaining and unavoidable negative effects on biodiversity. When every effort has been made to minimise and then rehabilitate remaining impacts to a degree of no net loss of biodiversity against biodiversity targets, biodiversity offsets can provide a mechanism to compensate for significant residual negative impacts on biodiversity.

The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives of project location, footprint siting, scale, layout, technology and phasing until the proposed development best 'suits' and can be accommodated without significant negative impacts in the receiving environment. In cases where the receiving environment cannot support the development (e.g. there is insufficient water) or where the project will eradicate unique biodiversity, the development may not be feasible; the earlier the developing company knows of these risks, and can plan to avoid them, the better. In cases where biodiversity impacts are likely to be severe, the guiding principle should therefore be to "anticipate and prevent" rather than "assess and repair".

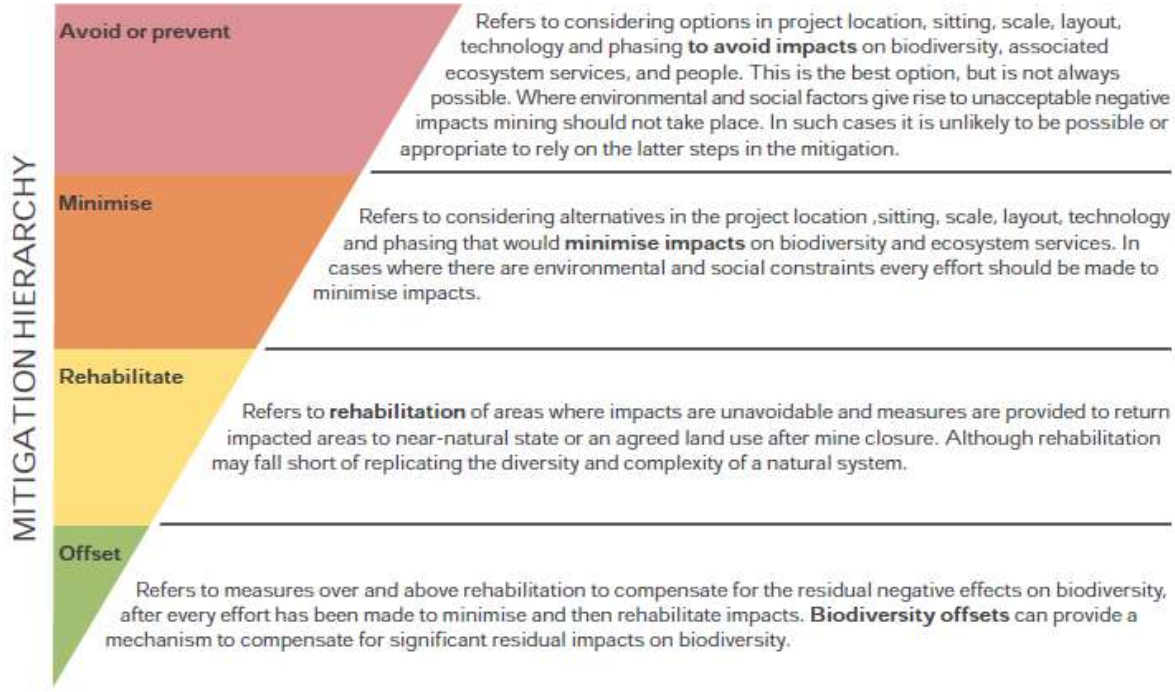


Figure 18: Mitigation hierarchy for dealing with negative impacts on biodiversity

17.2 Site Specific Mitigation Measures

Mitigation Measure 1 - Exclude all areas of high ecological sensitivity from the proposed development;

Mitigation Measure 2 - Avoid development across natural and/ or artificial boundaries;

Mitigation Measure 3 - Implement a suitable buffer zone (at least 100 m) between the edge of sensitive areas and any type of development or surface disturbance, with specific reference to the Eskom substation;

Mitigation Measure 4 - Prevent contamination of natural woodland, wetland and seasonal pans from stockpiling, conveyor lines, water treatment facilities or any other source of pollution;

Mitigation Measure 5 - Conduct a detailed walk through of the approved footprint to locate and identify all species of conservation importance (as defined by pertinent legislation). Permits must be obtained prior to disturbance or destruction of such species;

Mitigation Measure 6 - Remove and relocate as many plant species of conservation importance as possible that are present within development areas (within reason);

Mitigation Measure 7 - Limit potential damage to *Adansonia* individuals to an absolute minimum through the appropriate design of the facility and associated infrastructure;

Mitigation Measure 8 - Avoid any impacts on large *Adansonia* individuals during the final layout planning;

Mitigation Measure 9 - Relocate **smaller** *Adansonia* individuals from the proposed development footprint (this species has indicated a high success rate from transplanting efforts for smaller individuals);

17.3 General Aspects

Mitigation Measure 10 - Compile and implement a botanical monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Biodiversity monitoring should be conducted at least annually to assess the status of natural habitat and effects of the development on the natural environment;

Mitigation Measure 11 - Compile and implement an Alien and Invasive Management Programme;

Mitigation Measure 12 - Appoint an Environmental Officer (EO) prior to commencement of construction. Responsibilities should include, but not necessarily be limited to, ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;

Mitigation Measure 13 - Appoint a qualified Biodiversity Control Officer for the duration of the construction process that is versed in the identification of plants and animal species;

17.4 Fences & Demarcation

Mitigation Measure 14 - Demarcate the approved footprint and construction areas by permanent means at the onset of construction to prevent accidental, or unwanted impacts in surrounding natural habitat and to control movement of personnel, vehicles, providing boundaries for construction and operational sites;

Mitigation Measure 15 - No painting or marking of rocks or vegetation to identify locality or other information shall be allowed, as it will disfigure the natural setting. Marking shall be done by steel stakes with tags, if required;

17.5 Fire

Mitigation Measure 16 - The Project team must compile a Fire Management Plan (FMP) for implementation by all Contractors;

Mitigation Measure 17 - The FMP shall include *inter alia* aspects such as relevant training, equipment on site, prevention, response, rehabilitation and compliance to the National Veld and Forest Fire Act, Act No. 101 1998;

Mitigation Measure 18 - Prevent all open fires on site;

Mitigation Measure 19 - Provide demarcated fire-safe zones, facilities and suitable fire control measures;

Mitigation Measure 20 - Use of branches of trees, shrubs or any vegetation for fire making purposes is strictly prohibited;

Mitigation Measure 21 - The irresponsible use of welding equipment, oxy-acetylene torches and other naked flames, which could result in veld fires, or constitute a hazard should be guided by safe practice guidelines;

Mitigation Measure 22 - The use of fire as a vegetation management tool should be guided and instructed by a qualified ecologist;

17.6 Roads & Access

Mitigation Measure 23 - A road management plan should be compiled prior to the commencement of construction activities to avoid exacerbated impacts on vegetation and minimise the exposure of natural habitat to disruptive activities;

Mitigation Measure 24 - Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

Mitigation Measure 25 - Dust control on all roads should be prioritised during all stages of development and operation;

Mitigation Measure 26 - No roads should be allowed within ecologically sensitive areas;

17.7 Workers & Personnel

Mitigation Measure 27 - Provide temporary on-site ablution, sanitation, litter and waste management and hazardous materials management facilities;

Mitigation Measure 28 - Abluting anywhere other than in provided toilets shall not be permitted. Under no circumstances shall use of the veld be permitted;

17.8 Vegetation Clearance & Operations

Mitigation Measure 29 - Conduct a protected species survey. Results of this survey will guide permitting requirements for the removal of protected trees and plants from the selected development footprint;

Mitigation Measure 30 - Identify and relocate all plants of conservation concern that will be adversely affected as part of an ecological management plan for the area. It is emphasised that the removal and/ or relocation of any conservation important plant is subject to provincial permitting obligations;

Mitigation Measure 31 - The removal or picking of any protected or unprotected plants shall not be permitted and no horticultural specimens (even within demarcated working areas) shall be removed, damaged or tampered with;

Mitigation Measure 32 - The landowner must immediately take steps to remove alien vegetation as per Conservation of Agricultural Resource Act (No. 43 of 1983). This should be done based on an alien invasive management strategy that should be compiled by a suitable ecologist. The plan must make reference to:

- Uprooting, felling or cutting;
- Treatment with a weed killer that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;
- The application of control measures regarding the utilization and protection of veld in terms of regulation 9 of the Act;

- The application of control measures regarding livestock reduction or removal of animals in terms of regulations 10 and 11 of the Act;
- Any other method or strategy that may be applicable and that is specified by the executive officer by means of a directive.
- According to the Conservation of Agricultural Resource Act (No. 43 of 1983) as amended, the person applying herbicide must be adequately qualified and certified as well as registered with the appropriate authority to apply herbicides.

Mitigation Measure 33 - The size of areas subjected to land clearance must be kept to a minimum;

Mitigation Measure 34 - Only areas as instructed by the Site Manager must be cleared and grubbed;

Mitigation Measure 35 - Cleared vegetation and debris that has not been utilised must be collected and disposed of to a suitable waste disposal site. It may not be burned on site;

Mitigation Measure 36 - All vegetation not required to be removed must be protected against damage;

Mitigation Measure 37 - Removal of vegetation/ plants shall be avoided until such time as soil stripping is required and similarly exposed surfaces must be re-vegetated or stabilised as soon as is practically possible;

Mitigation Measure 38 - Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and vice versa and protecting the agricultural resources and soil conservation works are regulated by the Conservation of Agricultural Resources Act (No 43 of 1983) and must be addressed on a continual basis, through an alien vegetation control and monitoring programme;

Mitigation Measure 39 - Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes to facilitate regrowth of species that occur naturally in the area. Removal of topsoil should be done to a depth of at least 1 m;

Mitigation Measure 40 - Stored topsoil must be free of deleterious matter such as large roots, stones, refuse, stiff or heavy clay and noxious weeds, which would adversely affect its suitability for planting;

Mitigation Measure 41 - No spoil material may be dumped outside the defined site;

Mitigation Measure 42 - Disturbance of vegetation must be limited to areas of construction;

Mitigation Measure 43 - Ensure proper surface restoration and resloping to prevent erosion, taking cognisance of local contours and landscaping;

Mitigation Measure 44 - Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation;

Mitigation Measure 45 - The grass mix should consist of locally indigenous grasses adapted to the local environmental conditions;

Mitigation Measure 46 - Revegetated areas should be fenced to prevent damage by grazing animals;

Mitigation Measure 47 - Re-vegetated areas showing inadequate surface coverage (less than 30% within eight months after re-vegetation) should be prepared and re-vegetated from scratch;

Mitigation Measure 48 - Damage to re-vegetated areas should be repaired promptly;

Mitigation Measure 49 - As far as practically possible, only indigenous plant species that are endemic to the area/region are to be used in landscaping activities on the site, as these species are adapted to the specific conditions (climatic, soil, etc) of the area and would require the least amount of irrigation, pesticides, etc;

Mitigation Measure 50 - Exotic weeds and invaders that might establish on the re-vegetated areas should be controlled to allow the vegetation to properly establish.

17.9 Waste

Mitigation Measure 51 - As far as possible, waste should be avoided, reduced, re-used and/or recycled. Where this is not feasible, all waste (general and hazardous) generated during the construction of the power station may only be disposed of at appropriately licensed waste disposal sites (in terms of Section 20 of the Environment Conservation Act, No 73 of 1989 and in accordance with the new waste act: National Environmental Waste Management Act 2008);

Mitigation Measure 52 - Prevent and advocate against the indiscriminate disposal of rubbish, litter or rubble;

Mitigation Measure 53 - The burning of general waste material under any circumstances is not to be allowed;

Mitigation Measure 54 - Waste must be sorted at source (i.e. the separation of tins, glass, paper etc); recycled waste of this sort must be collected by an accredited waste removal contractor;

Mitigation Measure 55 - A stormwater management plan must be compiled that will address, inter alia, capturing and storage of stormwater;

Mitigation Measure 56 - All runoff water from fuel deposits, workshops, vehicles washing areas and other equipment must be collected and directed through oil traps to settlement ponds. These ponds must be suitably lined and should be cleaned as soon as practicable, and the sludge disposed of at a suitable and permitted/ approved waste site;

Mitigation Measure 57 - No wastewater or water containing any chemical or pollutant should be released from, or escape as effluent, from the site.

17.10 Preliminary Botanical Management Action Plans

Biodiversity Action Plans are presented for each of the identified impacts. These Action Plans are by no means regarded as comprehensive and should be elaborated and detailed as needed during the various phases of the proposed development.

Impact 1: Loss of plant taxa (individuals, stands, populations) of conservation importance (threatened taxa) as well as plant taxa of conservation concern (declining status, provincially protected taxa), including habitat that is regarded highly suitable for the persistence of these species;		
Objective:	Limit/ manage impacts on conservation important plants and protected tree species within the project area/ adjacent areas	
Project Components:	Any infrastructure development that will cause loss of natural habitat where protected tree species and/ or conservation important plants occur	
Potential Impacts:	Uncontrolled loss of protected species from remaining areas of natural habitat, legal compliance with permitting requirements, exacerbated losses of plant species of conservation concern, with specific reference to large *Adansonia* individuals	
Activity/ Risk Source:	Site preparation, land clearance, construction activities, operational activities	
Mitigation: Target/ Objective:	Limit the impact on protected and conservation important plant species. Prevent impacts on protected and conservation important plants in remaining areas of natural habitat, remove suitable sample sizes of target species	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Ensure that a comprehensive walkthrough of the site is conducted prior to commencement of activities to identify and count all protected plants that occur within the footprint	Construction Contractors, Environmental Team, Environmental Officer, Botanists	Prior to site preparation activities, permitting requirements
Ensure compliance in terms of the NFA and LEMA requirements pertaining to removal, damage or destruction of protected and/ or conservation important plants and trees		Prior to site preparation activities, permitting requirements
Ensure all activities that result in destruction of natural habitat are contained within the authorized footprint and do not spread beyond the boundaries of the site		Site preparation, Construction Phase
Identify tree species that can be retained in position on the site to aid with landscaping and conservation of the species		Prior to site preparation activities
Identify individuals that would be suitable for rescue and relocation purposes to aid with landscaping and conservation		Prior to site preparation activities, construction phase, rehabilitation and revegetation
Performance Indicator:	No significant loss of protected trees and conservation important plants in natural habitat surrounding the site and infrastructure, approved permits for the removal and/ or destruction of certain species	
	The presence of protected trees within the project area that are used for aesthetic, rehabilitation purposes	
Monitoring:	Density counts of protected trees within adjacent areas of natural habitat, continued monitoring of conservation important plants in the natural environment	
Impact 2: Loss of natural vegetation (physical modifications, removal, damage) including the loss of atypical, sensitive, conservation important habitat types or ecosystems of restricted abundance		
Objective:	Limit/ manage the loss of natural vegetation (physical modifications, removal, damage) and local depletion of plant taxa, reduction of phytodiversity	
Project Components:	Any infrastructure development that will cause loss of natural habitat, land clearance	
Potential Impacts:	Uncontrolled loss of natural habitat that would result in a reduction of local phytodiversity	
Activity/ Risk Source:	Site preparation, land clearance, construction activities, operational activities	
Mitigation: Target/ Objective:	Allow for remaining areas of natural habitat to function ecologically effective within the environment of industrial development, clear and defined boundaries	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Identify a selection of suitable management areas in collaboration with specialists and appointed environmental personnel that will address requirements and objectives, including the consideration of areas of significant impact on biodiversity attributes	Developer, environmentalists, ecologists, project environmental team	Prior to site preparation activities
Propose and select a range of management areas that will suffice in the objectives of a diversity	Construction Contractors, Environmental Team,	Prior to site preparation activities

programme and where conservation efforts will yield positive results	Environmental Officer	
Select a range of floristic diversity attributes that are considered important on a local and regional scale, attempting to align local conservation efforts with regional conservation plans, floristic diversity in management areas could be presented as performance indicators of intervention/ conservation, or rehabilitation efforts, ensure the continuance of a healthy, representative floristic composition and structure across the landscape		Site preparation, Construction Phase
Develop and implement a fire management programme, and grazing strategies for remaining areas of natural vegetation		Prior to site preparation activities, construction phase, rehabilitation and revegetation
Select a range of fixed points where periodic monitoring efforts will accurately assess and illustrate results of intervention/ conservation programmes		Prior to site preparation activities
The implementation of periodic monitoring programme should be aimed at assessing and guiding management activities to the benefit of the environment		Prior to site preparation activities, construction phase, rehabilitation and revegetation
Contribute information gained during the intervention process to relevant role-players and regional conservation efforts		Prior to site preparation activities, construction phase, rehabilitation and revegetation
Performance Indicator:	No significant loss of phytodiversity on a local or regional scale, the implementation of a conservation strategy that will benefit local and regional conservation efforts	
	Effective ecological functionality of remaining areas of natural vegetation within an environment of industrial development	
Monitoring:	Annual monitoring of phytodiversity in affected and surrounding areas of natural habitat as part of a bio monitoring programme	
Impact 3: Local depletion of plant taxa and reduction of phytodiversity.		
Objective:	To prevent/ mitigate the loss of phytodiversity, associated with sensitive, conservation important habitat types or ecosystems of restricted abundance	
Project Components:	All activities that will result in decimation of natural habitat, accidental or unforeseen impacts on neighbouring natural habitat	
Potential Impacts:	Uncontrolled and accidental deterioration of natural terrestrial woodland habitat	
Activity/ Risk Source:	Site preparation, land clearance, construction activities, operational activities	
Mitigation: Target/ Objective:	Limit the direct impacts on areas of natural vegetation	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Identify a selection of suitable management areas in collaboration with specialists and conservation panel that will address requirements and objectives, including the consideration of areas of significant impact on biodiversity attributes	Developer, environmentalists, ecologists, project environmental team	Prior to site preparation activities
Propose and select a range of management areas that will suffice in the objectives of a diversity programme and where conservation efforts will yield positive results	Construction Contractors, Environmental Team, Environmental Officer	Prior to site preparation activities
Select a range of habitat diversity attributes that are considered important on a local and regional scale, attempting to align local conservation efforts with regional conservation plans, habitat diversity in management areas could be presented as performance indicators of intervention/ conservation, or rehabilitation efforts, ensure the continuance of a healthy, representative floristic composition and structure across the landscape		Site preparation, construction and operational phases
Select a range of fixed points where the application of periodic monitoring programmes will accurately assess and illustrate results of intervention/ conservation programmes		
The implementation of periodic monitoring programme should be aimed at assessing and guiding management activities to the benefit of the environment		
Contribute information gained during the intervention process to relevant role-players and		

regional conservation efforts		
Performance Indicator:	No significant loss of sensitive landscapes or ecological types on a local or regional scale, no significant changes to phytodiversity attributes, the implementation of a conservation strategy that will benefit local and regional conservation efforts	
	Effective ecological functionality of remaining areas of natural vegetation within an environment of industrial development	
Monitoring:	Annual monitoring of sensitive landscapes in affected and surrounding areas of natural habitat as part of a bio monitoring programme	
Impact 4: Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc., also including Impacts on habitat types that are associated with plants of conservation importance (decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.)		
Objective:	To control and prevent a decrease in habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc., also including Impacts on habitat types that are associated with plants of conservation importance (decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.)	
Project Components:	Construction and development within a natural environment, also where natural environment of surrounding and adjacent areas will be affected through peripheral and uncontrolled impacts	
Potential Impacts:	Deterioration of adjacent natural habitat, spillages, contamination, exacerbation and infestation of weeds, encroacher and invasive species	
Activity/ Risk Source:	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective:	Ensure the conservation /preservation of natural habitat within adjacent areas, limit construction and operational impacts to footprints	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Identify activities and project components that are likely to cause degradation of surrounding natural habitat	Developer, environmentalists, ecologists, project environmental team, EO	Site preparation and clearance phase, construction and operational phases
Compile Standard Operating Procedures to deal with the prevention, timely identification and rehabilitation of adverse environmental events and occurrences		Site preparation and clearance phase, construction and operational phases
Implement suitable buffer zones around development footprints that will assist in preventing uncontrolled spread of impacts into adjacent areas of natural habitat		Planning, site preparation and construction phase
Limit construction activities and personnel movement to development footprints		Site preparation and clearance phase, construction and operational phases
Establish best-practice guidelines that will guide all operational activities within management areas, including aspects such as land clearance, roads and maintenance, movement and personnel presence, operational activities, waste management, etc.		Planning and site preparation phases
Identify and develop suitable site restoration goals and activities that will contribute to conservation objectives (removal of litter, erosion control/ restoration, rehabilitation, etc.)		Site preparation and clearance phase, construction and operational phases
Develop monitoring and feedback control mechanisms to identify and immediately remediate noted impacts outside control measures and boundaries		Construction and operational phases
Performance Indicator:	No visible or subjective changes to surrounding areas of natural habitat	
	Absence of invasive and encroacher species in surrounding areas of natural habitat	
	Effective ecological functionality of remaining areas of natural vegetation within an environment of industrial development	
Monitoring:	Annual monitoring of adjacent and surrounding vegetation as part of a bio monitoring programme	
Impact 5: Altered quality and ecological functionality (including fire, erosion) of surrounding areas and natural habitat		
Objective:	To sustain the existing/ improve on the existing quality and ecological functionality (including fire, erosion) of surrounding areas and natural habitat	
Project Components:	Construction and development within a natural environment, also where natural environment and ecological functionality of surrounding and adjacent areas will be affected through development and operational aspects	
Potential Impacts:	Deterioration of adjacent natural habitat, changes to local ecological functionality and quality	

Activity/ Risk Source:	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective:	Ensure the conservation /preservation of natural habitat and ecological functionality within adjacent areas, limit construction and operational impacts to footprints	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Identify activities and project components that are likely to cause degradation of surrounding natural habitat	Construction Contractors, Environmental Team, Environmental Officer	Prior to site preparation activities
Identify areas where exceptional and/ or ecological attributes of importance to the ecological functionality of the local area persists and retain these attributes as part of a conservation/ preservation programme		Site preparation, construction phase, operational phase
Compile Standard Operating Procedures to deal with the prevention, timely identification and rehabilitation of adverse environmental events and occurrences within areas of ecological importance		Planning, site preparation and construction phases
Compile and implement a biodiversity monitoring programme that aims to evaluate changes to the natural environment that would affect ecological functionality		Planning, site preparation and construction phases
Performance Indicator:	Persistence of ecological functionality of remaining areas of natural habitat within surrounds of the development footprint, operational areas	
	Retaining phytodiversity, ecological functionality. Also, in collaboration with faunal avifaunal attributes	
Monitoring:	Development and implementation of bio monitoring programme	
Impact 6: Decreased aesthetic appeal of the landscape		
Objective:	To limit the decrease in aesthetic appeal of the landscape resulting from the introduction of industrial components and infrastructure	
Project Components:	All development activities, land clearance, removal of natural vegetation, introduction of industrial components	
Potential Impacts:	Disfigurement of the natural environment beyond the development footprint	
Activity/ Risk Source:	Site preparation, construction activities, operational activities/ environmental management	
Mitigation: Target/ Objective:	Retain aesthetic appeal of the landscape through revegetation, rehabilitation. Prevent significant disfigurement	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Avoid the creation of sterile landscapes, deterioration and/ or structural changes to remaining areas of natural vegetation	Construction Contractors, Environmental Team, Environmental Officer	Site preparation, Construction Phase
Limit disturbance of natural habitat in surrounding areas		Site preparation, Construction Phase, Operational Phase
Implement timely rehabilitation procedures subsequent to land clearing activities		Construction Phase
Reintroduce large trees in proximity to development areas		Site preparation, Construction Phase, Operational Phase
Take cognisance of the visual impact assessment recommendations		Site preparation, Construction Phase, Operational Phase
Performance Indicator:	Retain natural vegetation in areas adjacent to development footprints, representative of the regional ecological types	
	Obscuring industrial and infrastructure components for visual observation lines/ points	
	Implementation of effective rehabilitation/ restoration programme	
Monitoring:	Ongoing monitoring of area by Environmental Control Officer during construction and operational phases	
Impact 7: Exacerbated encroachment of invasive, exotic and encroacher plant species		
Objective:	Control the persistence and occurrence of alien and invasive/ encroacher plant species within natural habitat surrounding the development site	
Project Components:	All development activities that will cause sterilisation of natural habitat that becomes suitable for infestation by alien and invasive and encroacher plant species	
Potential Impacts:	Displacement of natural vegetation by alien and invasive plants, displacement of natural vegetation by locally endemic encroacher species	
Activity/ Risk Source:	Site preparation, construction activities, operational activities/ environmental management	
Mitigation: Target/ Objective:	No alien and invasive/ encroacher plants within the development area, or surrounding natural habitat	

Mitigation: Action/ Control	Responsibility	Timeframe
Avoid the creation of sterile landscapes that are suitable for the infestation by alien and invasive plants	Construction Contractors, Environmental Team, Environmental Officer	Site preparation, Construction Phase
Limit disturbance of natural habitat		Site preparation, Construction Phase, Operational Phase
Implement timely rehabilitation procedures subsequent to land clearing activities		Construction Phase
Compile and implement ongoing monitoring programme to detect and quantify alien species as per the Conservation of Agricultural Resources Act		Site preparation, Construction Phase, Operational Phase
Implement immediate eradication procedures		Site preparation, Construction Phase, Operational Phase
Performance Indicator:	Absence of alien and invasive plants from the development site as well as surrounding natural habitat, effective preventative and rehabilitation procedures during construction and operational phases	
	Presence of natural vegetation that is representative of regional ecological types	
Monitoring:	Ongoing monitoring of area by Environmental Control Officer during construction and operational phases	
	Annual audit of project area and immediate surrounds by qualified botanist for the duration of the construction phase and biennualy for the duration of the project	
	Mapping, abundance, cover physical attributes of alien species. Results should be interpreted in term of risk posed to the environment.	
Impact 8: Increased exploitation of natural resources due to increased human presence and resource requirements		
Objective:	Prevent the exploitation of natural resources due to increased human presence and resource requirements	
Project Components:	All development activities where natural habitat is accessible to personnel and or local population	
Potential Impacts:	Decline in abundance of protected and or naturally occurring plants and species in the remaining areas of natural habitat	
Activity/ Risk Source:	Site preparation, construction activities, operational activities/ environmental management and operational phase	
Mitigation: Target/ Objective:	Retain/ improve current populations of target species	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Develop a suitable intervention/ conservation strategy that will identify, include potential target species	Construction Contractors, Environmental Team, Environmental Officer	Site preparation, Construction Phase
Develop a monitoring approach that will inform on the presence and abundance of target species		Site preparation, Construction Phase, Operational Phase
Establish a work group that will communicate with local muthi users, collectors to inform on the uses, abundance, harvesting of target species		Construction Phase
Establish guidelines ito picking/ harvesting of certain species within certain areas		Site preparation, Construction Phase
Investigate the possibility of establishing nurseries that might provide/ supply the local demand of certain species		Site preparation, Construction Phase
Conduct search and rescue operations within areas of development		Site preparation, Construction Phase
Allow harvesting of certain species within areas where development will take place		Site preparation, Construction Phase
Performance Indicator:	Continued persistence of target species within remaining areas of natural vegetation	
	Improved quality of natural habitat within remaining areas of natural vegetation	
Monitoring:	Ongoing monitoring of area by Environmental Control Officer during construction and operational phases	
	Annual audit of project area and immediate surrounds by qualified botanist for the duration of the construction phase and biennualy for the duration of the project	
	Mapping, abundance, cover physical attributes of alien species. Results should be interpreted in term of risk posed to the environment.	
Impact 9: Exacerbation of existing levels of habitat fragmentation and isolation		
Objective:	Limit deterioration of remaining areas of natural habitat, promote nodal type developments instead of the uncontrolled spread of infrastructure and development on a local and regional scale	
Project Components:	All development activities that will cause sterilisation of natural habitat	

Potential Impacts:	Uncontrolled spread of industrial and associated residential developments on a local and regional scale, uncontrolled loss of natural habitat, loss of aesthetic appeal	
Activity/ Risk Source:	Site preparation, construction activities, operational activities/ environmental management, future developments	
Mitigation: Target/ Objective:	Retain/ limit developments to small footprints, retain the natural character of the vegetation/ ecology on a local and regional scale	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
Avoid the creation of sterile landscapes that are suitable for the infestation by alien and invasive plants	Construction Contractors, Environmental Team, Environmental Officer	Site preparation, Construction Phase
Limit disturbance of natural habitat		Site preparation, Construction Phase, Operational Phase
Develop suitable land use and intensity options for intervention/ conservation sites		Construction Phase
Establish a work group with local land users/ developers/ role players to collaborate ito conservation and preservation strategies in terms of future developments in the natural environment		Site preparation, Construction Phase, Operational Phase
Collaborate with relevant role players to establish a working group to monitor levels of development/ habitat losses on a local and regional scale		Site preparation, Construction Phase, Operational Phase
Performance Indicator:	Continued presence of ecologically effective natural habitat within a region characterised by industrial and residential development	
	Prevention of uncontrolled spread of developments across the landscape	
Monitoring:	Ongoing monitoring of area by Environmental Control Officer during construction and operational phases	
	Biodiversity monitoring protocol in areas surrounding developments	
	Contribution to local and regional development programmes, land use monitoring, EMF, etc. through the Environmental Monitoring Committee that needs to entertain representatives from surrounding communities, development forums, etc.	
Impact 10: Cumulative impacts on local/ regional and national conservation targets and obligations		
Objective:	Prevent exacerbation of conservation levels, including ecological types and animals, plants, sensitive landscapes, etc.	
Project Components:	All development activities that will cause sterilisation and/or degradation of natural habitat	
Potential Impacts:	Loss of natural habitat that will result in threats to ecological types, species conservation and habitat preservation	
Activity/ Risk Source:	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective:	Ensure the effective preservation of species and habitat on a local and regional scale	
Mitigation: Action/ Control	***Responsibility***	***Timeframe***
Develop a suitable intervention/ conservation strategy that will identify, include potential target species, habitat types, etc, on a local and regional scale	Construction Contractors, Environmental Team, Environmental Control Officer	Prior to site preparation activities
Develop a monitoring approach that will inform on the persistence/ conservation treat and status of species and habitat types		Site preparation, Construction Phase
Contribute to a work group that will include all relevant role players to meet conservation target objectives		Prior to site preparation activities
Develop site-specific intervention strategies that will contribute to the status, diversity and preservation of selected sensitive landscapes and macro-habitat types		
Performance Indicator:	Continued persistence of natural, representative habitat on a local and regional scale	
	Avoidance of raised threat levels to species and ecological types	
Monitoring:	Development and implementation of bio monitoring programme	

17.11 Recommended Botanical Monitoring Programmes

To ensure the accurate gathering of data, the following techniques and guidelines (*inter alia*) should be followed:

» Fixed point monitoring should be applied as the preferred method of monitoring;
» All data gathered should be measurable (qualitative and quantitative);
» Monitoring report should be repeatable and temporally and spatially comparable;
» Data gathered should be an accurate representation of the PES of the study area, as well as the habitat units represented by each monitoring site;
» Data, when compared to previous sets, should show spatial and temporal trends; and
» General habitat unit overviews should also be undertaken to augment quantitative data.

As part of the proposed Botanical Monitoring Programme, the following aspects are recommended for inclusion into the monitoring programme:

» Temporal Monitoring of development related impacts;
» Floristic diversity & compositional monitoring;
» Floristic species richness monitoring;
» Compositional monitoring within affected areas;
» Conservation important plant monitoring programme;
» Plants with ethno-botanical properties monitoring programme;
» Alien and invasive plant monitoring;
» Structural and compositional monitoring for burning regime;
» Structural and compositional monitoring for stocking rates/ grazing potential;
» Structural and compositional monitoring; and
» Land change/ habitat loss and transformation monitoring programme.

The exact nature of a biological monitoring programme is subject to inputs from various role players; a representative workgroup should be established to determine the nature and detail of the relevant bio-monitoring protocol.

18 CONCLUDING STATEMENT

The receiving floristic environment is regarded natural and pristine, with extremely limited anthropogenic transformative and disruptive characteristics; uninterrupted woodland characterises the site and larger region. Despite the regional ecological type not being regarded to be under any immediate and significant threat (Musina Mopane Bushveld, Least Threatened), the proposed sites are characterised by locally sensitive areas, also comprising locally scarce species and protected tree species that has attained significant physical stature. The presence of these individuals and localised sensitive areas does not represent any Red Flag (No-Go option) to the proposed development as similar areas and species are most likely to be encountered on a scale local to the surrounding area, but due care is strongly advised to avoid impacting on these features by means of layout planning and selected relocation activities wherever possible.

The loss of these portions of woodland (on a regional scale) is not expected to result in significant and unacceptable impacts on the ecological type. It could also not be demonstrated

that unacceptable impacts on any conservation important (threatened) plant species is expected. An evaluation of potential and likely impacts on the receiving environment has demonstrated that cumulative impacts associated with the project are expected to be severe and will likely affect the receiving environment beyond the boundaries of the site on a permanent basis. Anthropogenic encroachment and the associated social issues, such as creation of informal settlements, densification of roads and other infrastructure, influx of job-seekers, expansion of the industrial and economic zones and the added pressure that these effects create on the natural environment (on a regional scale) is expected to cause significant environmental impacts. It is unfortunate that the management and effective mitigation of these impacts are mostly beyond the control and management of the project, apart from preventing the project altogether. However, anthropogenic densification (caused by other industrial developments within the region/ surrounds) is occurs irrespectively and cannot solely be attributed to the proposed development, although the contribution of the project cannot be ignored.

It is thefore the conclusion of this botanical assessment that, despite severe cumulative impacts that can reasonably be expected, the proposed project does not pose and unacceptable and threats to sensitive environs and species on a local scale. It is strongly advised that impacts on the botanical receiving environment should be managed according to the proposed mitigation strategy described in this document, but care should also be taken to identify *ad hoc* impacts which were not necessarily highlighted in this document and administer suitable and appropriate mitigation measures during the life of the project.

Based on results and recommendations presented in this botanical impact assessment, we do regard the project as acceptable, but cautions the use of a dedicated, acceptable and appropriate mitigation strategy to prevent undue and unneccesary impacts within the floristic environment.

19 APPENDIX 1 – RECORDED PHYTODIVERSITY OF THE SITE (2018)

Species Name	*Family*	*Growth Form*	*Status/ Uses*	*Common Name*
Abutilon fruticosum Guill. & Perr.	Malvaceae	Dwarf shrub	Typical on alkaline soils	Shrubby Abutilon (e)
Acanthospermum hispidum DC.	Acanthaceae	Prostrate herb	None	Upright starbur (e), Regopsterklits (a)
Adansonia digitata L.	Malvaceae	Tree	Protected Tree (National Forest Act, 1998)	Baobab (a), Cream-of-tartar-tree (e), Kremetartboom (a), Muvhuyu (v)
Adenium multiflorum Klotzsch	Apocynaceae	Succulent	Protected Plant, Schedule 11 (Mpumalanga Nature Conservation Act 10 of 1998)	--
Agelanthus sambesiacus (Engl. & Schinz) Polhill & Wiens	Loranthaceae	Parasite	Parasitic shrub in Mopane veld on Commiphora species	Zambezi Mistletoe (e), Zambezi-voelent (a)
Albizia brevifolia Schinz	Fabaceae	Small tree	None	Mountain False-thorn (e), Berg-valsdoring (a), Mohlalakgakga (ns)
Aptosimum lineare Marloth & Engl.	Scrophulariaceae	Forb	None	--
Aristida congesta subsp. *barbicollis*	Poaceae	Grass	Poor grazing potential, Increaser IIC	Spreading Three-awn (e), Lossteekgras (a)
Aristida congesta subsp. *congesta*	Poaceae	Grass	Poor grazing potential, indicator of poor habitat, Increaser IIC	Tassel Three-awn (e), Katstertsteekgras (a)
Aristida rhiniochloa Hochst.	Poaceae	Grass	Poor grazing value, ofen in disturbed areas, sandy soils	Rough Three-awn (e), Skurwesteekgras (a)
Aristida stipitata	Poaceae	Grass	Poor grazing potential, indicator of poor habitat, Increaser IIC	Long-awned Three-awn (e), Langnaaldsteekgras (a)
Asparagus species	Liliaceae	Shrub	None	Wild Asparagus (e), Katbos (a)
Barleria lancifolia T.Anderson	Acanthaceae	Dwarf shrub	None	Butterfly barleria (e), Skoenlapper-barleria (a)
Blepharis subvolubilis C.B.Clarke	Acanthaceae	Dwarf shrub	None	Eyelash flower (e)
Boscia albitrunca (Burch.) Gilg & Gilg-Ben.	Capparaceae	Tree	Protected Tree (National Forest Act, 1998), important fodder, traditional uses, traditional medicinal uses	Sheperd's Tree (e), Witgat (a), Matoppie (a), Mohlopi (ns)
Boscia foetida Schinz subsp. *rehmanniana* (Pestal.) Toelken	Capparaceae	Small tree	Medicinal uses, browsing value	Bushveld Shepherd Tree (e), Stinkwitgat (a), Mopipi (ns)
Brachiaria species	Poaceae	Grass	None	Signal grass (e)
Cadaba aphylla (Thunb.) Wild	Capparaceae	Shrub	Medicinal properties, potentially poisenous	Desert Spray (e), Bobbejaanarm (a)
Cassia abbreviata Oliv. subsp. *beareana* (Holmes) Brenan	Caesalpiniaceae	Tree	Least Concern, traditional medicinal uses	Sjambok pod (e), Sambokpeul (a), Molepelepe (tw)
Catophractes alexandri D.Don	Bignoniaceae	Shrub	Browsed by game	Trumpet Thorn (e), Trompetterdoring (a)
Ceratotheca triloba (Bernh.) Hook.f.	Pedaliaceae	Forb	Medicinal properties	Wild Foxglove (e), Vingerhoedblom (a)
Chamaesyce inaequilatera (Sond.) Soj k	Euphorbiaceae	Prostrate herb	None	--
Chloris roxburghiana Schult.	Poaceae	Grass	Common in Mopane veld in sandy areas, valuable grazing	Plume Chloris (e), Pluim-chloris (a)
Cienfuegosia digitata Cav.	Malvaceae	Dwarf shrub	None, found in disturbed places	Bushveld false Hibiscus (e)
Cissus cornifolia (Baker) Planch.	Vitaceae	Climber	Edible fruit	Wild Grape (e), Valsdruif (a)

Species Name	Family	Growth Form	Status/ Uses	Common Name
Colophospermum mopane (J.Kirk ex Benth.) J.Kirk ex J.Léonard	Caesalpiniaceae	Tree	Traditional medicinal uses, traditional uses, pods browsed by game, host plant for moth larvae Gonimbrasia belina (Mopane worm)	Mopane (e), Mopane (a), Mopane (tw)
Combretum apiculatum Sond. subsp. *apiculatum*	Combretaceae	Tree	Traditional medicinal uses, seeds possibly poisonous but consumed by Brown-headed Parrots, leaves eaten by game, firewood	Red bushwillow (e), Rooibos (a), Mogoeleri (ss)
Combretum imberbe Wawra	Combretaceae	Tree	Protected Tree (National Forest Act, 1998), firewood, medicinal uses	Leadwood (e), Hardekool (a), Motswiri (tw), Mudzwiri (v)
Commiphora africana (A.Rich.) Engl.	Burseraceae	Small tree	Water source, medicinal uses, edible roots, traditional uses	Hairy corkwood (e), Harige kanniedood (a), Iminyela (z)
Commiphora edulis (Klotzsch) Engl. subsp. *edulis*	Burseraceae	Small tree	Edible fruit	Rough-leaved Corkwood (e), Skurweblaar-kanniedood (a), Mohôta (tw)
Commiphora glandulosa Schinz	Burseraceae	Tree	Leaves eaten by game	Tall common corkwood (e), Groot gewone kanniedood (a), Iminyela (z)
Commiphora mollis (Oliv.) Engl.	Burseraceae	Small tree	Leaves eaten by game and cattle	Velvet Commiphora (e), Fluweel-kanniedood (a), Mokômoto (tw)
Commiphora pyracanthoides Engl.	Burseraceae	Shrub	Edible parts, traditional uses	Common corkwood (e), Gewone kanniedood (a) Iminyela (z)
Commiphora schimperi (O.Berg) Engl.	Burseraceae	Small tree	Traditional uses, browsed by game and cattle	Glossy-leaved Corkwood (e), Blinkblaar-kanniedood (a), Serôka (tw)
Commiphora viminea Burtt Davy	Burseraceae	Tree	Traditional uses, browsed by game and cattle	Zebra-bark Corkwood (e), Zebrabas-kanniedood (a), Mutonyombidi (v)
Corchorus asplenifolius Burch.	Tiliaceae	Forb	Traditional and medicinal uses, edible parts	Gusha (e), Geel varingblaartjie (a), Ubangalala (z)
Cordia grandicalyx Oberm.	Boraginaceae	Tree	Ornamental wood, fruit inedible	Large-fruit Saucer-berry (e), Grootvrugpieringbessie (a)
Cordia monoica Roxb.	Boraginaceae	Small tree	Edible fruit, traditional medicinal uses.	Sandpaper Saucer-berry (e), Snotbessie (a)
Cyphostemma sandersonii (Harv.) Desc.	Vitaceae	Climber	None	Bobbejaandruif (a)
Dichrostachys cinerea (L.) Wight & Arn. subsp. *africana* Brenan & Brummitt	Fabaceae	Small tree	Encroacher species, traditional medicinal uses, firewood, pods browsed extensively by game and stock	Small-leaved Sickle Bush (e), Kleinblaar-sekelbos (a), Ugagake (z)
Digitaria eriantha Steud.	Poaceae	Grass	Weaving, palatable grazing grass, Decreaser	Finger grass (e), Finger gras (a)
Enneapogon desvauxii	Poaceae	Grass	Moderate grazing potential	Eight-day Grass (e), Haasgras (a)
Enteropogon macrostachyus (A.Rich.) Benth.	Poaceae	Grass	Low grazing value, sometimes used in flower arrangements	Hare grass (e), Haasgras (a)
Eragrostis lehmanniana Nees var. *lehmanniana*	Poaceae	Grass	Indicator of overgrazing, valuable grazing grass,	Lehman Love Grass (e), Lehmann-eragrostis (a), Knietjiesgras (a)
Eragrostis rigidior Pilg.	Poaceae	Grass	Important grazing grass in arid regions	Broad curly leaf (e), Breë Krulblaar (a)
Eragrostis rotifer Rendle	Poaceae	Grass	Average palatibility, important during winter in arid areas	Pearly love grass (e), Vleipluimgras (a)
Eragrostis species	Poaceae	Grass	None	--

Species Name	Family	Growth Form	Status/ Uses	Common Name
Euphorbia limpopoana L.C.Leach ex S.Carter	Euphorbiaceae	Succulent	Rocky hills and sandy soils in Mopane woodland	Limpopo Euphorbia (e, a)
Euphorbia species	Euphorbiaceae	Succulent	None	--
Evolvulus alsinoides (L.) L.	Convolvulaceae	Forb	None	Blue Haze (e)
Geigeria acaulis (Sch.Bip.) Benth. & Hook.f. ex Oliv. & Hiern	Asteraceae	Dwarf shrub	In overgrazed areas	Rosulate Geigeria (e), Perdebynessie (a)
Geigeria burkei Harv. subsp. *burkei* var. *burkei*	Asteraceae	Dwarf shrub	Potentially poisonous	Vermeerbos (a)
Gomphrena celosioides Mart.	Amaranthaceae	Prostrate herb	Weed, South America	Bachelor's button (e), Mierbossie (a)
Grewia bicolor Juss. var. *bicolor*	Malvaceae	Shrub	Medicinal uses, edible parts, highly variable	White-leaved Raisin (e), Witrosyntjie (a)
Grewia flava DC.	Malvaceae	Shrub	Edible parts, weaving, traditional uses, declared indicator of encroachment	Velvet Raisin (e), Fluweelrosyntjiebos (a)
Grewia flavescens Juss.	Malvaceae	Shrub	Edible parts, beer brewing	Bushman Raisin (e), Kruisbessie (a)
Grewia monticola Sond.	Malvaceae	Shrub	Edible parts, traditional uses, important browsing	Silver raisin (e), Vaal rosyntjiebos (a)
Grewia villosa Willd. var. *villosa*	Malvaceae	Shrub	Traditional medicinal uses, edible fruit	Mallow raisin (e), Malvarosyntjie (a), Mupuna (v)
Gymnosporia buxifolia	Celastraceae	Small tree	Traditional uses	Common spike-thorn (e), Gewone pendoring (a)
Heliotropium ciliatum Kaplan	Boraginaceae	Forb	None	Kalahari String-of-stars (e), Vergeet-my-nietjie (a)
Hermannia modesta (Ehrenb.) Mast.	Malvaceae	Dwarf shrub	None	--
Hermannia tomentosa (Turcz.) Schinz ex Engl.	Malvaceae	Dwarf shrub	None	Lusernbos (a)
Hibiscus micranthus L.f. var. *micranthus*	Malvaceae	Herb	None	Tiny White Wild Hibiscus (e), Wilde klein Hibuscus (a)
Hoodia currorii (Hook.) Decne. subsp. *lugardii* (N.E.Br.) Bruyns	Apocynaceae	Succulent	Protected Species (LEMA), traditional uses, traditional medicinal uses	Ghaap (a)
Indigofera circinnata Benth. ex Harv.	Fabaceae	Dwarf shrub	None, irritant	Coiled bean (e), Krulboontjie (a)
Indigofera species	Fabaceae	Forb	None	--
Ipomoea magnusiana	Convolvulaceae	Prostrate herb	None	Small Pink Ipomoea (e)
Justicia flava (Vahl) Vahl	Acanthaceae	Forb	None	--
Justicia species	Acanthaceae	Forb	None	--
Kirkia acuminata	Simaroubaceae	Tree	Emergency water source	White Kirkia (e), Witsering (a), Modumêla (tw)
Kleinia longiflora DC.	Asteraceae	Succulent	Traditional uses	Sjambokbos (a)
Kyphocarpa angustifolia (Moq.) Lopr.	Amaranthaceae	Forb	None	Silky Burweed (e)
Lannea schweinfurthii (Engl.) Engl. var. *stuhlmannii* (Engl.) Kokwaro	Anacardiaceae	Tree	Edible fruit, confused for Sclerocarya birrea	False Marula (e), Bastermaroela (a), Umganunkomo (z)
Ledebouria species	Liliaceae	Geophyte	None	--
Limeum sulcatum	Molluginaceae	Prostrate herb	None	Klosaarbossie (a)
Litogyne gariepina	Asteraceae	Forb	Traditional uses	Dwarf Sage (e), Blougifbossie (a)
Maerua angolensis DC. subsp. angolensis	Brassicaceae	Tree	Fruit potentially poisonous, host plant	Bushveld Bead-bean (e),

Species Name	Family	Growth Form	Status/ Uses	Common Name
			for the butterfly family Pieridae (Whites)	Knoppiesboontjieboom (a), Mogôgwane (tw)
Megalochlamys revoluta (Lindau) Vollesen subsp. *cognata* (N.E.Br.) Vollesen	Acanthaceae	Dwarf Shrub	None	Blue Cloak (e)
Melhania acuminata Mast. var. *acuminata*	Malvaceae	Forb	None	Bushy honeycup (e)
Melinis nerviglumis (Franch.) Zizka	Poaceae	Grass	Increaser I	Bristle-leaved red top (e)
Momordica balsamina L.	Cucurbitaceae	Climber	Edible parts, medicinal uses	Balsam Pear (e), Laloentjie (a), Balsam Peer (a)
Mundulea sericea (Willd.) A.Chev.	Fabaceae	Small tree	Medicinal uses, traditional uses	Cork Bush (e), Visgif (a), Kurk boom (a)
Ocimum americanum L. var. *americanum*	Lamiaceae	Dwarf shrub	None	Wild Basil (e)
Orbivestus cinerascens (Sch.Bip.) H.Rob.	Asteraceae	Shrub	None	Pale Vernonia (e), Asbos Vernonia (a)
Ormocarpum trichocarpum (Taub.) Engl.	Fabaceae	Shrub		
Panicum maximum Jacq.	Poaceae	Grass	None	Buffalo Grass (e), Gewone Buffelsgras (a)
Pavonia species	Malvaceae	Forb	None	--
Pechuel-Loeschea leubnitziae (Kuntze) O.Hoffm.	Asteraceae	Shrub	Browsed by game under extreme conditions, potentially poisonous pats	Stinkbush (e), Stinkbossie (a)
Phyllanthus reticulatus Poir.	Euphorbiaceae	Small tree	Fruit potentially poisonous, eaten by birds and game, traditional medicinal uses	Potato-bush (e), Aartappelbos (a)
Rhigozum brevispinosum	Bignoniaceae	Shrub	None	Short-thorn pomegranate (e), Kortdoringgranaat (a)
Rhynchosia species	Fabaceae	Dwarf shrub	None	--
Sansevieria aethiopica Thunb.	Liliaceae	Geophyte	Medicinal properties, weaving, garden plants	Bowstring hemp (e), Wildewortel (a)
Sarcostemma viminale (L.) R.Br. subsp. *viminale*	Apocynaceae	Climber	Medicinal uses, potentially poisonous	Viny milkweed (e), Melktou (a)
Schkuhria pinnata (Lam.) Cabrera	Asteraceae	Forb	Medicinal uses, weed (S. America), common weed	Dwarf Marigold (e), Bitterbossie (a)
Schmidtia pappophoroides Steud.	Poaceae	Grass	Palatable grazing grass, Increaser	Sand Quick (e), Sandkweek (a)
Sclerocarya birrea (A.Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro	Anacardiaceae	Tree	Protected Tree (National Forest Act, 1998), edible parts, traditional uses	Marula (e), Maroela (a)
Senegalia erubescens (Welw. ex Oliv.) Kyal. & Boatwr.	Fabaceae	Small tree	None, irritant	Blue Thorn (e), Blouhaak (a), Moloto (tw)
Senegalia mellifera (Vahl) Seigler & Ebinger subsp. *detinens* (Burch.) Kyal. & Boatwr.	Fabaceae	Small tree	Declared indicator of enchroachment, medicinal uses, poison source	Black Thorn (e), Swarthaak (a)
Senegalia nigrescens (Oliv.) P.J.H.Hurter	Fabaceae	Tree	Tannin rich bark, important browse for game, Host plant for larvae of Charaxes phaeus	Knob thorn (e), Knoppiesdoring (a), Mokala (tw)
Senegalia senegal (L.) Britton var. *leiorhachis* (Brenan) Kyal. & Boatwr.	Fabaceae	Tree	None	Slender Three-hook Thorn (e), Slaploot (a), Muunga-thuda (v)
Senegalia senegal (L.) Britton var. *rostrata* (Brenan) Kyal. & Boatwr.	Fabaceae	Tree	None	Bushy Three-hook Thorn (e), Driehaakdoring (a),
Senna italica	Fabaceae	Prostrate herb	Medicinal uses	Wild senna (e), Elandsertjie (a)
Sericorema remotiflora (Hook.f.) Lopr.	Amaranthaceae	Dwarf shrub	None	Kwasbossie (a), Wolhaarbossie (a)

Species Name	***Family***	***Growth Form***	***Status/ Uses***	***Common Name***
Sesamothamnus lugardii N.E.Br. ex Stapf	Pedaliaceae	Succulent	None	Sesame-bush (e), Sesambos (a), shinonzhe (v)
Sporobolus species	Poaceae	Grass	None	--
Sterculia rogersii N.E.Br.	Sterculiaceae	Tree	Least Concern, traditional uses, edible seeds	Star-chestnut (e), Sterkastaiing (a), Mukakate (v)
Stipagrostis uniplumis (Licht.) De Winter var. *uniplumis*	Poaceae	Grass	Palatable grazing, Decreaser	Bushman Grass (e), Beesgras (a), Blinksaadgras (a)
Strychnos madagascariensis Poir.	Loganiaceae	Tree	Edible parts	Black monkey orange (e), Swartklapper (a)
Tephrosia species	Fabaceae	Forb	None	--
Terminalia prunioides M.A.Lawson	Combretaceae	Small tree	Traditional uses	Purple-pod Cluster-leaf (e), Sterkbas (a), Nshashantsawu (ts)
Tragus racemosus	Poaceae	Grass	Low grazing potential, Decreaser IIC	Large Carrot-seed grass (e), Grootwortelsaadgras (a)
Tribulus terrestris L.	Zygophyllaceae	Prostrate herb	Medicinal uses	Common Dubbeltjie (e), Gewone Dubbeltjie (a)
Vachellia grandicornuta (Gerstner) Seigler & Ebinger	Fabaceae	Small tree	None	Horned thorn (e), Horingdoring (a), Masaoka (tw)
Vachellia karroo (Hayne) Banfi & Gallaso	Fabaceae	Tree	Edible parts, dyes and tans, medicinal uses, traditional medicine, firewood	Sweet thorn (e), Soetdoring (a), Umnga-mpunzi (x)
Vachellia tortilis (Forssk.) Gallaso & Banfi subsp. *heteracantha* (Burch.) Kyal. & Boatwr.	Fabaceae	Tree	Medicinal uses (bark)	Curly-pod Acacia (e), Haak-en-steek (a), Isishoba (z)
Vigna frutescens A.Rich. subsp. *frutescens* var. *frutescens*	Fabaceae	Climber	None	Wild sweetpea (e)
Waltheria indica L.	Sterculiaceae	Forb	None	Meidebossie (a)
Xerophyta humilis (Baker) T.Durand & Schinz	Velloziaceae	Geophyte	Medicinal uses	Reenmetertjies
Ximenia americana L. var. *microphylla* Welw. ex Oliv.	Olacaceae	Small tree	Medicinal uses, often parasitic, edible fruit, traditional uses	Blue sourplum (e), Blousuurpruim (a)
Ziziphus mucronata Willd. subsp. *mucronata*	Rhamnaceae	Small tree	Edible parts, traditional medicinal uses, traditional uses	Buffalo-thorn (e), Blinkblaar-wag-'n-bietjie (a)

SECTION D –MAMMALIAN, INVERTEBRATE & HERPETOFAUNAL ATTRIBUTES OF THE RECIEVING ENVIRONMENT

Dewald Kamffer (Pr.Sci.Nat.)







20 BACKGROUND

South Africa's economy is highly fossil fuel dependent, with the main source (91%) of electricity being coal (Akpan and Moyo, 2017). Fossil fuel power plants, which are major sources of carbon dioxide (CO_2) emissions, also produce a large amount of harmful air pollutants such as fine particle matter that cause serious impacts on both human health and environmental sustainability (Purohit, 2018). Gasses such as sulphur dioxide (SO_2), carbon dioxide (CO_2) and greenhouse gases (GHG) affect potential habitat areas and biodiversity indexes (Dilmore and Zhang, 2017; Ahmed Bhuiyan *et al.*, 2018). Climate change and air pollution pose significant short-term and long-term health risks to South Africans due to the carbon intensity of the national economy, the severe air pollution around coal mining and coal-fired power stations in many widespread populated areas and the particular vulnerability of many subgroups in a country burdened by extreme inequality and a severe quadruple epidemic of acute and chronic disease (Cairncross *et al.*, 2017). The expansion of coal-fired power stations in South Africa has resulted in growing environmental concerns as they are the largest emitters of SO_2 - sulphur dioxide poses a potential threat to avian populations (Muyemeki *et al.*, 2017). The proposed project on the farms Du Toit 563 and Vrienden 589 in the Vhembe district of the Musina Local Municipality (Limpopo Province) in South Africa will undoubtedly have similar, significant impacts on the biodiversity of the region.

21 Method Statement

21.1 Desktop Investigation

The regional location of the study area, 2229DB, was determined using shapefiles in Google Earth Pro (*www.google.com/earth/download/gep/agree.html*, 2018). The regional statuses (red data listings) of species observed in the study area were obtained from various sources, including the following:

» Mammals: Mammal Red List, EWT & SANBI (*www.ewt.org.za/Reddata/reddata.html*, 2018);
» Reptiles: Animal Demography Unit – Virtual Museum (*www.vmus.adu.org.za*, 2018);
» Frogs: Animal Demography Unit – Virtual Museum (*www.vmus.adu.org.za*, 2018); and
» Invertebrates: Animal Demography Unit – Virtual Museum (*www.vmus.adu.org.za*, 2018).

The global red data statuses of the species found to occur in the study area was obtained from the International Union for Conservation of Nature (*www.iucnredlist.org*, 2018). A list of red data animals of the following IUCN categories was drafted from the known inhabitants of the study area's Q-grid:

» Data Deficient (DD);
» Near Threatened (NT);
» Vulnerable (VU);
» Endangered (EN); and
» Critically Endangered (CR).

The probabilities of occurrence (PoO) of the red data animals known from 2229DB were estimated using the known geographic distributions and habitat requirements of the species in comparison to the location of the study area and the diversity and statuses of the faunal habitats found within the study area. The following probabilities of occurrence categories were used:

» Low 0-19 %;
» Medium-low 20-39 %;
» Medium 40-59 %;
» Medium-high 60-79 %; and
» High 80-99 %.

21.2 Field Investigations

The focus areas were surveyed for mammals, herpetofauna and invertebrates between 12 and 19 January 2018, with specific focus on potential red data listed inhabitants. Mammals, reptiles and frogs were surveyed with the use of ecological indicators such as tracks, dung, diggings, nests and calls. Visual sightings of both diurnal and nocturnal species (night-time surveys were also included) were also used to identify both small and medium to large mammal species as well as frogs and reptiles. Bats were surveyed with the use of a handheld bat detector and frog's species-specific calls were recorded with the use of a field sound recorder. Carrion-baited infrared camera traps were used to attract and photograph carnivores and other species passing by (refer **Figure 19**).

Figure 19: Infrared camera trap

Thirty small mammal live traps (refer **Figure 20**) baited with peanut butter and oats as well as mixed chicken feed were used to sample for rodents and insectivores over a period of six consecutive nights.

Figure 20: Baited small mammal live trap

Well-known flying insects such as butterflies, moths, dragonflies, damselflies, bees and beetles were collected with the use of a handheld net. Active searches for rock dwelling invertebrate species such as millipedes, scorpions, spiders and various other groups were included in the survey methods. A USB endoscope was used to sample for burrowing scorpions and baboon spiders (refer **Figure 21**).

Figure 21: Endoscopic photograph of a female baboon spider in its burrow

Dung beetles were sampled with the use of cattle dung-baited pitfall traps (refer **Figure 22**). Fifteen baited pitfall traps were used during each of the six trap nights.

Figure 22: Cattle dung-baited pitfall trap

Nighttime surveys of scorpion species were conducted with the use of a UV-light (**Figure 15**).

Figure 23: A scorpion under UV-light

Species were identified with the use of the following field guides:

- Field Guide to Mammals of Southern Africa (Stuart and Stuart, 2000);
- A Field Guide to the Tracks and Signs of East and South African Mammals (Stuart and Stuart, 1994);
- Tracks and Tracking in Southern Africa (Liebenberg, 2000);
- Bats of Southern Africa (Taylor, 2000);
- Bats of southern and central Africa: a bio-geographic and taxonomic synthesis (Monadjem *et al.*, 2010);
- Handbook of the Mammals of the World: Vol. 1 – Carnivores (Sillero-Zubiri, 2009);
- Handbook of the Mammals of the World: Vol. 2 – Hoofed Animals (Zachos, 2012);
- Handbook of the Mammals of the World: Vol. 3 – Primates (Mittermeier, Wilson and Rylands, 2013);
- A photographic Guide to Snakes and other Reptiles of Southern Africa (Branch, 2001);
- A Guide to the Reptiles of Southern Africa (Alexander and Marais, 2007);
- Chameleons of Southern Africa (Tolley and Burger, 2007);
- Atlas and Red Data Book of the Frogs of South Africa (Minter *et al.*, 2004);
- A Complete Guide to the Frogs of Southern Africa (Du Preez and Carruthers, 2009);
- Frogs and Frogging in Southern Africa (Carruthers, 2001);
- Amphibians of Central and Southern Africa (Channing, 2001);
- Baboon and Trapdoor Spiders of Southern Africa: An Identification Manual (Dippenaar-Schoeman, 2002);
- Field Guide to the Spiders of South Africa (Dippenaar-Schoeman, 2014);
- Spiders of Southern Africa (Leroy and Leroy, 2003);
- African Spiders. An Identification Manual (Dippenaar-Schoeman and Jocqué, 1997);

» Southern African Spiders (Filmer, 1991);
» Spiders of the Savanna Biome (Dippenaar-Schoeman, Foord and Haddad, 2013);
» Butterflies of Southern Africa (Swanepoel, 1953);
» Field Guide to the Butterflies of South Africa (Woodhall, 2005);
» Pennington's butterflies of Southern Africa (Dickson and Kroon, 1978);
» Conservation Assessment of butterflies of South Africa, Lesotho and Swaziland: Red List and atlas (Mecenero *et al.*, 2013);
» Guide to the Dragonflies & Damselflies of South Africa (Tarboton and Tarboton, 2015);
» A Field Guide to the Dragonflies of South Africa (Tarboton and Tarboton, 2002b);
» A Field Guide to the Damselflies of South Africa (Tarboton and Tarboton, 2002a);
» Goggagids. Die Geleedpotiges van Suider-Afrika (Holm and Dippenaar-Schoeman, 2010);
» Insects of Southern Africa (Scholtz and Holm, 2008);
» Inseklopedie van Suider-Afrika (Holm, 2008);
» Fruit Chafers of southern Africa (Scarabaeidae: Cetoniini) (Holm and Marais, 1992);
» Alien and Invasive Animals: a South African Perspective (Picker and Griffiths, 2011);
» Field Guide to insects of South Africa (Picker, Griffiths and Weaving, 2002);
» Scorpions of Southern Africa (Leeming, 2003).

Species that could not be identified with the use of above-listed field guides and other online resources, were submitted to The Virtual Museum (*www.vmus.adu.org.za*, 2018) for identification.

21.3 Faunal Habitat Sensitivities

The faunal sensitivities of the macro habitat types were estimated using five comparable and relevant ecological characteristics:

1. Habitat Status (ST): the level of habitat transformation and degradation vs. pristine faunal habitat;
2. Habitat diversity (DV): the number and frequency of different faunal micro habitats found within each of the macro habitat types;
3. Habitat linkage (LN): the degree to which a macro habitat type is linked to other natural areas enabling movement of animals to and from the habitat found in the study area;
4. Habitat sensitivity (SN): the relative presence of elements of inherently sensitive faunal habitats such as surface rock associated with outcrops and surface and underground water found in wetlands; and
5. Red data species (RD): the degree to which suitable habitat for the red data species likely to be found in the study area is located within each macro habitat type.

The following faunal sensitivity categories were used:

» Low 0-19 %;
» Medium-low 20-39 %;
» Medium 40-59 %;
» Medium-high 60-79 %; and
» High 80-99 %.

22 FIXED SAMPLING POINTS IN THE STUDY AREA

The power station and associated infrastructure is proposed for the farms Du Toit 563 and Vrienden 589; (excluding the section south of the main dirt road which passes through Farm Vrienden), comprising a total surface area of approximately 1 899 ha (refer **Figure 24**):

» V BATS (Bat and scorpion night-time surveys on Vrienden 589);
» V TRAPS (Small mammal live trapping on Vrienden 589);
» V IR CAM (Carrion-baited infrared camera traps on Vrienden 589);
» DT BATS (Bat and scorpion night-time surveys on Du Toit 563);
» DT TRAPS (Small mammal live trapping on Du Toit 563); and
» DT IR CAM (Carrion-baited infrared camera traps on Du Toit 563).

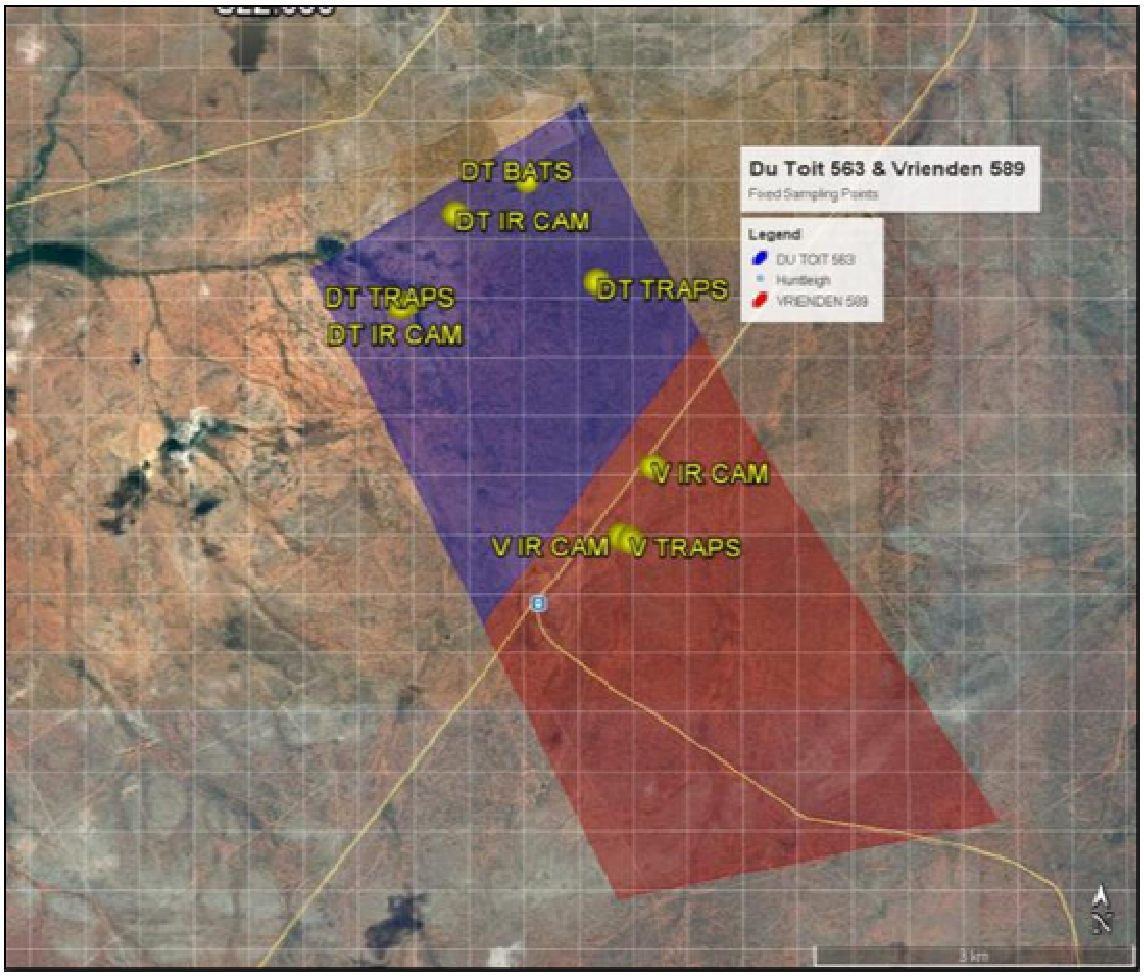


Figure 24: Fixed faunal sampling points in the study area

Section D

23 FAUNAL HABITAT TYPES

Animals do not exist in isolation within ecosystems; animals of terrestrial as well as aquatic ecosystems are closely linked to and significantly influenced by plant community structures and species diversities. Many aquatic species find refuge in extensive reedbeds that are frequently found within lowland wetland ecosystems (Sychra, Adamek and Petrivalská, 2010). Furthermore, the structure and age of vegetal formation of ponds and impounds play a significant role in selecting species traits related to the population dynamics and feeding habits of species (Cereghino *et al.*, 2008). Similarly, terrestrial animals' ecological reactions depend on plant community structure; studies on species richness have indicated that for spiders, local processes are important, with assemblages in a particular patch being constrained by habitat structure (Borges and Brown, 2004). Likewise, plant community structure is often influenced by primary consumers; herbivores are known key drivers of ecosystem function and nutrient dynamics within grazed plant communities (Duncan, 2005). The plant communities described for the study area (refer **Section C** for details on the plant communities) are considered representative of the macro faunal habitat types (refer **Figures 12 and 13**):

Vrienden 589:
» Artificial Dam;
» Calcareous Outcrops & Washes;
» Closed Woodland;
» Open Woodland;
» Open Woodland Watercourse; and
» Quartzitic Outcrops.

Du Toit 563:
» Artificial Dams;
» Closed Woodland;
» Closed Woodland Watercourse;
» Housing & Infrastructure;
» Natural Pans;
» Old Agricultural Fields;
» Open Woodland Watercourse;
» Quartzitic Outcrop; and
» Quartzitic Washes & Sandy Floodplains.

23.1 Transformed & Degraded Habitats

Transformed habitats represent areas of an atypical nature; areas where the natural vegetation has been removed and replaced by various substitutes of either a sterile or an artificial nature. These substitutes typically include agricultural lands, stands of exotic trees and human structures such as buildings, roads, mining areas, etc. These areas have lost the ability to function ecologically efficient and bear no biological resemblance to the original faunal habitat associated with the woodlands and associated wetlands of the Musina Mopane Bushveld (Mucina and Rutherford, 2006). These areas have little or no conservation value and it is highly unlikely that any threatened faunal taxa would persist in these areas (other than

potentially passing through). Further transformation and degradation of the transformed faunal habitats is unlikely to lead to an accelerated loss of biodiversity or a significant negative impact on the faunal assemblages currently persisting in these areas. Within the two farms investigated, the following macro faunal habitats are considered transformed:

» Artificial Dams;
» Housing and Infrastructure; and
» Old Agricultural Fields.

While transformed habitat types constitute areas of little or no propensity for natural wildlife, degraded habitat comprises parts of the study area where the natural habitat has been degraded to a status where it no longer resembles the original status or type. However, the vegetatal cover within these parts still allows for the establishment of an artificial, or altered, faunal component to reside in these parts. It is however regarded unlikely that animals of conservation importance will persist in these parts, other than for opportunistic or migration purposes. None of the habitats of the two farms constituting the study area is considered significantly degraded.

23.2 Natural Woodland Habitats

The natural woodland and wetland habitats of the two farms comprise those parts that still exhibit (to varying degrees) a significant proportion of the functional ecological characteristics of the original Musina Mopane Bushveld (Mucina and Rutherford, 2006). In other words, these areas currently constitute untransformed, functioning faunal woodland and wetland habitat characteristic of the Mopane Bioregion of South Africa. The natural faunal woodland and wetland habitats of the site alternatives include:

» Calcareous Outcrops & Washes;
» Closed Woodland;
» Closed Woodland Watercourse;
» Open Woodland;
» Open Woodland Watercourse;
» Natural Pans;
» Quartzitic Outcrop; and
» Quartzitic Washes & Sandy Floodplains.

Ecological interaction of natural terrestrial woodland habitats is often very complex. Potentially, some woodland specialist species might be excluded from degraded woodlands and will only be limited to natural woodlands (depending on the level of degradation), while others might be unaffected by woodland habitat degradation (up to a certain point). The level of habitat degradation that might be tolerated by woodland fauna species is different for each species; species loss rates compared to habitat degradation rates is also likely to differ between woodland habitat types. In a landscape matrix including fragments of natural, degraded and transformed terrestrial faunal habitats, it is often difficult to predict the faunal assemblages likely to persist in each fragment. Some fragments of a degraded (or even transformed) nature might (when considered in isolation) be of a poor ecological status or low biodiversity value, but when considered within the landscape matrix in relevance to other,

natural habitat fragments, might be of considerable conservation value as a movement corridor or sink population source.

24 RESULTS - DESKTOP INVESTIGATION

The study area is located within the Q-grid 2229DB; ninety-five animals (excluding birds) are listed for 2229DB (*www.vmus.adu.org.za*, 2018) (refer **Table 19**):

Table 19: Animals listed for 2229DB

Taxonomic rank	*Group*	*# species listed*
Scorpiones	Scorpions	5
Araneae	Spiders	1
Odonata	Dragonflies & Damselflies	10
Neuroptera & Megaloptera	Antlions & Allies	1
Scarabaeinae	Dung Beetles	1
Lepidoptera	Butterflies & Moths	29
Anura	Frogs	4
Reptilia	Reptiles	24
Mammalia	Mammals	20
Total # species recorded		**95**

The diversity of 95 species that are listed for 2229DB include three red data species (refer **Table 20**). The red data listed species include animals regionally listed as (RS):

» Near Threatened (NT): 1 species; and
» Vulnerable (VU): 2 species.

The three red data animals have the following global statuses (GS):

» Least Concern (LC): 1 species
» Near Threatened (NT): 1 species; and
» Vulnerable (VU): 1 species.

The following probabilities of occurrence (PoO) within the study area are estimated for the three red data species:

» Moderate-low: 1 species
» High: 1 species; and
» Presence confirmed: 1 species.

Table 20: Red Data Animals listed for 2229DB on 6 February 2018

Binomial Name	*English Name*	*RS*	*GS*	*PoO*
Squamata: Gekkonidae				
Homopholis mulleri Visser, 1987	Muller's Velvet Gecko	VU	VU	High
Squamata: Crocodylidae				
Crocodylus niloticus Laurenti, 1768	Nile Crocodile	VU	LC	moderate-low
Carnivora: Hyaenidae				
Parahyaena brunnea (Thunberg, 1820)	Brown Hyaena	NT	NT	confirmed

Section D

25 RESULTS – FIELD SAMPLING RECORDS

A total of one hundred and twenty-two (122) animal species (excluding avifauna) were recorded in the study area during the brief survey period. These 122 species represent a total of twenty-two orders (22) and fifty-five (55) families (refer **Table 21**). Of the 122 species, a diversity of 111 were recorded on Farm Du Toit 563 (DT) and a diversity of 82 species for Farm Vrienden 589 (V). Evidence of the presence of some of the species is presented in **Figure 25**. Species listed in green were confirmed by the landowner, but could not be verified during the field investigation (including the red data listed species of Cheetah and Leopard). The diversity of fauna species recorded in the study areas include a total of six red data listed species (listed in red in **Table 21**):

» *Copris cambeforti* Nguyen-Phung, 1988a (Dung Beetle) – Data Deficient;
» *Onthophagus quadrimaculatus* Raffray, 1877 (Dung Beetle) – Data Deficient;
» *Rhinolophus smithersi* Taylor, Stoffberg, Monadjem, 2012 (Smither's Horseshoe Bat) – Near Threatened;
» *Acinonyx jubatus* (Schreber, 1775) (Cheetah) – Vulnerable;
» *Panthera pardus* (Linnaeus, 1758) (Leopard) – Vulnerable; and
» *Parahyaena brunnea* (Thunberg, 1820) (Brown Hyaena) – Near Threatened.

Table 21: Animals observed in the study area

Binomial Name	*English Name*	*RS*	*GS*	*DT*	*V*
Spirostreptida: Spirostreptidae					
Doratogonus species	Black Millipede				x
Scorpiones: Buthidae					
Parabuthus transvaalicus Purcell, 1899	Transvaal Thicktail	NL	NL		x
Scorpiones: Scorpionidae					
Opistophthalmus boehmi (Kraepelin, 1896)	Northern Burrowing Scorpion	NL	NL		x
Scorpiones: Hormuridae					
Hadogenes troglodytes (Peters, 1861)	Giant Rock Scorpion	NL	NL		x
Araneae: Theraposidae					
Ceratogyrus brachycephalus Hewitt, 1919	Greater Horned Baboon Spider	NL	NL	x	x
Araneae: Eresidae					
Dresserus colsoni Tucker, 1920	Ground Velvet Spider	NL	NL		x
Seothyra species	Buckspoor Spider			x	
Araneae: Nephilidae					
Nephila senegalensis (Walckenaer, 1841)	Banded-legged Nephila	NL	NL	x	x
Odonata: Libellulidae					
Brachythemis leucosticta Burmeister, 1839	Banded Groundling	NL	LC	x	
Crocothemis erythraea Brullé, 1832	Broad Scarlet	NL	LC	x	
Pantala flavescens Fabricius, 1798	Pantala	NL	LC	x	x
Sympetrum fonscolombii Selys, 1840	Nomad	NL	LC	x	x
Tramea basilaris Palisot de Beauvois, 1817	Keyhole Glider	NL	LC	x	x
Orthoptera: Pyrgomorphidae					
Phymateus morbillosus (Linnaeus, 1758)	Common Milkweed Locust	NL	NL	x	
Isoptera: Termitidae					
*Macrotermes natalensis (*Haviland, 1898)	Large Fungus-growing Termite	NL	NL	x	x
Hemiptera: Reduviidae					
Ectrichodia crux (Thunberg, 1783)	Millipede Assassin	NL	NL	x	
Coleoptera: Buprestidae					
Acmaeodera species	Jewel Beetle	NL	NL	x	
Anthaxia species	Jewel Beetle	NL	NL		x

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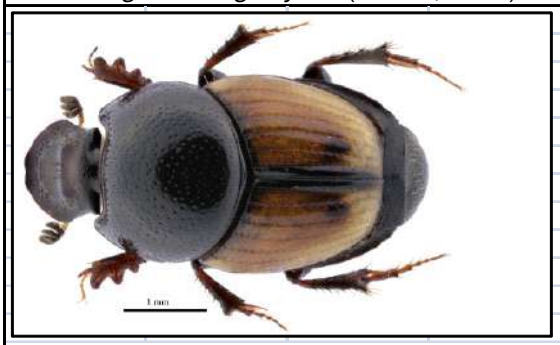
Spenoptera species	Small Jewel Beetle	NL	NL	x	
Sternocera orissa Buquet, 1837	Giant Jewel Beetle	NL	NL	x	
Coleoptera: Tenebrionidae					
Zophosis species	Frantic Surface Beetle	NL	NL	x	
Coleoptera: Scarabaeidae					
Chalconotus convexus Boheman, 1857	Dung Beetle	LC	LC	x	x
Copris cambeforti Nguyen-Phung, 1988a	Dung Beetle	DD	DD	x	
Copris elphenor Klug, 1855	Dung Beetle	LC	LC	x	x
Digitonthophagus gazella (Fabricius, 1787)	Dung Beetle	LC	LC	x	x
Drepanocerus patrizii (Boucomont, 1923a)	Dung Beetle	LC	LC	x	x
Euoniticellus intermedius (Reiche, 1848)	Dung Beetle	LC	LC	x	x
Garreta wahlbergi (Fahraeus, 1857)	Dung Beetle	LC	LC	x	x
Goliathus albosignathus Boheman, 1857	Black and White Fruit Chafer	NL	NL		x
Gymnopleurus aenescens Wiedemann, 1821	Dung Beetle	LC	LC	x	x
Gymnopleurus humeralis Klug, 1855	Small Green Dung Beetle	LC	LC	x	x
Gymnopleurus pumilus Reiche, 1850	Small Green Dung Beetle	LC	LC	x	x
Heliocopris andersoni Bates, 1868	Dung Beetle	LC	LC	x	x
Kheper lamarcki (Macleay, 1821)	Dung Beetle	LC	LC	x	x
Kheper nigroaeneus (Boheman, 1857)	Dung Beetle	LC	LC	x	x
Kheper subaeneus (Harold, 1869b)	Dung Beetle	LC	LC	x	x
Kurtops signatus (Fahraeus, 1857)	Dung Beetle	LC	LC	x	x
Metacatharsius troglodytes (Boheman, 1857)	Dung Beetle	LC	LC	x	x
Neosisyphus calcaratus (Klug, 1855)	Dung Beetle	LC	LC	x	x
Neosisyphus fortuitus (Péringuey, 1901)	Dung Beetle	LC	LC	x	x
Onitis alexis Klug, 1835	Dung Beetle	LC	LC	x	x
Onitis caffer Boheman, 1857	Dung Beetle	LC	LC	x	x
Onitis viridulus Boheman, 1857	Dung Beetle	LC	LC	x	x
Onthophagus cribripennis d'Orbigny, 1902	Dung Beetle	LC	LC	x	x
Onthophagus ebenicolor d'Orbigny, 1902	Dung Beetle	LC	LC	x	x
Onthophagus flavolimbatus Klug, 1855	Dung Beetle	LC	LC	x	x
Onthophagus lamelliger Gerstaecker, 1871	Dung Beetle	LC	LC	x	x
Onthophagus pallidipennis Fahraeus, 1857	Dung Beetle	LC	LC	x	x
Onthophagus pullus Roth, 1851	Dung Beetle	LC	LC	x	x
Onthophagus quadrimaculatus Raffray, 1877	Dung Beetle	DD	DD	x	x
Onthophagus rasipennis d'Orbigny, 1908	Dung Beetle	LC	LC	x	x
Onthophagus venustulus Erichson, 1843	Dung Beetle	LC	LC	x	x
Pachylomera femoralis (Kirby, 1828)	Dung Beetle	LC	LC	x	x
Phalops ardea (Klug, 1855)	Dung Beetle	LC	LC	x	x
Phalops boschas (Klug, 1855)	Dung Beetle	LC	LC	x	x
Rhabdotis species	Green Fruit Chafer	NL	NL		x
Sisyphus sordidus Boheman, 1857	Dung Beetle	LC	LC	x	x
Diptera: Hippoboscidae					
Hippobosca rufipes Olfers, 1816	Cattle Louse Fly	NL	NL	x	x
Lepidoptera: Hesperiidae					
Spialia colotes transvaaliae (Trimen, 1889)	Bushveld Sandman	LC	NL	x	x
Lepidoptera: Pieridae					
Belenois aurota (Fabricius, 1793)	Brown-veined White	LC	NL	x	x
Catopsilla florella (Fabricius, 1775)	African Migrant	LC	LC	x	x
Colotis annae annae (Wallengren, 1857)	Scarlet Tip	LC	NL	x	x
Colotis evenina evenina (Wallengren, 1857)	Orange Tip	LC	NL	x	x
Colotis vesta argillaceus (Butler, 1877)	Veined Arab	LC	NL	x	x
Pinacopteryx eriphia eriphia (Godart, [1819])	Zebra White	LC	NL	x	
Lepidoptera: Nymphalidae					
Byblia ilithyia (Drury, [1773])	Spotted Joker	LC	NL	x	

Charaxes jasius saturnus Butler, 1866	Foxy Charaxes	LC	NL	x	
Coenyropsis natalii natalii (Boisduval, 1847)	Natal Brown	LC	NL	x	
Danaus chryssipus orientis (Aurivillius, 1909)	African Monarch	LC	LC	x	
Junonia hierta cebrene Trimen, 1870	Yellow Pansy	LC	LC	x	x
Lepidoptera: Lycaenidae					
Azanus jesous (Guérin-Méneville, 1849)	Topaz Babul Blue	LC	NL	x	
Lepidoptera: Saturniidae					
Gonimbrasia belina Westwood 1849	Mopane Moth	NL	NL	x	x
Hymenoptera: Apidae					
Plebeina hildebrandti (Friese, 1900)	Mopane Bee	NL	NL	x	x
Anura: Bufonidae					
Sclerophrys gutturalis (Power, 1927)	Guttural Toad	LC	LC	x	
Anura: Rhacophoridae					
Chiromantis xerampelina Peters, 1854	Southern Foam Nest Frog	LC	LC	x	
Anura: Ptychadenidae					
Ptychadena anchietae Bocage, 1867	Plain Grass Frog	LC	LC	x	
Anura: Hyperoliidae					
Kassina senegalensis Duméril and Bibron, 1841	Bubbling Kassina	LC	LC	x	
Anura: Hemisotidae					
Hemisus marmoratus (Peters, 1854)	Mottled Shovel-nosed Frog	LC	LC	x	
Testudines: Testudinidae					
Stigmochelys pardalis Valverde, 2005	Leopard Tortoise	LC	LC	x	x
Testudines: Pelomedusidae					
Pelomedusa subrufa (Bonnaterre, 1789)	Central Marsh Terrapin	LC	NE	x	
Squamata: Pythonidae					
Python natalensis Smith, 1840	Southern African Python	LC	NL	x	
Squamata: Colubridae					
Dispholidus typus (Smith, 1828)	Boomslang	LC	NE	x	
Squamata: Elapidae					
Dendroaspis polylepis Günther, 1864	Black Mamba	LC	LC	x	
Naja mossambica Peters, 1854	Mozambique Spitting Cobra	LC	NL	x	
Squamata: Viperidae					
Bitis arietans arietans (Merrem, 1820)	Puff Adder	LC	NE	x	
Squamata: Scincidae					
Trachylepis varia (Peters, 1867)	Variable Skink	LC	NL		x
Squamata: Lacertidae					
Heliobolus lugubris Smith, 1838	Bushveld Lizard	LC	NL	x	x
Squamata: Agamidae					
Agama atra Daudin, 1802	Southern Rock Agama	LC	LC	x	x
Squamata: Gekkonidae					
Pachydactylus species	Gecko			x	
Macroscelidea: Macroscelidae					
Elephantulus brachyrhynchus (A. Smith, 1836)	Short-snouted Sengi	LC	LC		x
Elephantulus myurus Thomas & Schwann, 1906	Eastern Rock Sengi	LC	LC	x	x
Tubulidentata: Orycteropodidae					
Orycteropus afer (Pallas, 1766)	Aardvark	LC	LC	x	x
Primates: Galagidae					
Galago moholi A. Smith, 1836	Southern Lesser Galago	LC	LC	x	
Primates: Cercopithecidae					
Chlorocebus pygerythrus (F. Cuvier, 1821)	Vervet Monkey	LC	LC	x	x
Papio ursinus (Kerr, 1792)	Chacma Baboon	LC	LC	x	x
Lagomorpha: Leporidae					
Lepus species	Hare	LC	LC	x	
Rodentia: Sciuridae					

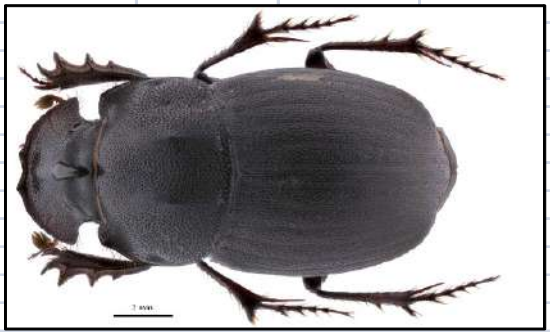
Paraxerus cepapi (A. Smith, 1836)	Tree Squirrel	LC	LC	x	x
Rodentia: Muridae					
Aethomys species	Veld Rat	LC	LC	x	
Rodentia: Hystricidae					
Hystrix africaeaustralis Peters, 1852	Cape Porcupine	LC	LC	x	x
Artiodactyla: Suidae					
Phacochoerus africanus (Gmelin, 1788)	Common Warthog	LC	LC	x	x
Artiodactyla: Bovidae					
Aepyceros melampus melampus (Lichtenstein, 1812)	Impala	LC	LC	x	x
Connochaetes taurinus taurinus (Burchell, 1823)	Blue Wildebeest	LC	LC	x	x
Kobus ellipsiprymnus ellipsiprymnus (Ogibly, 1833)	Common Waterbuck	LC	LC	x	
Oryx gazella (Linnaeus, 1758)	Gemsbok	LC	LC	x	x
Raphicerus campestris (Thunberg, 1811)	Steenbok	LC	LC	x	x
Sylvicapra grimmia (Linnaeus, 1758)	Bush Duiker	LC	LC	x	x
Taurotragus oryx (Pallas, 1766)	Common Eland	LC	LC		x
Tragelaphus strepsiceros (Pallas, 1766)	Greater Kudu	LC	LC	x	x
Chiroptera: Rhinolophidae					
Rhinolophus smithersi Taylor, Stoffberg, 2012	Smither's Horseshoe Bat	NT	LC	x	x
Chiroptera: Molossidae					
Chaerephon pumilus (Cretzschmar, 1826)	Little Free-tailed Bat	LC	LC	x	
Tadarida aegyptiaca (E. Geoffroy Saint-Hilaire, 1818)	Egyptian Free-tailed Bat	LC	LC	x	
Chiroptera: Vespertilionidae					
Neoromicia capensis (A. Smith, 1829)	Cape Serotine Bat	LC	LC	x	x
Chiroptera: Pteropodidae					
Rousettus aegyptiacus (E. Geoffroy, 1810)	Egyptian Fruit Bat	LC	LC	x	x
Carnivora: Felidae					
Acinonyx jubatus (Schreber, 1775)	Cheetah	VU	VU	x	
Caracal caracal (Schreber, 1776)	Caracal	LC	LC	x	
Panthera pardus (Linnaeus, 1758)	Leopard	VU	VU	x	
Carnivora: Viverridae					
Civettictis civetta (Schreber, 1776)	African Civet	LC	LC	x	x
Carnivora: Herpestidae					
Herpestes sanguineus (Rüppell, 1835)	Slender Mongoose	LC	LC	x	
Suricata suricatta (Schreber, 1776)	Suricate	LC	LC	x	
Carnivora: Hyaenidae					
Parahyaena brunnea (Thunberg, 1820)	Brown Hyaena	NT	NT	x	x
Carnivora: Canidae					
Canis mesomelas Schreber, 1775	Black-backed Jackal	LC	LC	x	x
Otocyon megalotis (Desmarest, 1822)	Bat-eared Fox	LC	LC	x	

Hadogenes troglodytes (Peters, 1861)

Opistophthalmus boehmi (Kraepelin, 1896)



Onthophagus flavolimbatus Klug, 1855



Copris cambeforti Nguyen-Phung, 1988a

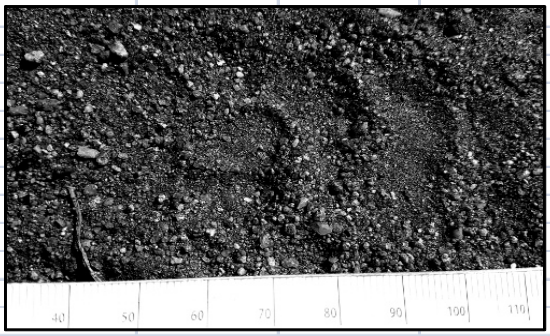
Ceratogyrus brachycephalus Hewitt, 1919

Dresserus colsoni Tucker, 1920

Civettictis civetta (Schreber, 1776)

Papio ursinus (Kerr, 1792)

Suricata suricatta (Schreber, 1776)



Parahyaena brunnea (Thunberg, 1820) - track

Figure 25: Photographic evidence of selected species observed

The species inventory results of the field investigation on the farms Du Toit 563 and Vrienden 589 compared well to the known inhabitants of the Q-grid 2229DB (*www.vmus.adu.org.za*, 2018). In total, 14 more species were recorded from the study area than what are listed for the Q-grid (for the selected groups represented in the Virtual Museum). Groups that were better represented during the field investigation included spiders, dung beetles, frogs and mammals. All evidence gathered on these species were submitted to the Virtual Museum (*www.vmus.adu.org.za*, 2018) for species identification conformation and to ensure the data collected are included in the national databases. A schematic comparison of the two species richness datasets is presented in **Figure 26**.

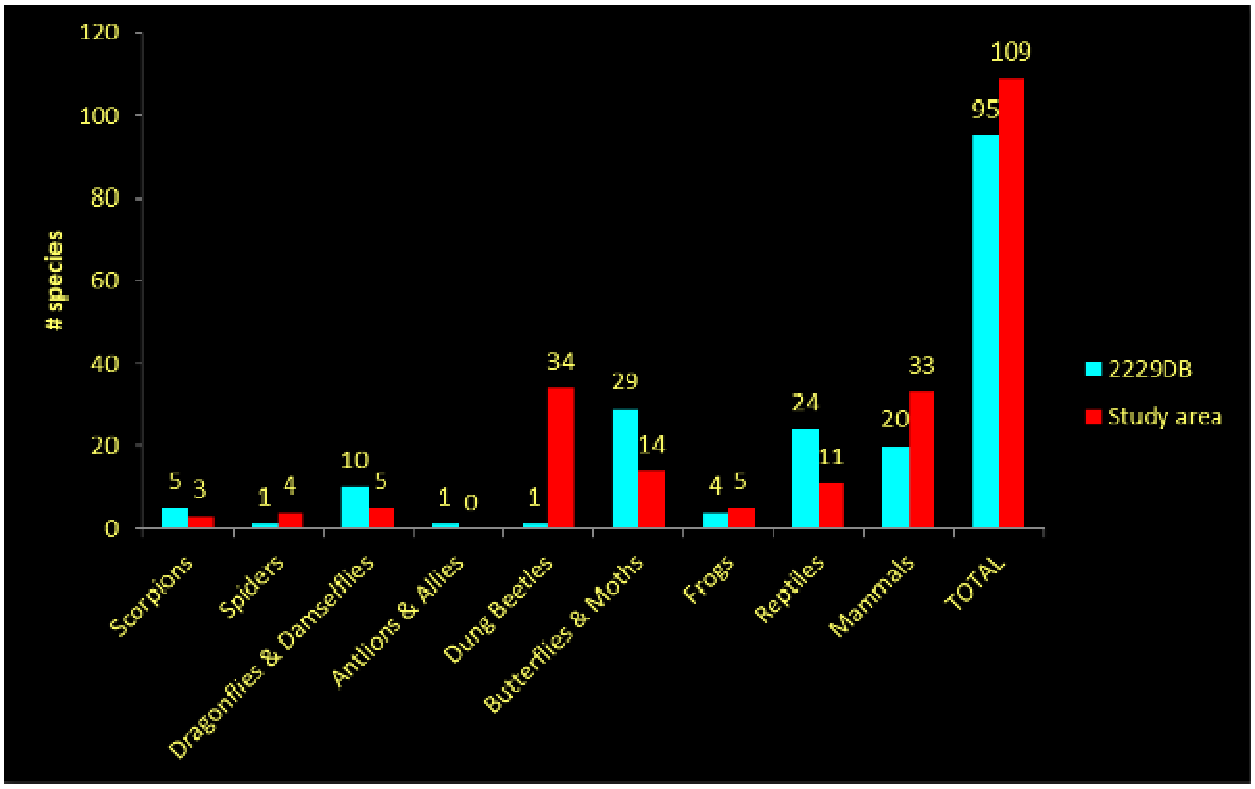


Figure 26: Comparison between recorded species richness of 2229DB and the study area

Section D

26 ANNOTATIONS ON LIKELY RED DATA SPECIES FOR THE AREA

26.1 *Copris cambeforti* Nguyen-Phung, 1988a

The Dung Beetle *Copris cambeforti* Nguyen-Phung, 1988a is globally and regionally listed as Data Deficient and is endemic to South Africa. Before the species was collected on the farm Du Toit 563, it was only known from two localities in the Limpopo Province of South Africa (unpublished data). The only record in the Virtual Museum of *C. Cambeforti* is for ¼-degree grid 2231CA (*www.vmus.adu.org.za*, 2018). Very little is known about the species; even less has been published. The species was collected in a pitfall trap baited with cattle dung during the field investigation.

26.2 *Onthophagus quadrimaculatus* Raffray, 1877

The Dung Beetle *Onthophagus quadrimaculatus* Raffray, 1877 is globally and regionally listed as Data Deficient. The species has been sporadically collected from Namibia, Botswana and South Africa within the subregion of Southern Africa (unpublished data). It has been previously recorded in the Limpopo, Mpumalanga and KwaZulu-Natal Provinces of South Africa (*www.vmus.adu.org.za*, 2018). Very little is known about the species; even less has been published. The species was collected in pitfall traps baited with cattle dung on the farms Du Toit 563 and Vrienden 589 during the 2018 field investigation.

26.3 *Rhinolophus smithersi* Taylor, Stoffberg, Monadjem, 2012

Smither's Horseshoe Bat, *Rhinolophus smithersi*, Taylor, Stoffberg, Monadjem, 2012, is regionally listed as Near Threatened (*www.vmus.adu.org.za*, 2018) and globally as Near Threatened (*www.iucnredlist.org*, 2018). In 2012, four new species were described in the *Rhinolophus hildebrandtii* Peters, 1878 species-complex of horseshoe bats (Taylor *et al.*, 2012). One of these species, Smither's Horseshoe Bat, is known from the Zambezi Escarpment in northwest Zimbabwe and from Pafuri in the Limpopo Valley in the foothills of the Soutpansberg Mountains of northern Limpopo Province, South Africa. It is likely more widespread across savanna woodlands of the Limpopo and Zambezi valleys and the escarpments.

The ecology of the species is poorly understood; it occurs sympatrically with *R. mossambicus* at one locality in miombo savanna on Karoo Sandstone, dominated by trees of *Brachystegia glaucescens*, and including large specimens of baobabs, *Adansonia digitata*, which is found across the study areas in moderate numbers. It has also been recorded along diverse riparian woodland fringes of the Lutope and Ngolanola rivers as well as along the Limpopo River at Pafuri. Daylight roosts were not observed in the study areas but these bats could use caves in the sandstone cliffs and/or hollows in baobabs (Taylor *et al.*, 2012).

The species appears to be locally quite widespread in the Soutpansberg, Blouberg and Waterberg ranges in Limpopo Province as well as in the Limpopo Valley, where it is dependent on natural caves or synthetic underground cavities such as old mine adits. The threat of extensive planned coal, platinum, natural gas and other mining developments over much of the Limpopo Valley and the foothills of the Soutpansberg and Waterberg mountains and the

Mahabeng Plateau, could affect heavily on populations through roosting and foraging habitat loss, noise, air and water pollution and water abstraction leading to degradation of riparian habitats. Limpopo is extremely drought-prone and water-stressed and with projected climate change. Since the species seems to be dependent on water sources for drinking, extreme droughts in the area have had potentially devastating effects on wildlife generally (Taylor, 2017).

26.4 *Acinonyx jubatus* (Schreber, 1775)

The Cheetah, *Acinonyx jubatus* (Schreber, 1775), is listed as Vulnerable both regionally (*www.ewt.org.za/Reddata/reddata.html*, 2018) and globally (*www.iucnredlist.org*, 2018). Assessing the numbers and distribution of threatened species is a central challenge in conservation, often made difficult because this species of concern is rare and elusive. For the Cheetah this may be compounded by their being sparsely distributed over large areas, although, there is a contiguous, transboundary population of cheetah in southern Africa, known to be the largest in the world. It has recently been suggested that this population is more threatened than believed due to the concentration of about 55 % of free-ranging individuals in two ecoregions. This area overlaps with commercial farmland with high persecution risk; adult cheetahs were removed at the rate of 0.3 individuals per 100 km² per year. Some authors have calculated the population estimate for confirmed cheetah presence areas at 11 % lower than the IUCN's current assessment for the same region, lending additional support to the recent call for the up-listing of this species from Vulnerable to Endangered status (Weise *et al.*, 2017). The most comprehensive data available on cheetah distribution and status indicates dramatic declines of cheetah across its distributional range. Most cheetahs occur outside protected areas, where they are exposed to multiple threats, but there is little information on population status. Simulation modelling have shown that, where cheetah population growth rates are suppressed outside protected areas, extinction risk increases markedly (Durant *et al.*, 2017).

The presence of the species within the study area could not be confirmed during the field investigation, but is known to periodically occur within the larger region. The landowner (Mr Du Toit) has indicated that individuals have sporadically been observed on his property, albeit at highly irregular intervals. Cheetahs are often observed in farming areas, which often results in human-wildlife conflict. They are known to select areas that are important for their dietary and social needs and prefer to avoid human-occupied areas (Van der Weyde *et al.*, 2017).

Competition is an important ecological factor influencing the population dynamics of carnivores especially as shifts in prey selection could have negative consequences for other members of the carnivore guild. The greatest potential for interspecific competition is between male cheetahs, especially those in coalitions, and lions (Broekhuis, Thuo and Hayward, 2017). Predation in the wildlife ranching industry has become more of an concern, as the financial losses due to predation on valuable antelope species are large (Schepers, Matthews and van Niekerk, 2018).

26.5 *Panthera pardus* (Linnaeus, 1758)

The Leopard, *Pathera pardus* (Linnaeus, 1758), is listed as Vulnerable both regionally (*www.ewt.org.za/Reddata/reddata.html*, 2018) and globally (*www.iucnredlist.org*, 2018). Even though the landowner's claims of the irregular presence of Leopard on his property could not be confirmed during the field investigation, it is well known that Leopard persist successfully in the game farm landscape matrix of the region (pers. obs.). Leopard populations across Africa are increasingly exposed to high levels of anthropogenic disturbance, and information on habitat use responses of leopards in human-disturbed landscapes can help inform status assessments and guide conservation interventions. The greatest contributing factor to leopard habitat use was a positive correlation with bush meat poachers and lions. While leopards generally avoided human settlements and were positively predicted by prey, it has been suggested that there often is sufficient prey and space for the species to use most available habitats (Strampelli *et al.*, 2018). However, prey abundance in core habitat has been shown to be critically important, and has higher influence than habitat area per se (Khosravi, Hemami and Cushman, 2018).

Predators and scavengers are frequently persecuted for their negative effects on property, livestock and human life. It has been shown that these species play important regulatory roles in intact ecosystems including regulating herbivore and mesopredator populations that in turn affect floral, soil and hydrological systems. Yet, predators receive surprisingly little recognition for their benefit to humans in the landscape they share. It is critical to recognize predators such as leopard's beneficial contributions to human health and well-being. Identifying, evaluating and communicating the benefits provided by species that are often considered problem animals is an important step for establishing tolerance in these shared spaces (O'Bryan *et al.*, 2018).

Human induced conflicts are further exacerbated by habitat loss and fragmentation and the reduction of wild prey (Alves and Albuquerque, 2018). The primary threats to leopards are anthropogenic in nature. Habitat fragmentation, reduced prey base and conflict with livestock and game farming have reduced leopard populations throughout most of their range. The conversion of savanna systems to other land uses has significantly reduced Leopard range. Recent trends have indicated that current threats have substantially reduced Leopard populations throughout most of its range (Stein *et al.*, 2016).

26.6 *Parahyaena brunnea* (Thunberg, 1820)

The Brown Hyaena, *Parahyaena brunnea* (Thunberg, 1820) is listed as Near Threatened both regionally (*www.ewt.org.za/Reddata/reddata.html*, 2018) and globally (*www.iucnredlist.org*, 2018). Tracks of the Brown Hyaena were evident on Du Toit 563 and Vrienden 589 during this 2018 survey period. The Brown Hyaena is endemic to southern Africa and is estimated to have a population of less than 10 000 individuals worldwide. Interestingly, findings have shown that the correlation between genetic diversity and the perceived risk of extinction is not particularly strong, since many species with higher genetic diversity than the brown hyaena are considered to be at greater risk of extinction (Westbury *et al.*, 2017). The largest population of the

species occurs in Botswana. It has been indicated that there are important links, critical for the long-term conservation of the species, between populations in South Africa and the agricultural landscape of Botswana (Winterbach *et al.*, 2017). An understanding of the influences of carnivore guild richness and resource availability is important for modern systems that are currently undergoing changes in competitive dynamics, where carnivores occupy the vulnerable position of apex predators (Mann, Van Valkenburgh and Hayward, 2017). The majority of the world's terrestrial large carnivores have undergone substantial range contractions and many of these species are currently threatened with extinction. It has been found that intact carnivore guilds occupy just 34 % of the world's land area, compared to 96 % in historic times. Spatial modelling of range contractions showed that contractions were significantly more likely in regions with high rural human population density, cattle density or cropland (Wolf and Ripple, 2017). The management battle between managing for short-term benefits and managing for longer term resilience in private land-conservation areas is also well-documented (Clements and Cumming, 2016).

Outside protected areas, the Brown Hyaena may come into conflict with humans, and they are often shot, poisoned, trapped and hunted with dogs in predator eradication or control programmes. Brown Hyaena body parts are used in traditional medicine. Increased efforts to educate farmers and pastoralists about the fact that Brown Hyaenas pose very little risk to livestock is likely to enhance conservation of these animals (Wiesel, 2015).

27 FAUNAL HABITAT SENSITIVITY

The following faunal sensitivities were estimated for the macro habitat types identified in the study area (refer **Table 22**, illustrated in **Figure 27**):

Table 22: Faunal sensitivities of the habitat types of the study area

Status	*Habitat type*	*HS*	*HD*	*HL*	*HS*	*RD*	*AVE*	*Sens Class*
Transformed	Artificial Dams	2	3	2	1	1	18%	low
	Housing and Infrastructure	1	1	1	1	1	10%	low
	Old Agricultural Fields	2	1	3	1	2	18%	low
Natural	Calcareous Outcrops & Washes	7	8	7	8	7	74%	medium-high
	Closed Woodland	5	5	7	5	5	54%	medium
	Closed Woodland Watercourse	8	9	7	8	8	80%	high
	Open Woodland	6	5	7	5	5	56%	medium
	Open Woodland Watercourse	8	9	7	8	8	80%	high
	Natural Pans	9	8	7	8	8	80%	high
	Quartzitic Outcrop	7	8	7	7	7	72%	medium-high
	Quartzitic Washes & Sandy Floodplains	6	5	7	5	5	56%	medium

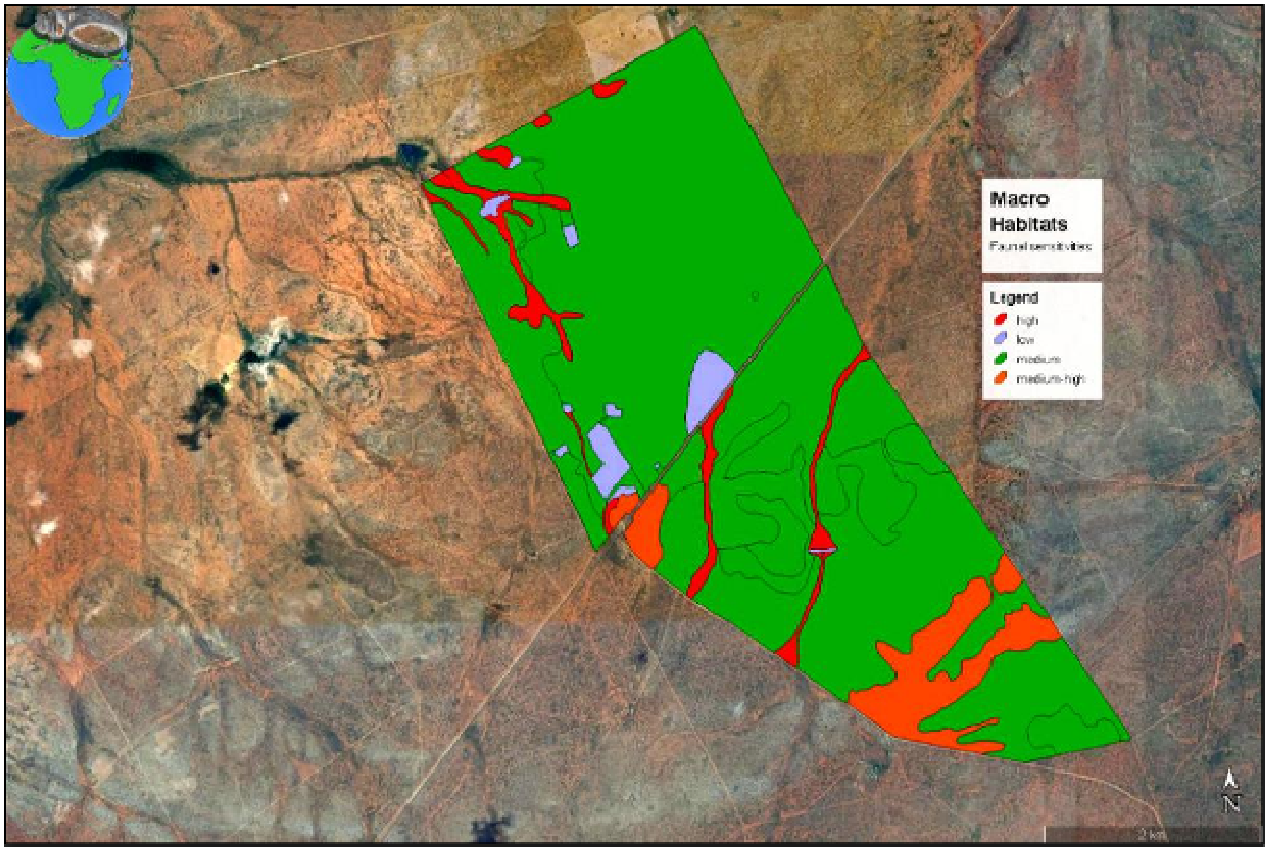


Figure 27: Faunal sensitivities of the macro habitats of the study area

28 ANTICIPATED IMPACTS ON THE FAUNAL ENVIRONMENT

The construction and operation of the proposed coal-fired power plant and associated infrastructure is not expected to have any positive or advantageous impacts as far as the faunal communities of the study area and surrounds are concerned. Direct, indirect and cumulative adverse impacts on the fauna are expected during the construction and operation of the proposed power station.

28.1 Direct Impacts

Direct impacts represent those that are indisputably a result of the proposed project and unequivocally influencing the fauna of the region. They are immediate and physical in nature and often irreversible and permanent. Anticipated direct impacts of the proposed project on the fauna of the study area include:

1. Impacts on/ losses of fauna taxa of conservation importance and habitat associated with conservation important (CI) species;
2. Loss of natural habitat, including essential habitat refugia; and
3. Depletion of faunal diversity, human/ animal conflict situations.

28.2 Indirect Impacts

Indirect impacts are mostly "spill-over" impacts that are removed from direct impacts by time and/or space. They might occur subsequent to the construction phase, even post closure, or in faunal habitat fragments located next to or close to the directly affected area. Indirect impacts might be immediate or delayed, they are often not easily linked to the project itself and their manifestations are often subtle. Indirect impacts might also be irreversible and permanent or rescindable and temporary. Anticipated indirect impacts of the proposed project on the fauna of the study area and surrounds include:

4. Degradation of untransformed habitat in areas surrounding the project area;
5. Indirect impacts on movement/ migration patterns of animals, ecological interaction and processes, including the introduction of invasive and non-endemic species; and
6. An increase in edge effects in the ecological region in which the project is located.

28.2.1 Quantification of Direct and Indirect Impacts on the Faunal Environment

Table 23: Quantification of Direct and Indirect impacts on the faunal environment		
Nature of impact:	Direct impacts on/ losses of fauna species of conservation importance and concern and habitat associated with these species. Impacts are unavoidable because of land clearing activities but are generally restricted to the immediate area. This impact is restricted to the construction phase but is permanent. Animals are generally mobile and will evacuate towards other suitable areas, but losses are reasonably expected	
	Without mitigation	***With mitigation***
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Very high (10)	Moderate (6)
Probability	Highly probable (4)	Probable (3)
Significance	***High (72)***	***Medium (36)***
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes, to some extent. Unavoidable impacts on conservation important animals will occur, irrespective of mitigation measures, albeit restricted to the local footprint. Implementation of mitigation measures will curtail losses to some extent	
Mitigation Measures:	Extent of impact likely to be restricted to site only. Ensure the absence of, particularly, sessile species, through a thorough walkdown (search and rescue) of development areas. Ensure the absence of larger animals through frequent patrols, particularly prior to development	
Residual Impacts:	Sterilised landscapes with no propensity for species of conservation concern, decline in population sizes and numbers, continual decline in habitat availability	
Nature of impact:	Losses of natural habitat through physical transformation, modifications, removals and damage. Also includes the losses of natural refugia, such as termitaria, dead trees, etc.	
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (65)**	**Medium (55)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, to some extent	
Can impacts be mitigated?	Yes, within areas surrounding the footprint	

Mitigation Measures:	Restrict losses of natural habitat to footprints, avoid peripheral or unnecessary losses of natural habitat. Ensure proper rehabilitation of areas outside development footprints should accidental habitat degradation occurr, promote nodal developments by grouping developments structures, avoid the uncontrolled spread of infrastructure	
Residual Impacts:	Decreased aesthetic appeal, loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat	
Nature of impact:	Depletion of faunal diversity through direct losses, evacuation of unfavourable habitat by animals, including the introduction of invasive and non-endemic species. Construction and operation creates opportunities for human/ animal conflict situations, with reference to potentially dangerous animal encounters, snaring, trapping and killing (vehicular events)	
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Medium term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (52)**	**Low (27)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Awareness programmes, ensuring minimal conflict situation, control of human movement in adjacent natural habitat, frequent patrols, biological monitoring programmes, animal control (vervet monkeys, feral cats, rats, baboons, dogs, etc). Ecological sound management of construction areas, with reference to waste management, food sources, etc.	
Cumulative Impacts:	Changes to faunal structures, assemblages, communities, depletion of faunal diversity, local and regional disappearance of certain species, introduction of invasive species in natural areas, changes to genetic populations	
Residual Impacts:	Depletion of faunal diversity, presence of invasive species, genetic modification of population, increased presence of unwanted (opportunistic) species	
Nature of impact:	Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Minor (2)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (48)**	**Low (27)**
Status (positive or negative)	Negative	
Reversibility	Moderately reversible, the nature of impacts is such that activities on the development site can be adapted to avoid impacts in surrounding areas	
Irreplaceable loss of resources?	Low	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Implement generic monitoring programme and mitigation measures that are aimed at identifying and preventing the uncontrolled spread of impacts into adjacent areas of natural habitat	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	
Nature of impact:	Indirect impacts on movement/ migration patterns of animals and ecological interaction and processes	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Highly probable (4)
Significance	**High (70)**	**Medium (40)**
Status (positive or negative)	Negative	

Reversibility	Irreversible
Irreplaceable loss of resources?	Low
Can impacts be mitigated?	Yes, to some extent
Mitigation Measures:	Limit development to footprint area, avoid impacts in adjacent habitat, implement biodiversity monitoring programmes, alien and invasive management programmes
Residual Impacts:	Fragmented, isolated portions of natural habitat, sterile landscapes, increased anthropogenic pressures on natural resources, changes to normal migration patterns on a local scale

Nature of impact:	Exacerbated increases of edge effects of the project areas	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (52)**	**Medium (30)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Implement biodiversity monitoring programmes, ensure proper restoration and rehabilitation of construction areas subsequent to construction	
Residual Impacts:	Degraded landscapes, loss of aesthetic appeal, poor species diversity	

Nature of impact:	Accelerated development patterns on a local and regional level implies significant increases in local and regional habitat fragmentation and isolation levels	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (4)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Medium (48)**	**Medium (48)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	These impacts are generally addressed on other platforms, such as regional councils and authority involvement and generally lies outside the scope of this particularly project. Avoidance of this impact will be through the relocation of the proposed project to existing populated areas and avoidance of areas situated far from populated areas; this is however no longer considered an option	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	

Nature of impact:	Cumulative depletion of faunal taxa, assemblages and communities, with specific reference to the conservation important species	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	Public awareness programmes, implementation of biodiversity monitoring protocols, search and rescue operations	

Residual Impacts:	Low faunal diversity, potential increase in threat status to certain taxa, exacerbated losses of faunal diversity, changes to local faunal patterns

28.3 Cumulative Impacts

Cumulative impacts are the totality of impacts in a given area resulting from this and other projects that impact upon the fauna of a region for any reason. The exact nature, duration, significance and scale of cumulative impacts are difficult to quantify; they are in fact not always considered during impact assessments as a result. However, cumulative impacts are significant and require consideration during this process of mitigating impacts and managing the natural ecological environment of the region. Anticipated cumulative impacts of the proposed project on the fauna of the region include:

7. Cumulative losses and degradation of natural faunal habitat; and
8. Cumulative depletion of faunal taxa, assemblages and communities on a regional scale, with specific reference to the conservation status of certain fauna taxa.

28.3.1 Quantification of Cumulative Impacts on the Faunal Environment

Table 24: Quantification of Cumulative impacts on the faunal environment		
Nature of impact:	Accelerated development patterns on a local and regional level implies significant increases in local and regional habitat fragmentation and isolation levels	
	Cumulative Contribution of Proposed Project	Cumulative Impact without Proposed Project
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (4)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Medium (48)**	**Medium (48)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Cnfidence of findings:	High	
Mitigation Measures:	These impacts are generally addressed on other platforms, such as regional councils and authority involvement and generally lies outside the scope of this particularly project.	
Nature of impact:	Cumulative depletion of faunal taxa, assemblages and communities, with specific reference to the conservation important species	
	Cumulative Contribution of Proposed Project	Cumulative Impact without Proposed Project
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	

Cnfidence of findings:	Public awareness programmes, implementation of biodiversity monitoring protocols, search and rescue operations
Mitigation Measures:	Low faunal diversity, potential increase in threat status to certain taxa, exacerbated losses of faunal diversity, changes to local faunal patterns

28.4 Summary of Impact Quantification on the Faunal Environment

Table 25: Summary table for impact significance on the faunal components

Impact	Without Mitigation	With mitigation
1. Loss of fauna species of conservation importance (threatened taxa) and habitat associated with CI species	High (72)	Medium (36)
2. Loss of natural habitat, including essential habitat refugia	High (65)	Medium (55)
3. Depletion of faunal diversity, human/ animal conflict situations, including the introduction of invasive and non-endemic species	Medium (52)	Low (27)
4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.	Medium (48)	Low (27)
5. Indirect impacts on movement/ migration patterns of animals and ecological interaction and processes	High (70)	Medium (40)
6. Exacerbated increases of edge effects of the project areas	Medium (52)	Medium (30)
7. Cumulative losses and degradation of natural habitat	Medium (48)	Medium (30)
8. Cumulative depletion of faunal taxa, assemblages and communities, with specific reference to the conservation important species	Medium (36)	Low (24)

29 ALTERNATIVE PROJECT LAYOUTS

Three alternative layouts are proposed for the project. These alternatives were rated in terms of estimated suitability based on differences in anticipated impacts on the animal communities of the study area and surrounding areas. Option 1 (refer **Figure 28**) and Option 3 (refer **Figure 30**) are restricted to the farm Vrienden 589 with most of the proposed project's footprint planned on faunal habitat with a medium sensitivity. Option 2 (refer **Figure 29**) will comprise selected portions of both farms.

29.1 Option 1

Faunal habitat within the proposed footprint of Option 1 has been indicated to contravene mostly habitat with a medium faunal sensitivity, this is excluding the proposed access road and pipeline servitude that will comprise portions of medium-high faunal sensitivity (which remains constant for all the Options). Locating the proposed project within a single property is regarded a beneficial option as the road and railway line between the properties will act as an artificial barrier for impacts. Lastly, the location of the proposed ash dump away from the seasonal water courses renders this option preferable, in contrast to Option 3 where the ash dump will be placed between the watercourses of Farm Vrienden.

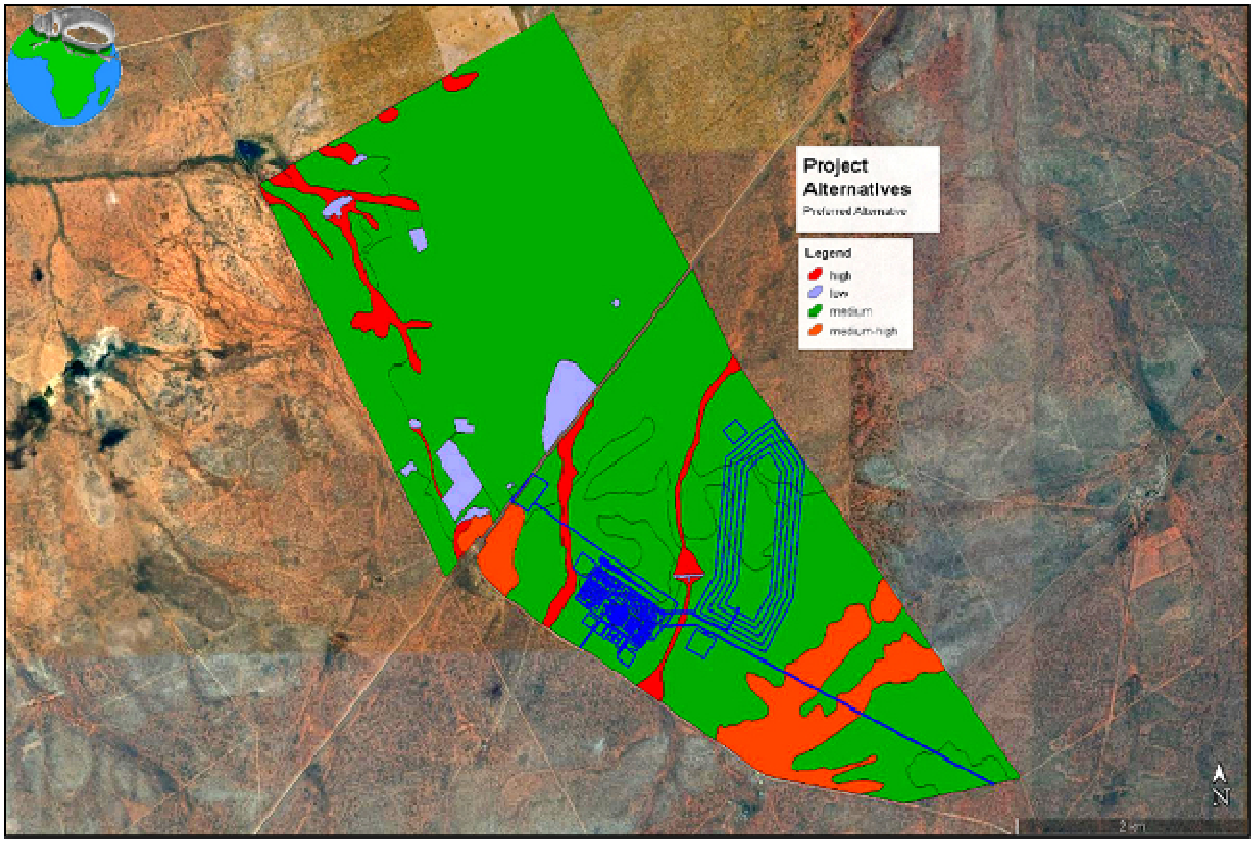


Figure 28: Footprint layout of Option 1

29.2 Option 2

As with Option 1, this Option will comprise habitat that exhibit a moderate faunal sensitivity. However, the spatial placement of appurtenant infrastructure across the border/ road between the farms, the length of the required conveyor between the power station and the ash dump and the potential impact on localised and sensitive faunal receptors, ultimately renders this option the second preferred alternative.

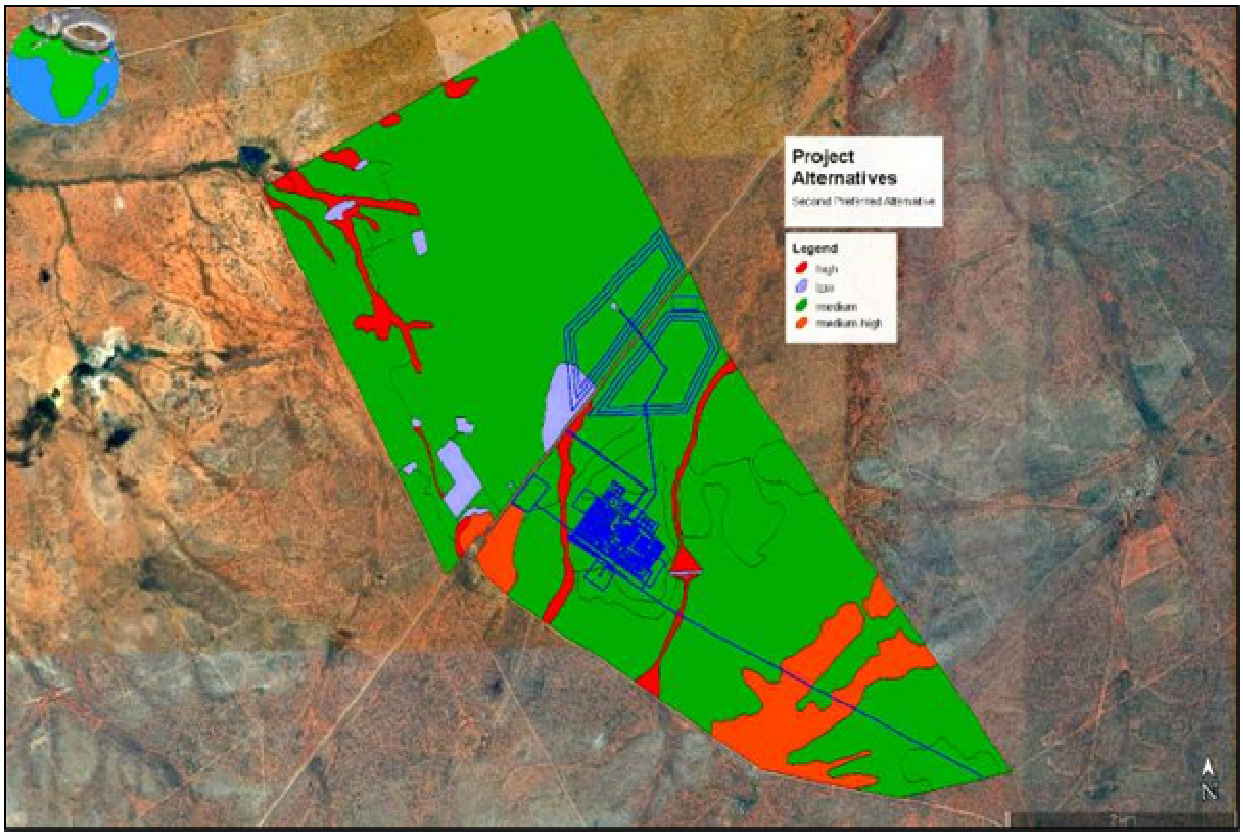


Figure 29: Footprint layout of Option 2

29.3 Option 3

The footprint of the least preferred project alternative layout is mostly restricted to habitats of a medium faunal sensitivity on the farm Vrienden 589; however, most of the footprint is situated in proximity to faunal habitats with high faunal sensitivities, i.e. between the seasonal water courses. This alternative is therefore regarded the least preferred option as far as potential and likely impacts on the faunal receiving environment is concerned.

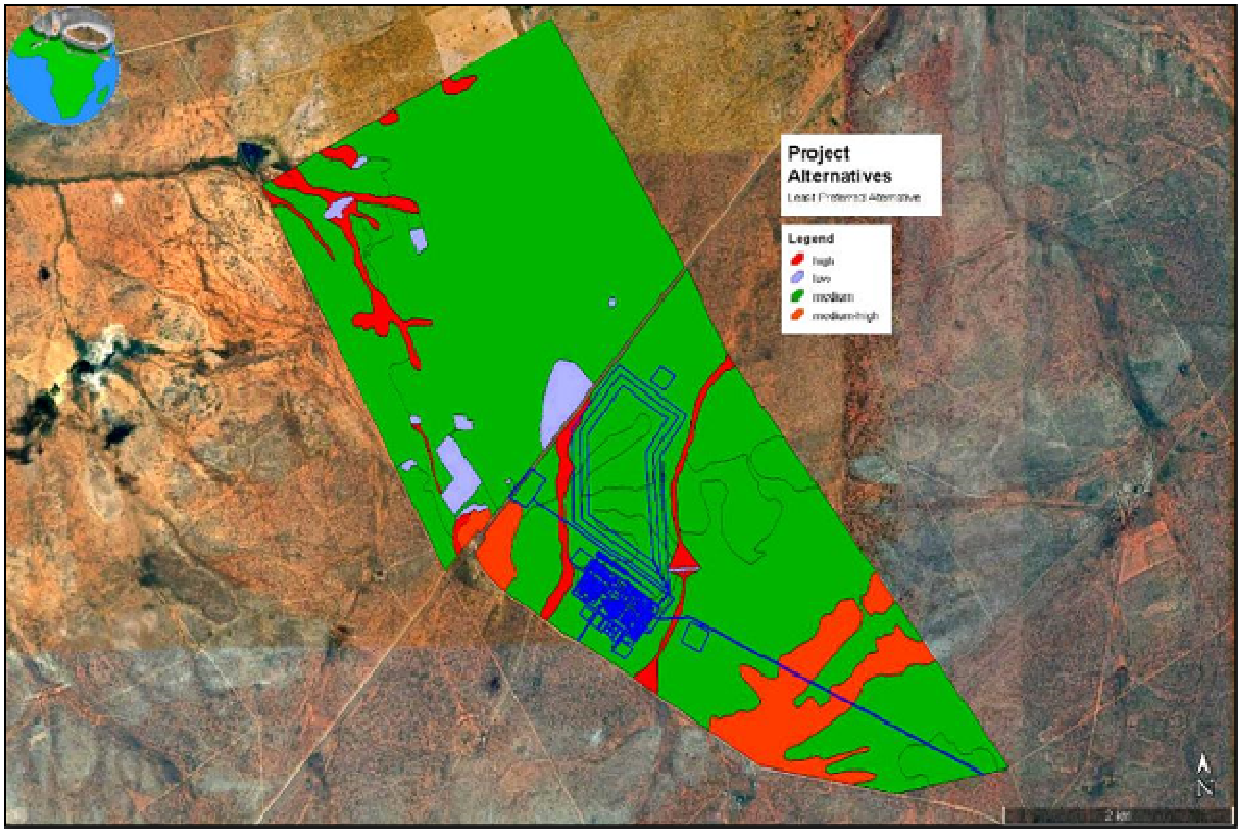


Figure 30: Footprint layout of Option 3

The three project alternatives are very similar in layout and estimated footprint sensitivity regarding the faunal receiving environment and, particularly, conservation important animal species. The evaluation of anticipated impacts on the faunal receiving environment of the study area did not indicate any significant difference between the three proposed alternatives. The faunal discipline is therefore not likely to represent a significant driver in the selection process between the layout options as only minor advantages/ disadvantages are indicated between the variations.

29.4 Mitigation

Mitigation of adverse impacts should aim to constrain effects of impacts on faunal assemblages and taxa that persist naturally within the project area, the immediate surrounds as well as on a regional scale by means of specific and diverse measures. Mitigation might aim to change the 'where', 'how', 'when', 'how much' or the 'if', to regulate impact significance, duration, scale or all of the above to acceptable levels. It is important to note that mitigation is not always successful or even possible; some impacts cannot be mitigated but only avoided by extreme means (such as preventing the project all together). Nevertheless, effective and applicable mitigation measures can often soften the blow considerably.

29.4.1 Site Specific Mitigation Measures

Mitigation Measure 1 - Exclude all areas of high faunal sensitivity from the proposed development, localised adjustments might be required to the footprint;

Mitigation Measure 2 - Implement a suitable buffer zone (at least 30 m) between the edge of these sensitive areas habitat and any type of development or surface disturbance;

Mitigation Measure 3 - Prevent contamination of natural woodland, wetlands, etc. from stockpiling areas, conveyor lines, water treatment facilities or any other source of pollution;

Mitigation Measure 4 - Develop an integrated management plan to deal with aspects such as littering, inappropriate discarding of food, the infestation of invasive and problem animal species, including rats, mice, vervet monkeys, baboons, etc.

Mitigation Measure 5 - Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

29.4.2 Roads & Access

Mitigation Measure 6 - A road management plan (allowing for management of impacts on surrounding faunal habitats, i.e. dust, erosion, destruction of faunal habitats with high sensitivities) should be compiled prior to the commencement of construction activities to avoid exacerbated impacts on natural habitat and minimise the exposure of natural habitat to disruptive activities;

Mitigation Measure 7 - No roads should be allowed within ecologically sensitive areas. The use of roads around ecologically sensitive areas for buffers should be done with circumspect particularly in view of accidental killing of animals;

Mitigation Measure 8 - Vehicular traffic on site should not be allowed after dark to limit accidental killing of nocturnal animals;

Mitigation Measure 9 - Speed of vehicles on site should be limited to 30km/h to allow for sufficient safety margins;

29.4.3 Animals

Mitigation Measure 10 - Ensure the absence of conservation important sessile animal species, such as baboon spiders, from the site through a walkthrough procedure prior to the commencement of construction activities. Because of the high numbers of baboon spiders within the study area and the inevitable severe impacts on these animals, it is strongly suggested that oversight be exercised, and a suitable proportion of the communities be excavated and, either relocated or, donated to institutions for scientific research purposes;

Mitigation Measure 11 - By no means should any wild animal be captured to be kept as pets or for any other purpose;

Mitigation Measure 12 - No animal may be hunted, trapped, snared or killed for any purpose whatsoever. Fences and boundaries should be patrolled weekly to ensure the removal of snares;

Mitigation Measure 13 - Dangerous animals should be handled by a competent person, with specific reference to spiders, snakes, scorpions, mammals, etc.;

Mitigation Measure 14 - No indiscriminate killing of animals should be allowed;

Mitigation Measure 15 - Compile a graphic list of potentially dangerous animals and present this to all workers as part of site induction;

Mitigation Measure 16 - Ensure that a competent snake handler is available at all times to remove and relocate snakes from the construction site;

Mitigation Measure 17 - Ensure that proper treatment facilities and competent personnel is available in cases of snake bites;

Mitigation Measure 18 - Fences and boundaries should be patrolled weekly to locate and remove snares/ traps;

Mitigation Measure 19 - Sensitize all personnel to the presence, characteristics and behaviour of animals on the site;

Mitigation Measure 20 - Include suitable procedures in the event of encountering potentially dangerous animals on the site;

Mitigation Measure 21 - No domestic pets should be allowed on the site whatsoever, with specific reference to domestic feral cats.

29.5 Faunal Management Action Plans

Biodiversity Action Plans are presented for each of the identified impacts. These Action Plans are by no means regarded as comprehensive and should be elaborated and detailed as needed during the various phases of the proposed development.

Impact 1: Loss of fauna species of conservation importance (threatened taxa) and habitat associated with CI species		
Objective:	Limit/ manage impacts on fauna species of conservation importance within the development footprint/ property/ immediate surrounds	
Project Components	Any infrastructure development that will cause loss of natural habitat where conservation important species are likely to occur or activities that could cause the disturbance of populations or individuals of these species	
Potential Impacts	Loss of habitat suitable for populations of conservation important species or direct impacts and losses of populations or individuals of these species	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Limit the impact on conservation important animals, prevent impacts on these animals in remaining areas of natural habitat	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Compile a list of conservation important animals that are known to occur in the region	Construction Contractors, Environmental Team, Environmental Officer	Prior to site preparation activities
2. Implement awareness programmes for all contractors and workers on site		Site preparation, Construction Phase
3. Compile Standard Operational Procedures for the effective handling, capture, release and/ or relocation of these animals, should they be threatened by construction/ operational activities		Prior to site preparation activities
4. Adapt operational activities to prevent direct impacts on these animals, including personnel presence in areas of natural habitat and vehicular movements/ speeds		Prior to site preparation activities
Performance Indicator	No significant losses of conservation important animals as a result of construction or operational activities	
	The persistence of individuals and populations of protected animals in natural habitat surrounding the development	

Monitoring	Annual monitoring of presence/ abundance of conservation important animals within property boundaries as well as immediately surrounding properties as part of bio monitoring programme. The monitoring programme should be compiled and effected by a qualified SACNASP Zoological specialist that is familiar with the region	
Impact 2: Loss of natural habitat, including essential habitat refugia		
Objective:	Limit/ manage the loss of natural vegetation (physical modifications, removal, damage) and local depletion of plant taxa, reduction of phytodiversity	
Project Components	Any infrastructure development that will cause loss of natural habitat	
Potential Impacts	Uncontrolled loss of natural habitat that would result in a reduction of local phytodiversity	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Allow for remaining areas of natural habitat to function ecologically effective within the environment of industrial development	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify a selection of suitable management areas in collaboration with specialists and conservation panel that will address requirements and objectives, including the consideration of areas of significant impact on biodiversity attributes	Developer, environmentalists, ecologists, project environmental team	Prior to site preparation activities
2. Propose and select a range of management areas that will suffice in the objectives of a diversity programme and where conservation efforts will yield positive results	Construction Contractors, Environmental Team, Environmental Officer	Prior to site preparation activities
3. Select a range of habitat diversity attributes that are considered important on a local and regional scale, attempting to align local conservation efforts with regional conservation plans, floristic diversity in management areas could be presented as performance indicators of intervention/ conservation, or rehabilitation efforts, ensure the continuance of a healthy, representative floristic composition and structure across the landscape		Site preparation, Construction Phase
5. Select a range of fixed points where periodic monitoring efforts will accurately assess and illustrate results of intervention/ conservation programmes		Prior to site preparation activities
Performance Indicator	No significant loss of faunal diversity on a local or regional scale, the implementation of a conservation strategy that will benefit local and regional conservation efforts	
	Effective ecological functionality of remaining areas of natural habitat within an environment of industrial development	
Monitoring	Annual monitoring of faunal diversity in affected and surrounding areas of natural habitat as part of biodiversity monitoring programme. The monitoring programme should be compiled and effected by a qualified SACNASP Zoological specialist that is familiar with the region	
Impact 3A: Depletion of faunal diversity, human/ animal conflict situations, including the introduction of invasive and non-endemic species		
Objective:	Facilitate effective displacement of animals from the development site, prevent continuous impacts on animals surrounding the development	
Project Components	All activities that will result in decimation of natural habitat occupied by animal species, activities that are likely to result in deaths of animals, activities that might attract animals to development/ construction sites	
Potential Impacts	Uncontrolled/ accidental death of animals that occupy natural habitat within the development site or temporarily occupy parts of the site/ infrastructures	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Limit the direct impacts on animals occupying natural habitat where development will take place, limit the presence/ occurrence of animals within construction/ operational areas, effect removal and relocation to suitable areas	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify animals present within the development footprint, with particular reference to spiders, snakes, scorpions, large mammals, etc.	EO, appointed specialist	Prior to site preparation activities
2. Compile and implement a capture and relocation programme prior to construction phase		Prior to site preparation activities

3. Compile Standard Operating Procedures for the capture and relocation of animals during the construction phase		Site preparation, construction and operational phases
Performance Indicator	No significant losses of animals, successful relocation and release of animals captured on site	
	Continued presence of a high diversity of animals in immediate surrounds	
Monitoring	Development and implementation of bio monitoring programme	
Impact 3B: Minimise human/ animal conflict situations, including the introduction of invasive and non-endemic species		
Objective:	Minimise human-animal conflict situations	
Project Components	The presence of personnel within a development area that is occasionally occupied by opportunistic species, the presence of personnel remaining areas of natural habitat occupied by animals	
Potential Impacts	Uncontrolled/ accidental death of animals caused by uninformed and/or deliberate actions of personnel	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Limit adverse human-animal conflict opportunities, promote high awareness of personnel with accurate and constructive information	

Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify target species likely to result in conflict situations, such as snakes, spiders, bats, owls, rodents, feral cats & dogs, etc	EO, appointed specialist	Prior to site preparation activities
2. Compile and implement a capture and relocation programme		Prior to site preparation activities
3. Compile Standard Operating Procedures for the capture and relocation of animals during the construction phase		Site preparation, construction and operational phases
4. Compile and implement awareness programmes to prevent accidental and/ uninformed killing of animals, with particular reference to snaring, traditional beliefs, capturing, introduction of pets, etc.		Site preparation, construction and operational phases
Performance Indicator	No significant losses of animals, successful relocation and release of animals captured on site	
	Absence of snares from site fences and trapping of animals	
	Continued presence of a high diversity of animals in immediate surrounds	
Monitoring	Development and implementation of bio monitoring programme	
Impact 4: Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc. during construction and operational phases		
Objective:	Limit the direct and peripheral effects of construction and operational activities in surrounding areas of natural habitat	
Project Components	Any infrastructure development or activity that could result in adverse impacts on adjacent areas of natural habitat	
Potential Impacts	Infestation of adjacent areas of natural habitat by alien and invasive plants, degradation and/ or contamination of natural habitat, uncontrolled spread of impacts from development site	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Prevent impacts from speeding into adjacent areas of natural habitat, prevent degradation of surrounding habitat	

Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify activities and project components that are likely to cause degradation of surrounding natural habitat	Construction Contractors, Environmental Team, Environmental Officer	Prior to site preparation activities
2. Compile Standard Operating Procedures to deal with the prevention, timely identification and rehabilitation of adverse environmental events and occurrences		Site preparation, Construction Phase
3. Compile and implement an Alien and Invasive management programme, with particular reference to access roads, power lines, conveyor sections, and development boundaries		Prior to site preparation activities
Performance Indicator	Absence of alien and invasive plants from the development site as well as surrounding natural habitat, effective preventative and rehabilitation procedures during construction and operational phases, typical and normal faunal assemblages and abundance	

	Absence of litter and effluent from roads, development footprint, minimal dust during construction activities	
Monitoring	Development and implementation of biodiversity monitoring programme	
Impact 5: Indirect impacts on movement/ migration patterns of animals and ecological interaction and processes		
Objective:	Prevent disruptions on the movement patterns of animals within the surrounding region	
Project Components	Construction and development within a natural environment, also where natural environment and ecological functionality of surrounding and adjacent areas will be affected through development and operational aspects	
Potential Impacts	Disruption of migration patterns that will lead to depletion of faunal diversity	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	To maintain existing habitat diversity and patterns that will sustain migration patterns of a high faunal diversity	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify and delineate areas that are important for animal migration patterns, i.e., watering holes, atypical habitat, etc. and provide for the preservation and enhancement (management) of these areas	Construction Contractors, Environmental Team, Environmental Officer, Ecologist	Prior to site preparation activities
2. Ensure all activities that result in destruction of natural habitat are contained within the authorized footprint and do not spread beyond the boundaries of the site		Site preparation, construction phase, operational phase
3. Identify habitat that can be retained within the development footprint in order to aid with effective migration patterns		Planning, site preparation and construction phases
4. Allow for the development/ management of 'stepping stones' within the larger region through effective ecological management of remaining habitat		Planning, site preparation and construction phases
Performance Indicator	High diversity of fauna species, including disciplines of mammals, avifauna, invertebrates and herpetofauna	
	Seasonal variation of diversity	
Monitoring	Annual diversity monitoring protocol during the construction period and an biennial monitoring programme for the operational phase of the project.	
Impact 6: Exacerbated increases of edge effects of the project areas		
Objective:	Limit the effects of development within surrounding habitat	
Project Components	All development activities that will cause sterilisation of natural habitat that becomes suitable for infestation by alien and invasive and encroacher plant species	
Potential Impacts	Deterioration of remaining natural habitat adjacent to development footprints that will lead to depletion of faunal diversity	
Activity/ Risk Source	Site preparation, construction activities, operational activities/ environmental management	
Mitigation: Target/ Objective	Prevent edge effects and habitat deterioration of adjacent areas of natural habitat	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify activities and project components that are likely to cause degradation of surrounding natural habitat	Construction Contractors, Environmental Team, Environmental Officer	Site preparation, Construction Phase
2. Identify areas within the property where exceptional and/ or ecological attributes of importance to the ecological functionality of the local area persists and retain these attributes as part of a conservation/ preservation programme, if at all possible, in oversight with a conservation specialist		Site preparation, Construction Phase, Operational Phase
3. Compile Standard Operating Procedures to deal with the prevention, timely identification and rehabilitation of adverse environmental events and occurrences within areas of ecological importance		Construction Phase
4. Compile and implement a biodiversity monitoring programme that aims to evaluate changes to the natural environment that would affect ecological functionality		Site preparation, Construction Phase, Operational Phase

5. Identify activities and project components that are likely to cause degradation of surrounding natural habitat		Site preparation, Construction Phase, Operational Phase
Performance Indicator	High diversity of fauna species, including disciplines of mammals, avifauna, invertebrates and herpetofauna	
	Comparable habitat diversity and status to regional and local ecological types	
Monitoring	Biodiversity monitoring protocol	
Impact 7: Cumulative losses and degradation of natural habitat		
Objective:	Prevent cumulative depletion and degradation of remaining areas of natural habitat	
Project Components	All development activities, land clearance, removal of natural vegetation, introduction of industrial components	
Potential Impacts	Habitat loss and degradation larger than development footprint	
Activity/ Risk Source	Site preparation, construction activities, operational activities/ environmental management	
Mitigation: Target/ Objective	Prevent edge effects and habitat deterioration of adjacent areas of natural habitat	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Avoid the creation of sterile landscapes and limit disturbance of remaining natural habitat	Construction Contractors, Environmental Team, Environmental Officer	Site preparation, Construction Phase, Operational Phase
2. Develop suitable land use and intensity options for intervention/ conservation sites		Construction Phase
Performance Indicator	Sustained high faunal diversity in adjacent natural habitat	
	Comparable habitat diversity and status to regional and local ecological types	
	Biodiversity monitoring protocol	
Monitoring	Annual biodiversity monitoring protocol	
Impact 8: Cumulative depletion of faunal taxa, assemblages and communities, with specific reference to the conservation important species		
Objective:	Sustain the current population and species diversity	
Project Components	All development activities where natural habitat is accessible to personnel and or local population	
Potential Impacts	Depletion of faunal habitat and species diversity through degradation of remaining natural habitat|	
Activity/ Risk Source	Site preparation, construction activities, operational activities/ environmental management	
Mitigation: Target/ Objective	To manage remaining natural habitat in ecological effective manner in order to sustain current population trends	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Compile a list of conservation important fauna species that are known to occur in the region	Construction Contractors, Environmental Team, Environmental Officer	Site preparation, Construction Phase, Operational Phase
3. Compile Standard Operational Procedures to deal with the effective capture and relocation of these animals, should they be threatened by construction/ operational activities		Construction Phase
4. Adapt operational activities to prevent direct impacts on these animals, including personnel presence in areas of natural habitat and vehicular movements/ speeds		Site preparation, Construction Phase
Performance Indicator	Continued presence of a high diversity of animals in surrounding areas of natural habitat, including species of conservation concern	
Monitoring	Annual biodiversity monitoring protocol	

29.6 Concluding Statement

Based on the results obtained during the field investigation and data analyses performed and the assessment of perceived and anticipated impacts of the activities associated with the construction, operation and closure phases of the proposed project, it is the opinion of the faunal specialist that no reason exists to deem the project as unsuitable. If the mitigation measures proposed are included in the EMP and adhered to, no reason can be provided to

oppose the authorization of the proposed project, including all proposed activities and portions thereof.

SECTION E – AVIFAUNAL ATTRIBUTES OF THE RECIEVING ENVIRONMENT

Lukas J. Niemand (Pr.Sci.Nat.)

30 BACKGROUND

30.1 Terms of Reference

30.1.1 Providing a Baseline Avifauna (bird) Assessment

The focus areas include the entire surface area of the Farm Du Toit 563 MS and Farm Vrienden 589 MS (excluding the section south of the main dirt road which passes through Farm Vrienden), comprising a total surface area of approximately 1 899 ha.

An avifaunal assessment must be conducted per identified homogenous vegetation unit identified from aerial photographs and/ or plant communities identified during the vegetation assessment within the relevant farms. The assessment must be conducted in such a way that the correlation between vegetation of the identified plant communities and the associated avifaunal community is reflected in the results.

A detailed method description will be used during the assessment, as well as equipment to be used.

30.1.2 Objectives

Determination of the current ecological status of the avifaunal environment, the evaluation of the extent of site-related effects in terms of certain ecological indicators, as well as identification of specific important ecological attributes such as rare, threatened and near threatened species, protected species and endemic species.

A detailed desktop study (conducted during the scoping phase) and baseline avifaunal assessment are required to address the following objectives:

a. Identification of all bird species that might potentially be present based on the results of detailed desktop studies;
b. Identification, documentation and distribution of all bird species recorded during a detailed assessment;
c. Identification of all threatened, near threatened, protected and conservation important bird species and distribution maps and GPS coordinates of their distribution.

The detailed desktop study should include historical bird records, their national and global IUCN (Red Data) status and protected status according to the NEMBA (TOPS List) and the LEMA Act.

30.1.3 Scope of Work

A desktop study of bird species that may potentially occur, as well as species recorded in the past (e.g. SABAP1) needs to be included. A detailed list of birds recorded in the past within the relevant quarter degree grid in which the respective farms are situated is required. Any protected species recorded in the past within the relevant quarter degree grid, their scientific names and colloquial names, including protected status according to IUCN red data lists,

NEMBA TOPS list and LEMA are required. The potential of these protected species to occur needs to be evaluated and included.

The following must be recorded during the avifaunal baseline survey:

a. All bird species encountered or noted during the survey;
b. A list of the most prominent birds encountered, and possible species that can be expected to be present;
c. A list of protected, threatened and near threatened species encountered (according to IUCN red data list, NEMBA TOPS list and provincial legislation) during the baseline survey and GPS coordinates where these were recorded;
d. Possible migratory or nomadic species that are not detected during the baseline survey must be assessed from literature surveys; and
e. An inventory of all the birds that can possibly be present within the relevant grid in which the farms are situated must be compiled.

In addition, the following are also provided:

a. Impact assessment of the proposed new activities on the avifaunal community; and
b. Mitigation measurements to manage the existing and expected impacts.

30.2 Methods & Approach

The information provided in this report was principally sourced from:

a. relevant literature (see section below)
b. a baseline survey of the area (12 - 19 January 2018)
c. personal observations during a scoping assessment of the farms (24 - 26 January 2017)
d. personal observations from similar habitat types in proximity to the study area, with emphasis on assessments conducted by Pachnoda Consulting (2009; 2015) of which the avifauna study was conducted by the author.

30.3 Literature Survey & Data Acquisition

A desktop and literature review of the area under investigation was commissioned to collate as much information as possible prior to the baseline survey. The literature consulted makes primarily use of small-scale datasets that were collected by citizen scientists and were located at various governmental and academic institutions (e.g. Animal Demography Unit & SANBI). These include (although not limited to) the following:

» Hockey et al. (2005), Harrison et al. (1997) and Del Hoyo et al. (1992-2011) was consulted for general information on the life history attributes of the relevant bird species. They also provide basic distributional information at small geographic scales;
» Marnewick et al. (2015) was consulted for information regarding the biogeographic affinities (*sensu* Important Bird and Biodiversity Areas) of selected bird species that could be present on the study area;
» The conservation status of bird species was categorised according to the global IUCN Red List of threatened species (IUCN, 2018) and a recent regional conservation assessment of Taylor et al. (2015);

» The list of threatened and protected species under sections 56(1), 57(2) and 57(4)(a) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) was consulted to identify those species that are threatened or in need of protection (updated 2015);
» Schedule 2, 3 and 4 of the LEMA (Act No 7 of 2003) was consulted to identify species with provincial protective status;
» Distributional data was sourced from the South African Bird Atlas Project (SABAP1) and verified against Harrison et al. (1997) for species corresponding to the quarter-degree grid cells (QDGC) 2229DB. *The information was then modified according to the prevalent habitat types present on the study area.* 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 15 min lat and 15 min long). 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 therefore provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991;
» Additional distributional data was also sourced from the SABAP2 database (http://www.sabap2.adu.org.za). *The information was then modified according to the prevalent habitat types present on the study area*. Since bird distributions are dynamic (based on landscape changes such as fragmentation and climate change), SABAP2 was born (and launched in 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). The pentad grids relevant to the current project include 2235_2945, 2240_2945 and 2240_2950. In addition, the eight pentads adjacent to 2240_2945 were also scrutinized during the assessment.
» The choice of scientific nomenclature, taxonomy and common names were recommended by the International Ornithological Committee (the IOC World Bird Names, v.8.1), unless otherwise specified (see www.worldbirdnames.org as specified by Gill & Donsker, 2018). The updated nomenclatural sequence of Hackett et al. (2008) and del Hoyo et al. (2014; 2016) was adopted according to a recent upsurge of phylogenetic studies, which differs from the more traditional classification of Sibley & Ahlquist (1990). Colloquial (common) names were used according to Hockey et al. (2005) to avoid confusion;
» In addition, all observations obtained during the site visit of 12 - 19 January 2018 were submitted to the South African Bird Atlas Project (SABAP2).

30.4 Baseline survey

A site visit (during 12 - 19 January 2018) was conducted to obtain baseline information on the avifaunal composition and relative species abundance residing on the study area and immediate surroundings. An inventory of bird species along with their COMMON and SCIENTIFIC NAMES observed during the surveys is included (refer **Appendix 2**). All observations were processed and submitted to the South African Bird Atlas Project (SABAP2).

The baseline avifaunal survey was conducted by means of the following techniques:

» *Point Counts*

Bird data was collected by means of 53 point counts (Buckland et al. 1993) (refer **Figure 31**). The data from the point counts was analysed to determine dominant and indicator (including discriminant) species and to delineate the different communities present. The use of point counts is advantageous since it is the preferred method to use for cryptic or elusive species. In addition, it is the preferred method to line transect counts where access is problematic, or when the terrain appears to be complex. It is a good method to use, and very efficient for gathering a large amount of data in a short period of time (Sutherland 2006).

At each point, all the bird species seen within approximately 50 m from the centre was recorded along with their respective abundance values using a Swarovski 8.5x42 EL binoculars and a Swarovski 30-70x95 ATX spotting scope. Each point count lasted approximately 20 minutes while the area within the immediate vicinity was slowly traversed to ensure that all bird species were detected (according to Watson, 2003). To ensure the independence of observations, points were positioned at least 200 m apart. Bird richness estimates were augmented by the deployment of both infrared trail cameras (to document large terrestrial and wading birds) and bio-acoustic recorders (by using a SM4 songmeter, Wildlife Acoustics Inc) at selected areas (c. manmade dams, *Grewia* thickets and near large *Adansonia digitata* trees) (refer **Figure 32**).

Broadcasting of *Glaucidium perlatum* (Pearl-spotted Owlet) calls was performed for approximately 30 seconds at each point count to facilitate the detection of 70 % of the passerine bird species in the vicinity of the point count. Most passerine bird species are attracted to the calls of Pearl-spotted Owlets since it is perceived as a predatory intruder, which they try to drive away by mobbing it. However, broadcasting was limited and used with caution and was not repeated or used for extended time periods.

Data generated from the point counts was analysed according to Clarke & Warwick (1994) based on the computed percentage contribution (%) of each species, including the consistency (calculated as the similarity coefficient/standard deviation) of its contribution. Hierarchical Agglomerative Clustering (a cluster analysis-based group-average linkages; Clarke & Warwick 1994) was performed on calculated Bray-Curtis coefficients derived from the data. A cluster analysis is used to assign "species associations" between samples with the aim to objectively delineate groups or assemblages. Therefore, sampling entities that group together (being more similar) are believed to have similar compositions.

The species diversity of each species association was analysed by means of rarefaction, while richness measures (such as the total number of species recorded (S) and various diversity indices) were calculated to compare the associations with each other. The advantage of rarefaction is that it adjusts the number of species expected from each sample if all were reduced to a standard size.

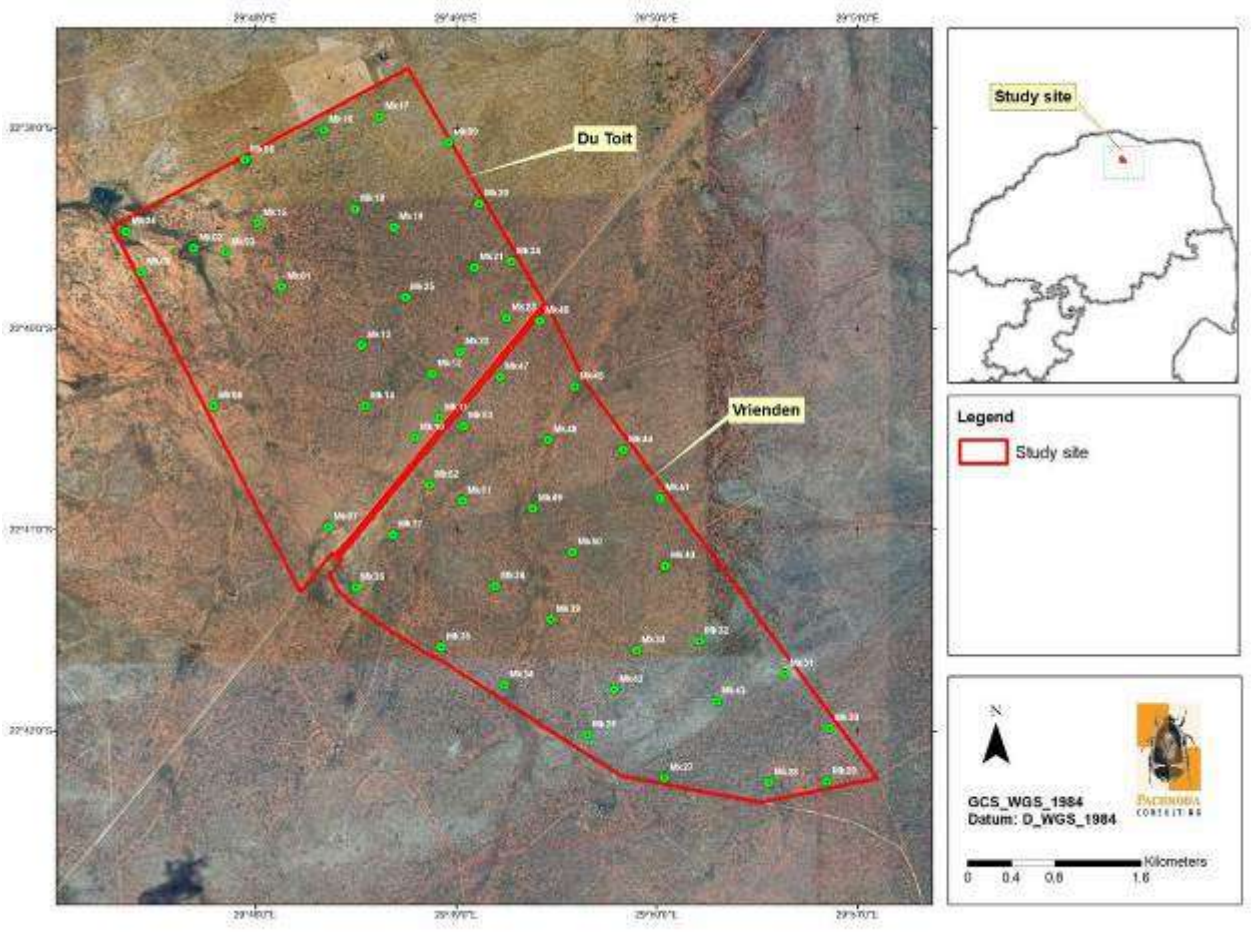


Figure 31: Spatial position of 53 bird point counts conducted within the study area

» *Random (ad hoc) surveys*

To obtain an inventory of bird species present (apart from those observed during the point counts), all bird species observed/detected while moving between point counts were identified and noted. Particular attention was devoted to suitable roosting, foraging and nesting habitat for threatened or near threatened species. Besides visual observations, bird species were identified by means of their calls and other signs such as nests, discarded eggshells and feathers.

» *Nocturnal bird surveys*

Nocturnal bird species (owls and nightjars) were searched for by driving slowly or walking (depending on safety and accessibility) on roads at night. Attention was paid to calling bird species such as owls and nightjars. Nocturnal surveys were only conducted during the January site visits. The occurrence of nocturnal bird species was augmented by the deployment of bio-acoustic recorders (by using a SM4 songmeter, Wildlife Acoustics Inc) at selected areas (c. manmade dams, *Grewia* thickets and near large *Adansonia digitata* trees) (refer **Figure 32**).

» *Playback/broadcasting of bird vocalisations*

The probability of detecting skulking or elusive species was verified by playback of bird calls/songs wherever suitable habitat was detected (e.g. Thrush Nightingale *Luscinia*

luscinia). Special care was taken to keep disturbance to a minimum and not to affect the bird's natural behaviour (e.g. to prevent unnecessary habituation).

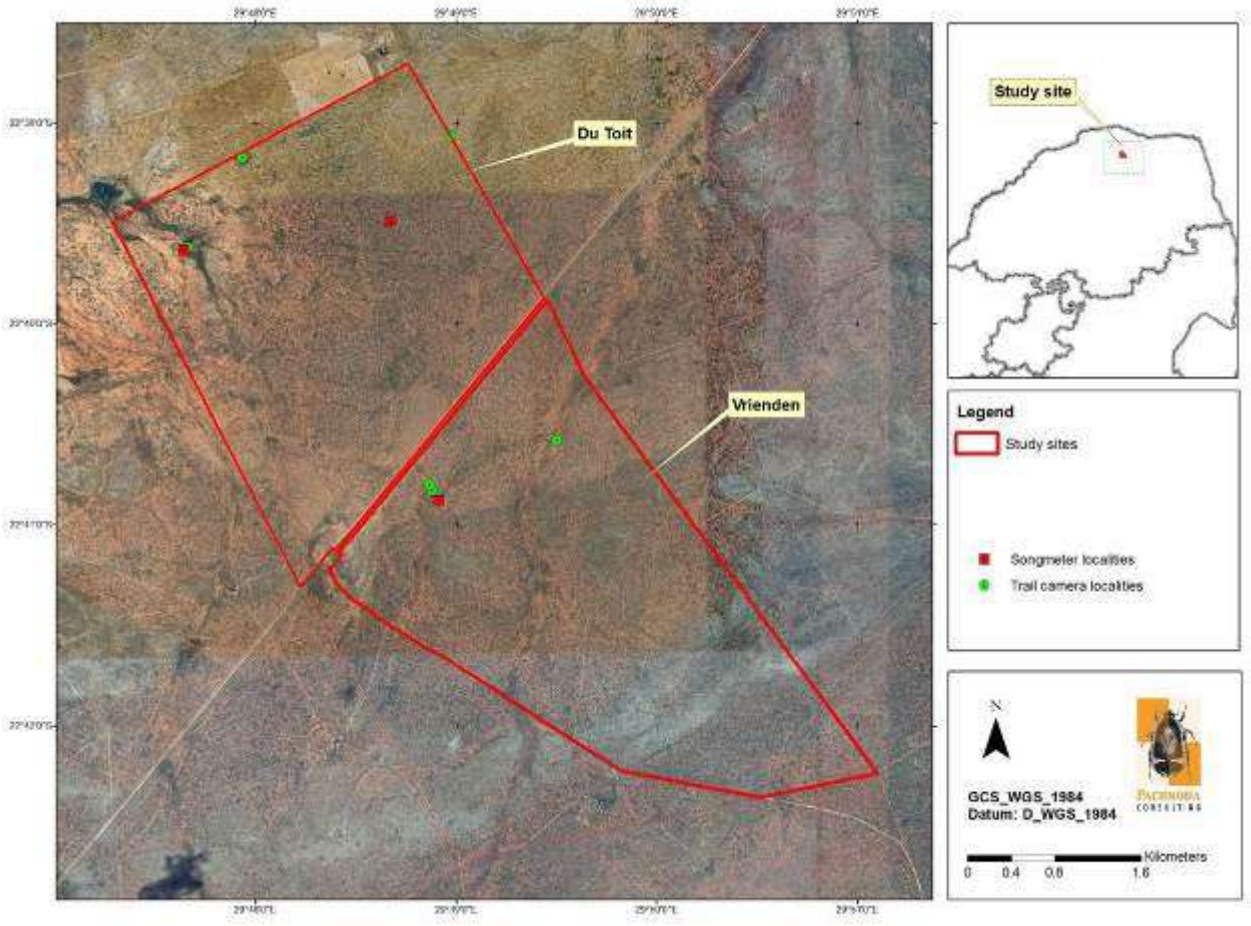


Figure 32: Spatial position of infrared trail cameras and songmeters with the intent to document bird richness

30.5 Avifaunal sensitivity analysis

An avifaunal sensitivity analysis was performed for each habitat type on the study site based on its inherent ecosystem service (ecological function) and the preservation of bird diversity (avifaunal importance).

30.5.1 Ecological Function

The extent to which a habitat type is ecologically connected to the surrounding area is an important determinant of the sensitivity analysis. Habitat with a high degree of landscape connectivity or with extensive drainage systems amongst one another are perceived to be more sensitive and will be those contributing to important avifaunal flyways.

30.5.2 Avifaunal Importance

Avifaunal importance relates to species diversity, endemism and the presence of topographical features or primary habitat units with the intrinsic ability to sustain conservation important species.

30.5.3 Sensitivity Scale

Very High - Sensitive habitat with either low inherent resistance or low resilience towards disturbance factors. These habitat types represent ecosystems with high connectivity and support high bird diversities while providing suitable habitat for a number of threatened or near-threatened species.

High – Highly dynamic habitat considered important for the maintenance of ecosystem integrity. These habitat types support high bird diversities and provide suitable habitat for at least one or more threatened or near-threatened species.

Medium – These are slightly modified habitat types, which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems, OR habitat types with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species.

Low –Disturbed/transformed habitat with little ecological function and is generally very poor in species diversity with a dominant composition of unspecialised and widespread species.

Very Low - Severely modified habitat where ecosystem service is arrested or non-functional. Species diversity is extremely low and often dominated by very few bird species.

30.6 Limitations and assumptions

» It is assumed that third party information (obtained from government, academic/research institution, non-governmental organisations) is accurate and true;

» Some of the datasets 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;

» The datasets are mainly small-scale and could not always consider azonal habitat types that may be present on the study area (e.g. small dams, pans and depressions). In addition, these datasets encompass surface areas larger than the study area, which could include habitat types and species that are not present on the study area. Therefore, the potential to overestimate species richness is highly likely while it is also possible that certain cryptic or specialist species could have been overlooked in the past; and

» Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town were recently initiated and therefore incomplete.

» To obtain a comprehensive understanding of the diversity and dynamics of avifaunal community on the study area, as well as the status of endemic, rare or threatened species in the area, 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 are mostly based on instantaneous sampling bouts. It should also be realised that bird distribution patterns fluctuate widely in

response to environmental conditions (e.g. local rainfall patterns, nomadism, migration patterns, seasonality), meaning that a composition noted at a particular moment in time will differ during another time period at the same locality. This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented.

31 SPECIES COMPOSITION & PATTERNS IN DIVERSITY

31.1 Regional Vegetation Types – Regional Context

The study area corresponds to the Savanna Biome and more particularly to the Mopane Bushveld Bioregion as defined by Mucina & Rutherford (2006) and comprehends an ecological type known as Musina Mopani Bushveld (Mapping Unit SVmp 01; Mucina & Rutherford, 2006).

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 (=Hardwickia) mopane*, *Terminalia prunioides*, *Commiphora* species (C*. glandulosa, C. mollis, C. viminea and C. africana*), *Kirkia acuminata* and *Combretum apiculatum*. The graminoid layer is open and sparse, while the herbaceous layer is poor in species richness. *Adansonia digitata* and *Senegalia (=Acacia) nigrescens* are typical canopy constituents albeit sparse in the landscape.

This vegetation type was widespread, least threatened and dominant on the study area.

The high palatability of the graminoid composition and the geographic position of the study area makes this vegetation type very suitable for game and livestock (mainly cattle) farming practices, which is also responsible for the occasional occurrences of large-bodied birds of prey (especially scavenging vultures).

It should be noted that bird diversity is invariably positively correlated with vegetation structure, although floristic richness is not regarded to be the most important contributor of bird abundance patterns. Therefore, grasslands are generally poor in woody plant species although it is considered an important habitat for many terrestrial bird species such as larks, pipits, korhaans and cisticolas. On the other hand, woodlands are rich in woody plant species and are an important constituent of the Savanna Biome that provides habitat for numerous bushveld bird species that are not partial to grassland habitat types (notably birds of prey).

However, in contrast to the Grassland Biome, the bird assemblages occupying the Savanna Biome are generally rich in Accipitriform taxa such as the Tawny Eagle (*Aquila rapax*), African White-backed Vulture (*Gyps africanus*), Brown Snake-eagle (*Circaetus cinereus*), Black-chested Snake-eagle (*Circaetus pectoralis*), African Harrier-hawk (*Polyboroides typus*), African Hawk Eagle (*Aquila spilogaster*) and Wahlberg's Eagle (*Hieraaetus wahlbergi*).

This regional habitat type supports a fairly high richness of bird species. However, it is evident that several smaller habitat units (depressions, seasonal drainage lines and cultivated land) are also prevalent and provide habitat for bird compositions that are different to those ecological types that dominate the region. It should be emphasised that the depressions provide ephemeral habitat for wetland-dependant bird species (mainly wading bird and wader species) which have subsequently contributed to the local avifaunal richness in the area. These wetland features also provide foraging habitat for threatened stork species.

31.2 Avifaunal Broad-scale Habitat Types – Local Context

From an avifaunal perspective, two dominant broad-scale habitat types are prominent in the area based on historical disturbance events (e.g. vegetation clearing), which is an important successional driver of the observed vegetation composition and subsequent bird assemblages:

1. *Undifferentiated mixed closed woodland on sandy soils* - This habitat type is prominent and by far the most dominant habitat on the study area. It corresponds to deep, highly leached sandy soils, which is synonymous with a *Combretum apiculatum - Grewia flavescens - Colophospermum mopane* sand association (refer **Figure 33**). The majority of the two Farms consists of arid mixed woodland located on sandy soils. It comprises of a well-developed woody layer consisting of *Colophospermum (=Hardwickia) mopane*, *Terminalia prunioides*, *Vachellia tortilis, Kirkia acuminata, Grewia bicolor, Boscia albitrunca, Lannea schweinfurthii* and various species of *Commiphora*. Typical canopy constituents include *Xanthocercis zambesiaca (rare), Senegalia nigrescens* and *Adansonia digitata*. The graminoid layer includes dominant taxa such as *Panicum maximum, Schmidtia pappophoroides* and *Stipagrostis uniplumis*. Based on their distribution, the avifaunal assemblages occurring on the study area are likely to include a proportion of taxa with evolutionary links to the Zambezian region and the Kalahari-Highveld basin (refer **Table 25**).
2. The open structure and sparse graminoid layer (presumably due to grazing pressure and climatic factors such as unpredictable precipitation resulting in frequent aridity) favoured the colonisation of large terrestrial bird species such as the Kori Bustard (*Ardeotis kori*), Red-crested Korhaan (*Lophotis ruficrista*) and Double-banded Sandgrouse (*Pterocles bicinctus*). Prominent birds of prey include Wahlberg's Eagle (*Hieraaetus wahlbergi*) and Dark Chanting Goshawk (*Melierax metabates*).
3. Some parts of the study site are characterised by dense tall mopani woodland (mainly on the northern parts of Farm Du Toit) that represents habitat colonised by typical species pertaining to broad-leaved woodland and were rare elsewhere. Typical bird species include African Golden Oriole (*Oriolus auratus*), Grey Penduline Tit (*Anthoscopus caroli*), Yellow-throated Petronia (*Gymnoris superciliaris*) and very rarely even (Southern) Crested Guineafowl (*Guttera pucherani edouardi* - pers. obs. from Du Toit).
4. Some sections of the woodland type consist of dense *Grewia flavescens* and *G. bicolor* shrub which are colonised by elusive and skulking warbler and robin taxa such as Marsh Warbler (*Acrocephalus palustris* - a relatively abundant species that was only recently discovered in the area) and Bearded Scrub-robin (*Cercotrichas quadrivirgata* - extremely rare in the area and only occurring on Farm Du Toit), and potentially also Thrush

Nightingale (*Luscinia luscinia*), especially when on passage. These species are easily overlooked and have not been recorded previously from the area.

Table 26: A list of biome-restricted species[5] (according to Marnewick et al., 2015) expected to be present on the study area.

Species	*Common Name*	*Biome Affinity*	*Predicted Status*
Cercotrichas paena	Kalahari Scrub-robin	Kalahari-Highveld	Fairly common
Cossypha humeralis	White-throated Robin-chat	Zambezian Affinity	Uncommon
Poicephalus cryptoxanthus	Brown-headed Parrot	East African Coastal Affinity	Uncommon (study area is part of western edge of distribution)
Turdus libonyanus	Kurrichane Thrush	Zambezian Affinity	Fairly common
Calamonastes fasciolatus	Barred Wren-warbler	Kalahari-Highveld	Common
Cinnyris talatala	White-bellied Sunbird	Zambezian Affinity	Common

5. *Secondary microphyllous woodland* - These represent areas of secondary woodland previously used for agricultural purposes. The sequential colonisation by graminoid (grass) species makes it possible for terrestrial species (mainly Kori Bustard - *Ardeotis kori*) to utilise these areas. It is synonymous with the *Vachellia tortilis - Cienfuegosia digitata* old fields community (refer **Figure 33**). This habitat is characterised by a high prominence of short *Acacia* woodland dominated by *Vachellia tortilis* and *Dichrostachys cinerea*. This habitat supports a distinct and rich avifaunal composition of arid "thornveld" species such as the Crimson-breasted Shrike (*Laniarius atrococcineus*), Southern Pied Babbler (*Turdoides bicolor*), Black-faced Waxbill (*Estrilda erythronotos*), Violet-eared Waxbill (*Uraeginthus granatina*), Scaly-featured Finch (*Sporopipes squamifrons*), Cape Penduline Tit (*Anthoscopus minutus*) and Burned-necked Eremomela (*Eremomela usticollis*). The *Vachellia* trees, in particular taller specimens, provide habitat for Palaearctic warblers, which include the Icterine Warbler (*Hippolais icterina*).

   An early successional form of this habitat consists mainly of short annual grasses and weeds species that are favoured by a complete different assemblage of terrestrial species which include many nomadic species. During early succession, this habitat is colonised by bird species such as Crowned Lapwing (*Vanellus coronatus*), Temminck's Courser (*Cursorius temminckii*), Chestnut-backed Sparrow-Lark (*Eremopterix leucotis*) and Buffy Pipit (*Anthus vaalensis*). This habitat also attracts several aerial insectivores, most notably Southern Carmine Bee-eater (*Merops nubicoides*) in summer.

[5] A species with a breeding distribution confined to a single biome

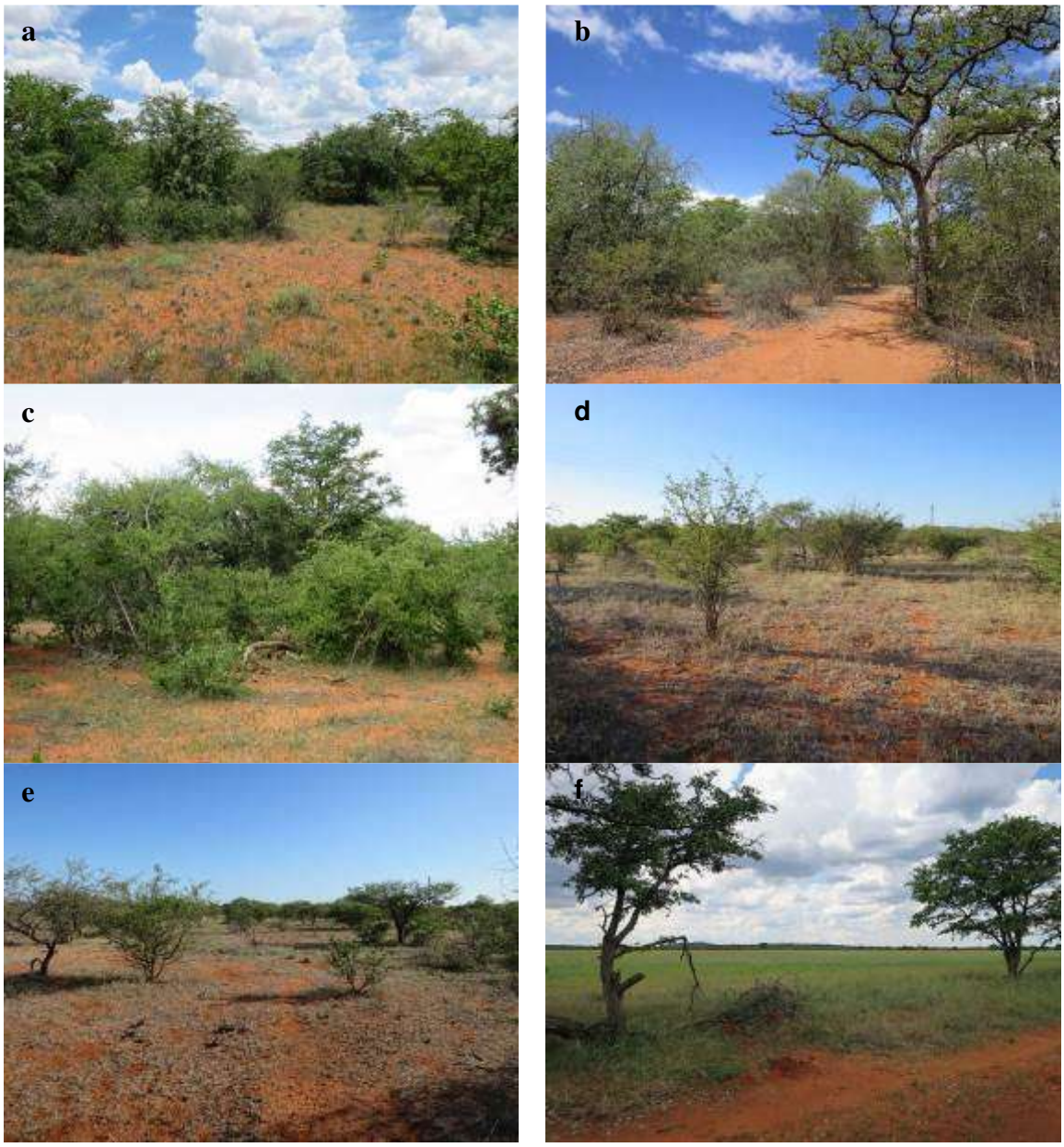


Figure 33: A collage of images illustrating the different broad scale habitat types on the study area
(a-b) Undifferentiated mixed closed woodland on sandy soils; note the poorly developed basal or graminoid layer, (c) dense *Grewia* thickets which provide suitable habitat for Palearctic migratory warbler taxa when on passage, (d-e) secondary microphyllous woodland as viewed on the Farm Du Toit and (f) secondary savannoid grassland along the edge of Farm Du Toit, the typical foraging habitat of the near threatened Kori Bustard (*Ardeotis kori*).

31.3 Azonal Avifaunal Habitat Types – Local Context

Apart from the aforementioned habitat types, six azonal habitat types were also prevalent and scattered across the study area (refer **Figure 34**), namely:

1. *Calcareous plains and quartz outcrops* - these represent calcrete plains and quartz outcrops, which were mainly confined to Farm Vrienden. From a floristic and avifaunal perspective, they appear to be similar in composition to the surrounding undifferentiated mixed closed woodland. In addition to the dominance of *Colophospermum mopane*, *Vachellia grandicornuta* and *Boscia foetida* they become numerous of which the former

often holds an arid thornveld bird composition similar to the secondary microphyllous woodland. This habitat is probably more important from an invertebrate perspective.

2. *Impoundments and natural depressions (pans)* – these respectively represent man made water bodies and shallow natural depressions dominated by *Combretum imberbe*. These waterbodies have undoubtedly benefitted the colonisation and range expansion of many waterbird species that favours open water habitat (e.g. White-faced Duck - *Dendrocygna viduata*, Knob-billed Duck - *Sarkidiornis melanotos* and Egyptian Goose - *Alopochen aegyptiacus*). They also provide foraging habitat for threatened stork species (e.g. Saddle-billed Stork - *Ephippiorhynchus senegalensis*) and many wader taxa (e.g. Black-winged Stilt - *Himantopus himantopus* and Wood Sandpiper - *Tringa glareola*). This habitat type was restricted to Farm Du Toit.
3. *Seasonal drainage lines* - this habitat type represents a linear riparian zone along drainage lines. The vegetation consists of a dense canopy of *Schotia brachypetala, Xanthocercis zambesiaca* and *Peltophorum africanum*. The understorey is well defined and thicket-like, consisting of *Grewia flava* and *Ziziphus mucronata*. *Panicum maximum* dominates the graminoid layer. The high vertical heterogeneity and leaf litter deposition associated with the alluvial vegetation allow for avifaunal compositions not typically associated with adjacent dryland habitat types - thereby enhancing local biodiversity. From a functional perspective, these habitat types play an important role in maintaining genetic stability between bird 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.
4. *Artificial game watering holes* - these watering points provide drinking water to livestock and game species. They act as congregation areas for many of the smaller passerine bird species, which in turn attract numbers of hunting birds of prey.
5. *Large dead trees* - this habitat type consists of large dead trees that are largely scattered in the study site. These dead trees provide essential roosting and breeding habitat for hole- and cavity-nesting species.
6. *Large Adansonia digitata (Baobab) canopy constituents* – these include large baobab trees, which were scattered across the study area, but were particularly prominent on the Farm Vrienden. They provide optimal roosting and breeding habitat for a host of cavity-nesting bird species (including Brown-headed Parrot - *Poicephalus cryptoxanthus*). In addition, these trees are also the favourite breeding platforms used by Red-billed Baffalo Weavers (*Bubalornis niger*) and Red-headed Weavers (*Anaplectes rubriceps*). Lastly, they also occasionally function as hunting and roosting posts for large birds of prey (e.g. Brown Snake-eagle - *Circaetus cinereus*).


a
b
c
d
e
f
g
h

Figure 34: A collage of images illustrating the different azonal habitat types on the study area
(a-b) Calcrete plains with *Vachellia grandicornuta*, (c-d) inundated and dry impoundments as viewed on the Farm Du Toit, (e-f) natural ephemeral pans on the Farm Du Toit, (g-h) artificial watering holes for game and livestock, (i) a large dead tree utilised by hole-nesting bird species, and (j) a large *Adansonia digitata* tree on the Farm Vrienden which provide breeding habitat for Red-billed Baffalo Weavers (*Bubalornis niger*) and Brown-headed Parrot (*Poicephalus cryptoxanthus*).

31.4 Species Richness and predicted summary statistics

31.4.1 Regional Perspective: Richness

According to the South African Bird Atlas Project (SABAP1 (Harrison et al., 1997) & SABAP2), approximately 359[6] bird species have been recorded in the quarter degree square that are sympatric to the study region. This equates to approximately 37 % of the approximate 975[7] species listed for the southern African subregion[8] (and approximately 42 % of the 854[9] species recorded within South Africa[10]). However, the SABAP2 database (www.sabap2.adu.org.za) for the three pentad grids corresponding to the study site was lower (c. 84-124 species/pentad), which emphasises the poor atlas coverage of the area[11]. According to personal observations, the average number of species observed per pentad within a given time period (c. 2 hours) is approximately 90 - 100 species. This is much lower than the regional SABAP1 statistic, and best explained by the monotonous habitat structure that is prevalent across the two farms. On a national scale, the species richness per pentad on the study area is considered moderate-high (75-140 species)

[6] The statistic was corrected by excluding erroneous submissions pertaining to the Damara Hornbill (*Tockus damarensis*) and hybrids with Southern Red-billed Hornbill (*T. rufilatus*), Northern Grey-headed Sparrow (*Passer griseus*), Green-backed Camaroptera (*Camaroptera brachyura*), White-browed Coucal (*Centropus superciliosus*), Schalow's Turaco (*Turaco schalowi*) and Orange River White-eye (*Zosterops pallidus*).
[7] *sensu* www.zestforbirds.co.za (Hardaker, 2016) with the addition of Rufous-tailed Scrub-Robin (*Cercotrichas galactotes*), European Pied Flycatcher (*Ficedula hypoleuca*), Upcher's Warbler (*Hippolais languida*) and White Wagtail (*Motacilla alba*) - some of these species are currently vetted by the Rarities Committee.
[8] A geographical area south of the Cunene and Zambezi Rivers (includes Namibia, Botswana, Zimbabwe, southern Mozambique, South Africa, Swaziland and Lesotho).
[9] *sensu* BirdLife South Africa (2016) with the addition of Rufous-tailed Scrub-Robin (*Cercotrichas galactotes*), European Pied Flycatcher (*Ficedula hypoleuca*), Upcher's Warbler (*Hippolais languida*), Little Ringed Plover (*Charadrius dubius*) and White Wagtail (*Motacilla alba*) - some of these species are currently vetted by the Rarities Committee.
[10] With reference to South Africa (including Lesotho and Swaziland).
[11] Range of 84 - 124 species based on 9 full protocol card submissions (including 8 *ad hoc* cards and 16 incidental records).

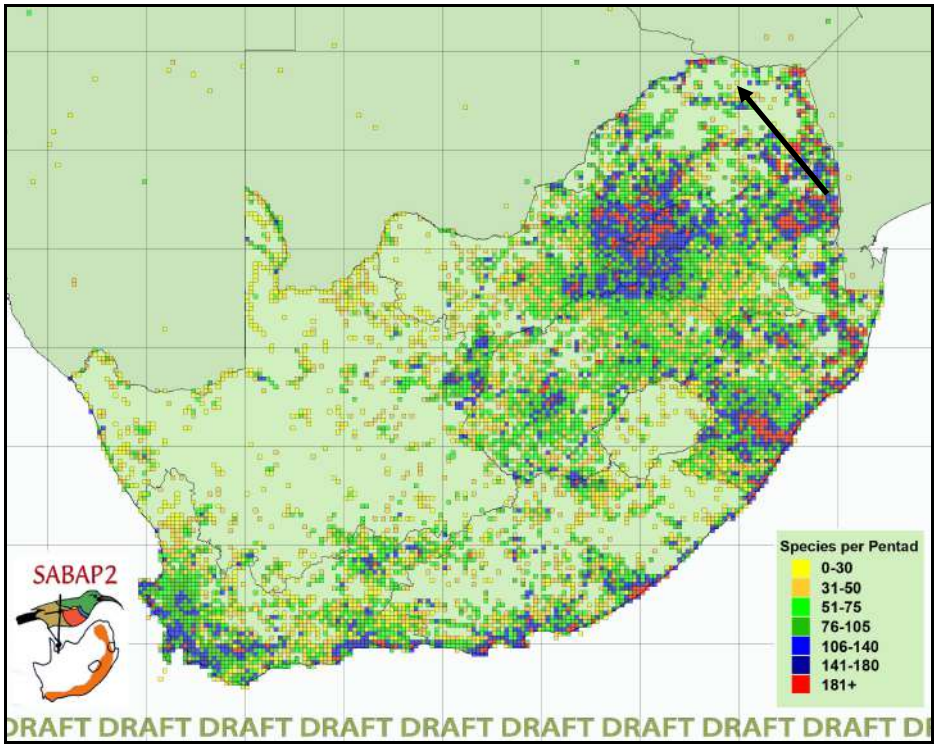


Figure 35: Bird species richness per pentad grid for South Africa (Map courtesy of SABAP2 and the Animal Demography Unit)

31.4.2 Local Perspective: Richness

The study area is expected to support 270 bird species of which 176 species were recorded during the respective surveys (refer **Appendix 2**). Therefore, the observed number of species represents 65 % of the expected number of species (refer **Table 26**). The observed species richness equates to 21 % of the approximate 854 species listed for South Africa (including Lesotho and Swaziland).

Table 27: Summary table of the total number of species, Red Listed species (Taylor et al., 2015; IUCN 2017), endemics and biome-restricted species (Marnewick et al., 2015) expected to occur and observed within the proposed study area

	*Expected***	*Observed***
Total number of species*	270 (32 %)	176 (65 %)
Number of Red Listed species (Taylor et al., 2015 & IUCN 2017)*	14 (9 %)	4 (31 %)
Number of biome-restricted species (Marnewick et al., 2015 – Zambezian, East african Coast & Kalahari-Highveld Biome)*	6 (23 %)	6 (100 %)
Number of local endemics (BirdLife SA, 2017)*	0	0
Number of local near-endemics (BirdLife SA,2017)*	2 (7 %)	0
Number of regional endemics (Hockey *et al.* 2005)**	6 (6 %)	2 (33 %)
Number of regional near-endemics (Hockey *et al.* 2005)**	19 (31 %)	14 (74 %)

** only species in the geographic boundaries of South Africa (including Lesotho and Swaziland) were considered.*

*** only species in the geographic boundaries of southern Africa (including Namibia, Botswana, Zimbabwe and Mozambique south of the Zambezi River) were considered*

**** Percentage values in brackets refer to derived totals compared against the South African avifauna (Expected) and those species expected to occur on the study area (Observed)*

The observed totals are well within the limit (> 50 %; refer **Table 25**) of the number of expected species and provide a realistic indication of the thoroughness and general coverage of the study area during the respective surveys. In support of the aforementioned statement, it is evident that the species accumulation curve across sampled point counts has reached a saturation threshold (refer **Figure 36**). Although the expected richness of bird species for the area is high, it is poorly represented by local and regional endemic species, although containing 30 % of the regional near-endemic species. The latter are mainly arid thornveld species with distribution ranges centred on the Kalahari-Highveld. In addition, the study area provides habitat for several biome-restricted species, and it contains six of the 26 biome-restricted species (Zambezian, East Coast Littoral and Kalahari-Highveld biome) in South Africa. One of the six species are restricted to East Cost Littoral (c. Brown-headed Parrot *Poicephalus cryptoxanthus*) and reaches its western distributional limit on the study area.

Please note that the expected species composition include waterfowl taxa (Anatidae) and stork species (Ciconiidae) which will only be present during exceptionally wet years. Normally these species are absent or rare on the study area due to the absence of suitable surface water habitat.

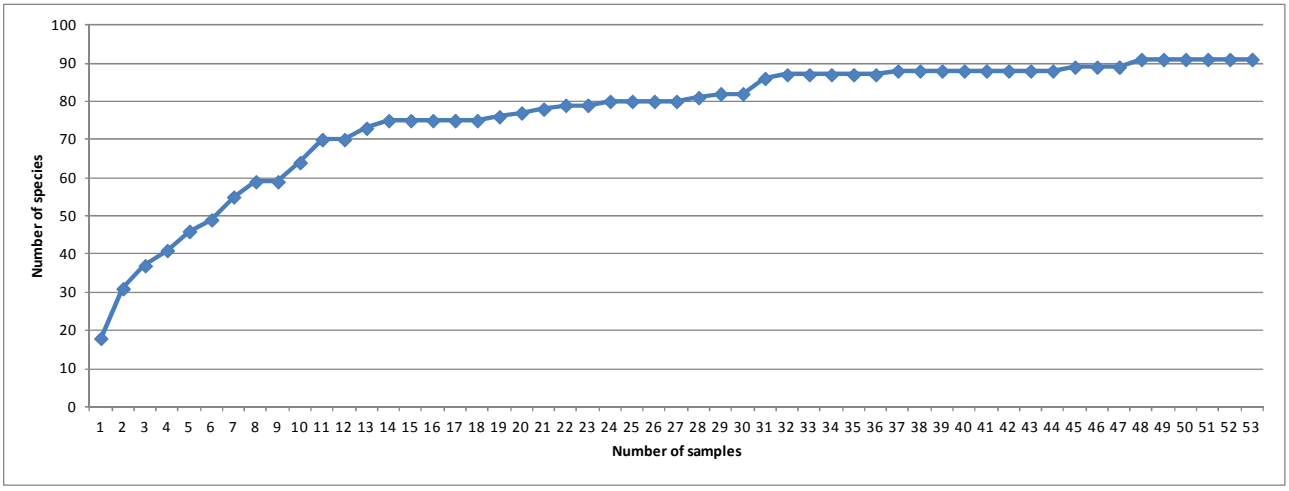


Figure 36: Species accumulation curve based on terrestrial bird counts

31.4.3 Dominance & Rarity (low abundance species)

The dominant (typical) species across all habitat types on the study area are presented in **Table 27**. Only those species that cumulatively contributed to more than 90% of the overall similarity are listed. It is evident that the seven most dominant species (#1-7 in **Table 27**) are present in nearly every mixed species flock. In addition, most of the species are invariably obligate insectivorous, although a few are also facultative granivores. However, most of the species are widespread in the Savanna Biome and are present in almost every Bushveld Bioregion as defined by Mucina and Rutherford (2006), apart from Barred Wren-warbler (*Calamonastes fasciolatus*). The latter is restricted to the Kalahari-Highveld biome (Marnewick et al., 2015) and is abundant on the study area.

Table 28: Dominant bird species recorded in the study area			
Species	*Average abundance*	*Consistency*	*Percentage Contribution*
1. White-browed Scrub Robin (*Cercotrichas leucophrys*)	1.23	1.9	11.33
2. Willow Warbler (*Phylloscopus trochilus*)	1.53	1.42	10.59
3. Long-billed Crombec (*Sylvietta rufescens*)	1.57	1.18	8.95
4. Cape Turtle Dove (*Streptopelia capicola*)	1.57	1.02	7.65
5. Southern Red-billed Hornbill (*Tockus rufirostris*)	1.47	0.89	7.42
6. Chinspot Batis (*Batis molitor*)	1.45	0.90	6.93
7. Barred Wren-warbler (*Calamonastes fasciolatus*)	0.83	0.97	5.89
8. Blue Waxbill (*Uraeginthus angolensis*)	1.30	0.71	5.04
9. Green-winged Pytilia (*Pytilia melba*)	1.21	0.65	4.33
10. Spotted Flycatcher (*Muscicapa striata*)	0.77	0.68	4.06
11. Golden-breasted Bunting (*Emberiza flaviventris*)	0.94	0.51	3.55
12. White-bellied Sunbird (*Cinnyris talatala*)	0.58	0.56	3.38
13. Brubru (*Nilaus afer*)	0.92	0.52	2.63
14. Acacia Pied Barbet (*Tricholaema leucomelas*)	0.49	0.47	1.85
15. Southern Black Tit (*Melaniparus niger*)	0.77	0.39	1.58
16. Yellow-fronted Canary (*Crithagra mozambicus*)	0.58	0.36	1.45
17. Fork-tailed Drongo (*Dicrurus adsimilis*)	0.45	0.37	1.39
18. Southern Grey-headed Sparrow (*Passer diffuses*)	0.74	0.34	1.26
10. Sabota Lark (*Calendulauda sabota*)	0.51	0.32	1.10

Most of the low abundance species include taxa that are partial to specific habitat requirements, which were spatially restricted on the study area. For example, many of the species listed in **Table 27** (*c*. 30 %) are confined to inundated depressions and pans or are cavity-nesting species dependent on dead trees, or are restricted to tall woodland. These habitat types are patchy in the landscape and have a "density-dependant" effect on their numbers.

In addition, many of the other low abundant species are in fact widespread, but their numbers on the study area are severely limited due to the scarcity of their preferred habitat (e.g. impoundments and shoreline habitat).

Table 29: Low abundance (rare) species on the study area with contributions of < 0.01 %		
Species	*Av. Abundance*	*Habitat preference*
White-faced Duck (*Dendrocygna viduata*)	0.02	Surface water (dams, pans)
Wood Sandpiper (*Tringa glareola*)	0.02	Surface water with vegetated shoreline
Scaly-feathered Finch (*Sporopipes squamifrons*)	0.06	Short arid microphyllous woodland
Striped Kingfisher (*Halcyon chelicuti*)	0.04	Tall open woodland, with dead trees
Violet-eared Waxbill (*Granatina granatina*)	0.04	Short arid microphyllous woodland
Rufous-cheeked Nightjar (*Caprimulgus rufigena*)	0.02	Unspecified
Klaas's Cuckoo (*Chrysococcyx klaas*)	0.02	Unspecified
Little Grebe (*Tachybaptus ruficollis*)	0.04	Surface water (dams, pans)
Square-tailed Nightjar (*Caprimulgus fossii*)	0.02	Unspecified
Knob-billed Duck (*Sarkidiornis melanotos*)	0.02	Surface water (dams, pans)
Dark Chanting Goshawk (*Melierax metabates*)	0.02	Tall woodland
Dusky Lark (*Pinarocorys nigricans*)	0.02	Open woodland with sparse graminoid cover
Egyptian Goose (*Alopochen aegyptiaca*)	0.04	Surface water (dams, pans)
Blacksmith Lapwing (*Vanellus armatus*)	0.04	Surface water (dams, pans)
Bearded Scrub-robin (*Cercotrichas quadrivirgata*)	0.02	Dense woodland and thicket
African Golden Oriole (*Oriolus auratus*)	0.02	Tall woodland

Table 29: Low abundance (rare) species on the study area with contributions of < 0.01 %		
Species	*Av. Abundance*	*Habitat preference*
African Hawk-eagle (*Aquila spilogaster*)	0.02	Tall woodland
Black-chested Prinia (*Prinia flavicans*)	0.04	Short arid microphyllous woodland
Black-faced Waxbill (*Estrilda erythronotos*)	0.02	Short arid microphyllous woodland
Brown-hooded Kingfisher (*Halcyon albiventris*)	0.02	Unspecified

Many of these species were only recorded once during the point count surveys. However, the majority is widespread, but occurs naturally at low densities

31.4.4 Novelties and "out of range species"

Several observed bird species represents new or additional records for the area since they are either fully or marginally out of range according to their respective known distribution ranges. These species have simply not been observed in the region owing to the paucity of dedicated citizen scientists (e.g. the birding fraternity) visiting the area and issues revolving around access to the farms (which were privately owned farms). However, these observations include overlooked species that were not previously recorded in the area during SABAP1 ("full out of range" species), which include the following:

» Brown-headed Parrot (*Poicephalus cryptoxanthus*) - localised and restricted to large *Adansonia digitata* trees. The occurrence of this species represents a westward extension of its known distribution range, where it also co-occur with Meyer's Parrot (*P. meyeri*).
» Marsh Warbler (*Acrocephalus palustris*) - a fairly common Palearctic migrant in *Grewia* thicket and most individuals represent birds on passage.
» Black-winged Stilt (*Himantopus himantopus*) - a shorebird along the edges of dams and pans. Probably nomadic in response to habitat availability.
» Bushveld Pipit (*Anthus caffer*) - an uncommon resident confined to broad-leaved woodland on deep sandy soils.
» Buffy Pipit (*Anthus vaalensis*) - a common visitor to pioneer and early successional habitat.
» Icterine Warbler (*Hippolais icterina*) - an uncommon Palearctic migrant confined to *Vachellia* and *Senegalia* trees.
» Crested Guineafowl (*Guttera pucherani eduardi*) - an unobtrusive species more commonly associated with thickets and forest habitat of the Soutpansberg (refer **Figure 38**).

The following species represent marginal out of range species that were not recorded since the inception of SABAP2:

» White-faced Duck (*Dendrocygna viduata*) - a common species in the area if surface water is prevalent.
» Cape Penduline Tit (*Anthoscopus minuta*) - a fairly common species restricted to arid thornveld. The study site represents probably the eastern limit of its distribution.

Figure 38: An example of a Crested Guineafowl (*Guttera pucherani eduardi*) on the study site - a full out of range species

31.4.5 Community Structure & Species Composition

A cluster analysis of the bird abundance values and composition suggests six bird associations (apart from an outlier group) based on vegetation structure, floristic dominance and the presence of surface water (refer **Figure 39**). It was evident that the compositional difference between the undifferentiated mopani woodlands and the secondary woodland was negligible, although the latter assemblage was discussed as a variation of the dominant bird assemblage on the area. One sampling site represents an outlier, which contained very few species due to extreme heat and timing of the day, which was not conducive towards peak bird activity patterns.

The main avifaunal associations on the study area are as follow (according to a clustering ordination):

1 *An association confined to undifferentiated mixed woodland*: This association is widespread and prominent on the study area and often referred to as the dominant bird assemblage. It is characterised by multi-species flocks, which tend to forage together and minimizing inter-specific competition between them by exploiting different niches (by feeding in different ways and different levels in the canopy). The bird composition is typified by Long-billed Crombec (*Sylvietta rufescens*), White-browed Scrub-robin (*Cercotrichas leucophrys*), Southern Red-billed Hornbill (*Tockus rufirostris*), Barred Wren-warbler (*Calamonastes fasciolatus*), Blue Waxbill (*Uraeginthus angolensis*), Chinspot Batis (*Batis molitor*) and Cape Turtle Dove (*Streptopelia capicola*). In summer, it

provides habitat for Spotted Flycatcher (*Muscicapa striata*) and Willow Warbler (*Phylloscopus trochilus*).

Indicator species with a high abundance in this habitat (species largely restricted to this habitat on the study area) include Fork-tailed Drongo (*Dicrurus adsimilis*), Yellow-fronted Canary (*Crithagra mozambicus*), Violet-backed Starling (*Cinnyricinclus leucogaster*), Common Scimitarbill (*Rhinopomastus cyanomelas*) and Red-backed Shrike (*Lanius collurio*).

A variation of this assemblage contains arid Thornveld species confined to the *Vachellia tortilis* secondary woodlands. Typical species include many transient or nomadic taxa such as Red-billed Quelea (*Quelea quelea*) and Sabota Lark (*Calendulauda sabota*), with the remainder of the species similar to the aforementioned. However, discriminant taxa include granivorous taxa such as Violet-eared Waxbill (*Granatina granatina*), Black-faced Waxbill (*Estrilda erythronotos*), Crimson-breasted Shrike (*Laniarius atrococcineus*), Cape Penduline Tit (*Anthoscopus minutus*), Burned-necked Eremomela (*Eremomela usticollis*), Scaly-feathered Finch (*Sporopipes squamifrons*) and Namaqua Dove (*Oena capensis*).

2 *An association confined to areas with surface water (e.g. dams)*: This association is prominent on areas where surface water accumulates or persists such as inundated dams and pans. It consists primarily of waterbirds and shorebirds such as Little Grebe (*Tachybaptus ruficollis*), Egyptian Goose (*Alopochen aegyptiaca*), Knob-billed Duck (*Sarkidiornis melanotos*), White-faced Duck (*Dendrocygna viduata*), Black-winged Stilt (*Himantopus himantopus*), Blacksmith Lapwing (*Vanellus armatus*) and two Palearctic wader species such as Wood Sandpiper (*Tringa glareola*) and Common Sandpiper (*Actitis hypoleucos*).

In addition, the dams and inundated pans provide ephemeral foraging habitat for two threatened stork species namely the endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*) and the vulnerable Black Stork (*Ciconia nigra*).

3 *An association confined to homogenous stands of Colophospermum mopani*: This association is widespread and essentially similar in composition to the undifferentiated mixed mopani woodlands. It is restricted to dense homogenous stands of *Colophospermum mopani* with a high abundance of Chinspot Batis (*Batis molitor*), White-bellied Sunbird (*Cynnyris talatala*) and Grey-backed Camaroptera (*Camaroptera brevicaudata*). It is the only habitat which provide roosting habitat on the study site for Square-tailed Nightjar (*Caprimulgus fossii*) and a high numerical abundance of Black-headed Oriole (*Oriolus larvatus*).

4 *An association confined to stunted Colophospermum mopani along watercourses*: This association is invariably associated with short mopani woodland along seasonal watercourses. It shares a composition with that of the undifferentiated woodland type although it holds higher numbers of Cape Turtle Dove (*Streptopelia capicola*), Red-faced Mousebird (*Urocolius indicus*) and Red-billed Buffalo Weaver (*Bubalornis niger*).

5 *An association confined to natural pans*: This association is confined to the natural panveld (when dry) dominated by large *Combretum imberbe* trees. It shares a composition with that of the undifferentiated woodland type although it holds higher numbers of White-crested Helmet-shrike (*Prionops plumatus*), Green-winged Pytilia (*Pytilia melba*), Red-headed Weaver (*Anaplectes rubriceps*) and Golden-tailed Woodpecker (*Campethera abingoni*). It is one of the few habitat types containing African Golden Oriole (*Oriolus auratus*).

6 *An association confined to calcrete plains and outcrops*: This association is confined to the calcrete plains and quartz outcrops which mainly occur on Farm Vrienden. It also shares a composition with that of the undifferentiated woodland type, but holds significant numbers of Golden-breasted Bunting (*Emberiza flaviventris*). Apart from the latter differences, the composition on this habitat type is similar to the remainder of the Farm Vrienden.

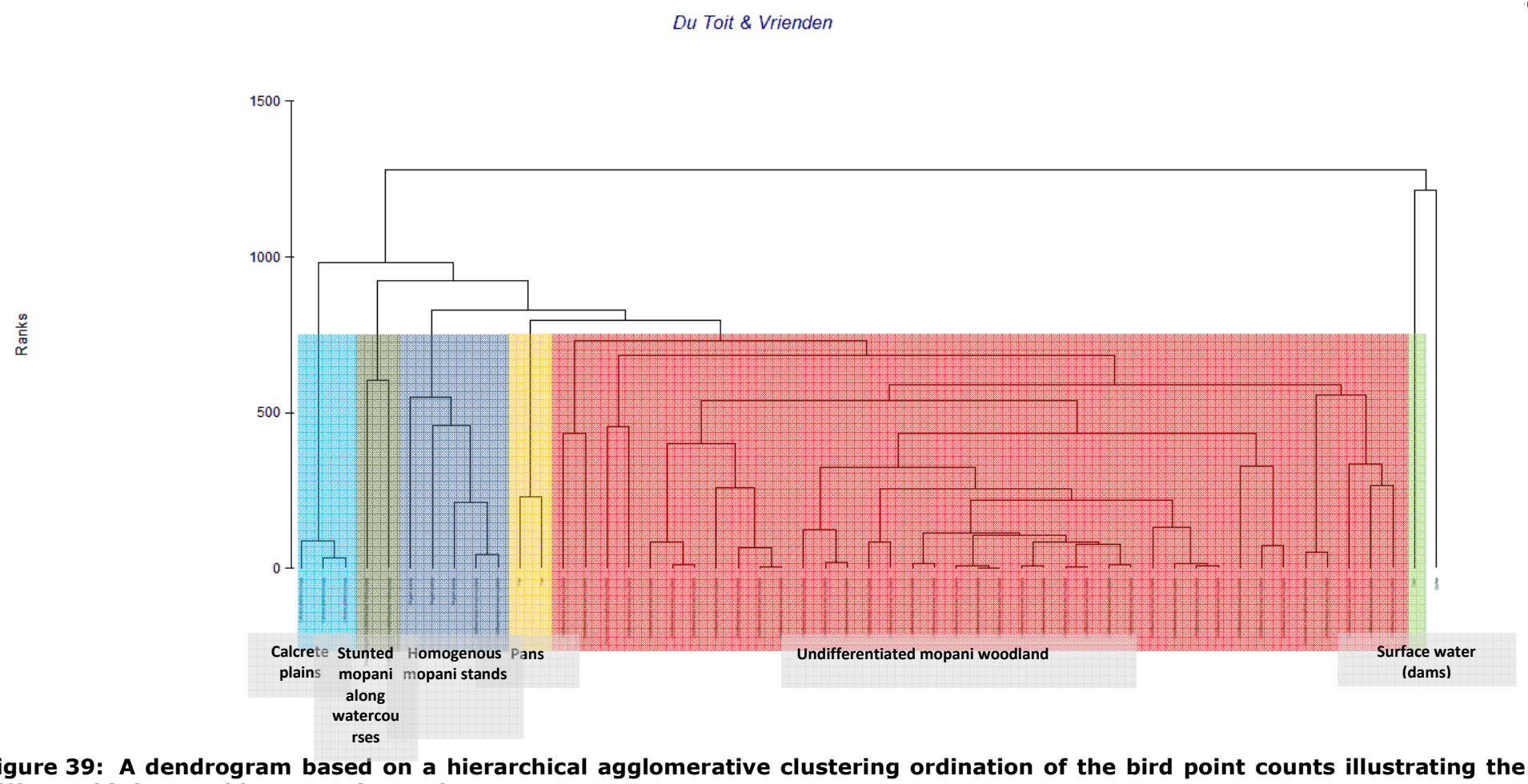


Figure 39: A dendrogram based on a hierarchical agglomerative clustering ordination of the bird point counts illustrating the different bird assemblages on the study area

31.5 Species Diversity & Habitat Specialists

It was evident from the results that avian associations pertaining to the undifferentiated mixed woodland holds the highest number of species, followed by the secondary microphyllous woodlands and panveld habitat (c. expected number of species; **Table 29** and **Figure 40.** Associations with low diversities occur on the calcrete plains while the remainder of the habitat types hold intermediate diversities. Nevertheless, perturbed habitat types such as the secondary woodlands support high numbers of bird individuals which explain a low evenness with many transient seed-eaters flocking on this particular habitat type.

Areas with surface water, specifically inundated dams and pans, provide habitat for specialist such as waterbird and shorebird taxa, which were ominously absent from the terrestrial habitat types.

Table 30: Summary of the observed species richness for four prominent bird compositions

Avian association	*Number of species*	*Mean number of individuals*	*H'*	*Expected number of species (n=25)*
Undifferentiated mixed woodland	75	33	3.78	25.90
Secondary microphyllous woodland	34	72	2.71	20.04
Panveld (with *Combretum imberbe*)	27	40	2.97	17.69
Homogenous Mopani stands	23	17	2.99	15.04
Stunted Mopani woodland along watercourses	20	26	2.79	14.69
Areas with surface water (dams, pans)	17	46	1.93	15.67
Calcrete plains and outcrops	10	10	2.19	8.62

H' – Shannon-Weaver diversity index (H_{loge})

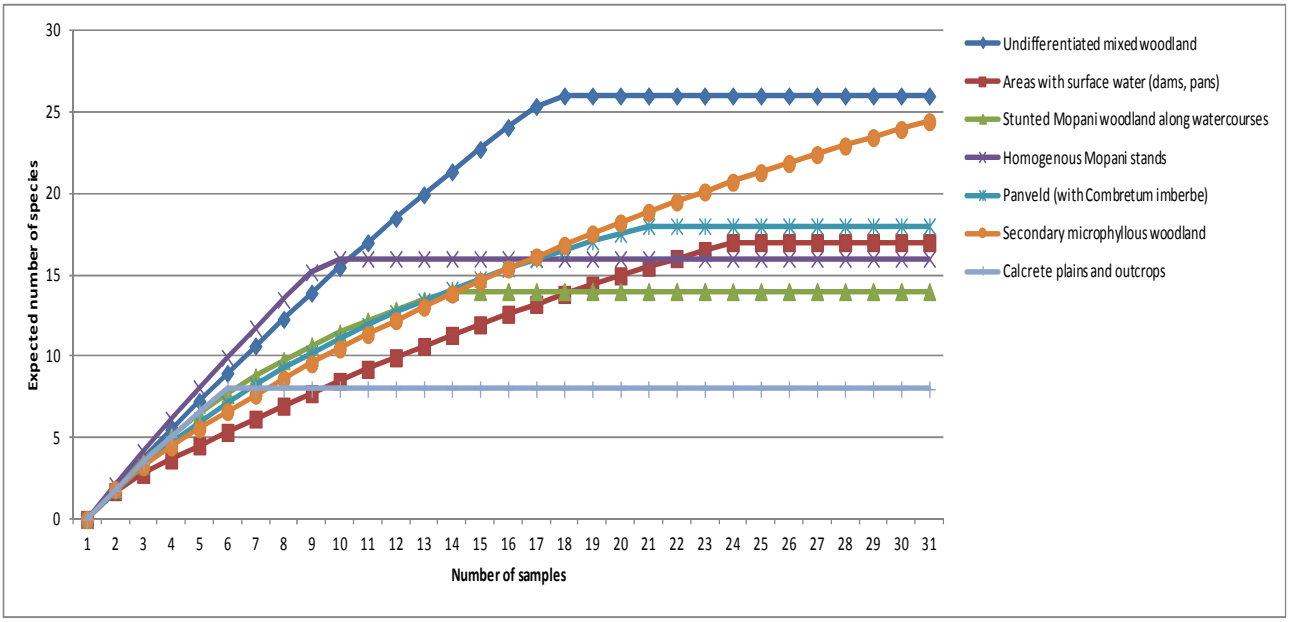


Figure 40: Rarefaction curves illustrating species diversities between the different avifaunal associations.

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31.6 Species of Conservation Concern

Table 30 provides an overview of the threatened and near-threatened bird species that could occur on the study area based on their respective distribution ranges and the presence of suitable habitat. According to **Table 30**, 14 species are known to occur in the region of which five species are expected to be regular. Six of the 14 species are globally threatened species and two are globally near-threatened, while 11 are regionally threatened species and three regionally near-threatened species. Noteworthy species **confirmed** from the study area include the regionally near-threatened Kori Bustard (*Ardeotis kori*), the critically endangered African White-backed Vulture (*Gyps africanus*), the vulnerable Black Stork (*Ciconia nigra*) and the endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*). The remaining species are regarded as uncommon or irregular residents and highly opportunistic foraging visitors to the area.

Table 31: Threatened and near threatened bird species that could utilise the proposed study area based on their known and historical distribution range and the presence of suitable habitat

Species	*Global Conservation Status**	*Regional Conservation Status***	*SABAP1 reporting rate*	*SABAP2 reporting rate*	*referred Habitat*	*ccurrence Status*
Aquila rapax (Tawny Eagle)	-	Endangered	13.04	It was not recently recorded from the area since 2007	Lowveld and Kalahari savannas, especially game farming areas and reserves.	An irregular foraging visitor. Its occurrence depends on the presence of carcasses.
Ardeotis kori (Kori Bustard)	Near-threatened	Near-threatened	39.13	27.78	Arid open lowland savanna and karroid shrub.	A fairly common resident and expected to be widespread on the study area (especially Farm Du Toit)
Bucorvus leadbeateri (Southern Ground Hornbill)	Vulnerable	Endangered	21.74	Only a single observation from the area during 12/08/2007	Mainly open woodland and large trees for roosting.	An uncommon resident to the area.
Ciconia abdimii (Abdim's Stork)	-	Near-threatened	7.14	5.56	Open stunted grassland, fallow land and agricultural fields.	An uncommon summer foraging visitor to areas consisting of secondary grassland or areas cleared of woodland.
Ciconia nigra (Black Stork)	-	Vulnerable	9.52	5.56	Breeds on steep cliffs within mountain ranges; forages on ephemeral wetlands.	A fairly common summer visitor to the pan depressions and dams in the area (when inundated). A single adult was confirmed from a pan on Du Toit during January 2017.
Ephippiorhynchus senegalensis (Saddle-billed Stork)	-	Endangered	-	5.56	Breed mainly in lowlands areas in large conservation areas. Forages along large lowland rivers or wetlands, including inundated pans and dams.	A fairly common foraging visitor to the pan depressions and dams in the area (when inundated). A pair was confirmed from a dam on Du Toit during January 2018.
Falco biarmicus (Lanner Falcon)	-	Vulnerable	10.77	5.56	Varied, but prefers to breed in mountainous areas.	An occasional foraging visitor to the study area. Partial to depressions and open woodland (utilised as hunting habitat).

Table 31: Threatened and near threatened bird species that could utilise the proposed study area based on their known and historical distribution range and the presence of suitable habitat

Species	*Global Conservation Status**	*Regional Conservation Status***	*SABAP1 reporting rate*	*SABAP2 reporting rate*	*referred Habitat*	*ccurrence Status*
Gyps africanus (White-backed Vulture)	Critically Endangered	Critically Endangered	12.12	5.56	Breed on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	An occasional foraging visitor to the area.
Gyps coprotheres (Cape Vulture)	Endangered	Endangered	12.31	It was not recently recorded from the area since 2007	Mainly confined to mountain ranges, especially near breeding colonies. Ventures far afield in search of food.	An uncommon and highly irregular foraging visitor - often in company with White-backed Vultures (*Gyps africanus*).
Leptoptilos crumeniferus (Marabou Stork)	-	Near-threatened	-	It was not recently recorded from the area since 2007	Varied, from savanna to wetlands, pans and floodplains – dependant of game farming areas	An irregular foraging visitor - often encountered at pans.
Polemaetus bellicosus (Martial Eagle)	Vulnerable	Endangered	17.39	It was not recently recorded from the area since 2007	Varied, from open karroid shrub to lowland savanna.	An uncommon foraging visitor.
Sagittarius serpentarius (Secretarybird)	Vulnerable	Vulnerable	21.74	It was not recently recorded from the area since 2007	Prefers open grassland or lightly wooded habitat.	Regarded as a fairly common visitor to the secondary and open woodland. It will share the same habitat with Kori Bustard.
Terathopius ecaudatus (Bateleur)	Near-threatened	Endangered	13.51	It was not recently recorded from the area since 2007	Lowveld and Kalahari savanna; mainly on game farms and reserves.	An uncommon foraging visitor - access to carcasses regarded as important. Its occurrence may be more frequent in the area since it could have been overlooked in the area.
Aegypius tracheliotos (Lapped-faced Vulture)	Endangered	Endangered	21.43	It was not recently recorded from the area since 2007	Lowveld and Kalahari savanna; mainly on game farms and reserves.	An irregular foraging visitor

Conservation categories were used according to the IUCN (2017) and Taylor et al. (2015)**. Species highlighted in grey were confirmed during the respective surveys*

31.7 Annotations on Conservation Important Species

31.7.1 Kori Bustard (Ardeotis kori) - globally and nationally near threatened

Ardeotis kori is globally listed as near-threatened (BirdLife International 2013a) while a recent conservation assessment has downgraded it from regionally vulnerable to near threatened (Taylor et al., 2015). *A. kori* is a large terrestrial bird with a preference for lightly wooded savanna which is nowadays mainly encountered on larger conservation areas and game farms (Taylor et al., 2015; BirdLife International, 2013a). It was recorded five times in the region during SABAP2 and seven times during SABAP1, making it the most regularly observed bird species of conservation concern on the study area.

It is expected to be fairly common on the study area (refer **Figure 41**), with three observations pertaining to this species made during the survey. It is expected to be more abundant during the dry season when most of the undifferentiated woodland areas are accessible due to the sparse graminoid layer. It should be emphasised that collisions of birds with the game fence and overhead power lines are a real risk to the long-term survival of this species. However, it also utilises old cultivated land, which allows for unrestricted movement during foraging bouts. Therefore, this species has undoubtedly benefited from selective clearing of woodland areas, which facilitate unhindered movement and foraging of such a large-bodied species, and for this reason it will also utilise the secondary microphyllous woodlands during foraging bouts.

Although it could occur on nearly any part of the study area, optimal foraging habitat was primarily observed from Farm Du Toit. A satellite image illustrating the suitability of the study area for the occurrence of the regionally near threatened Kori Bustard (*Ardeotis kori*).

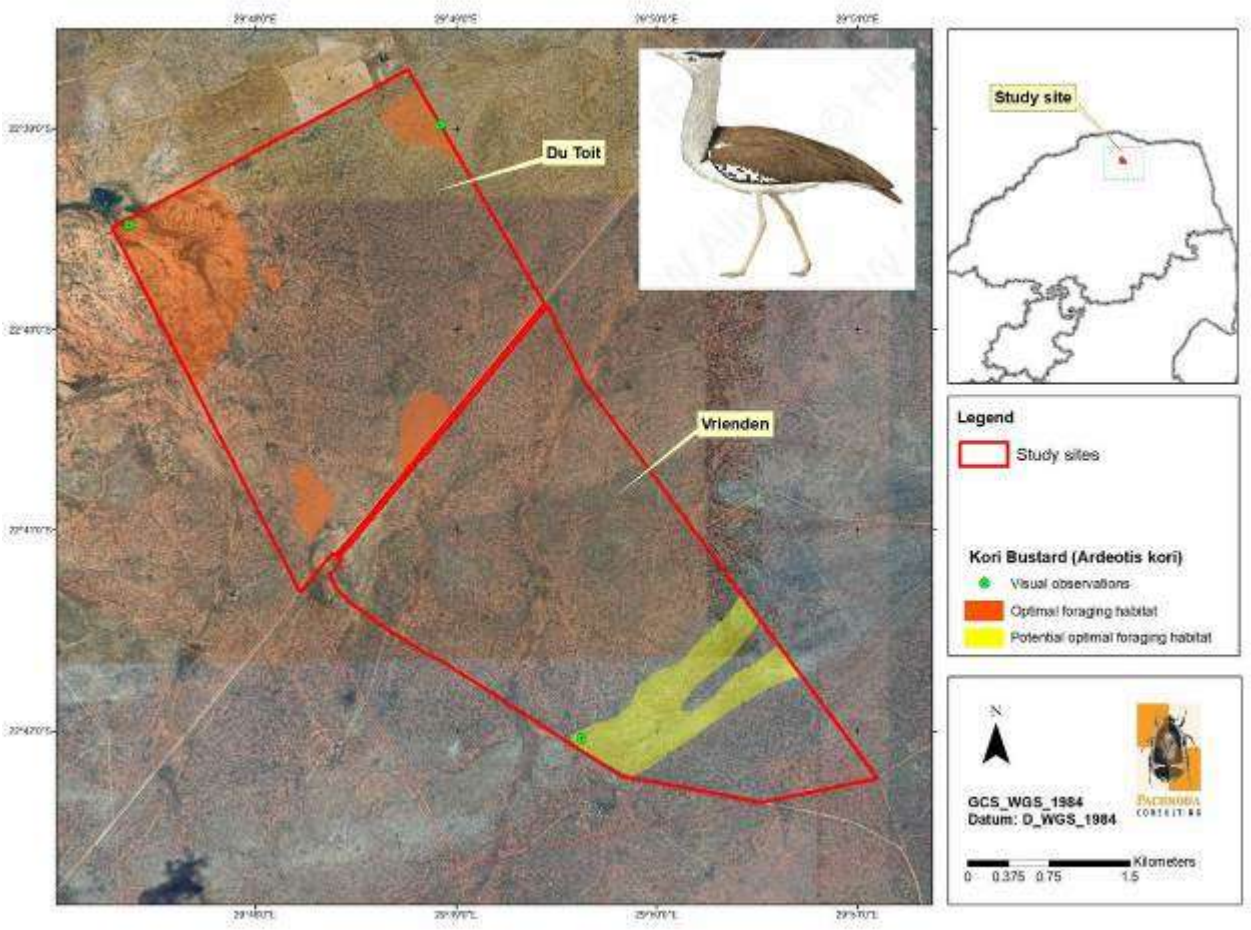

Figure 41: A map illustrating the occurrence of Kori Bustard (*Ardeotis kori*) on the study area
(please note that the species could utilise the entire study area although certain areas provide optimal foraging habitat where it is predicted to occur more regularly

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31.7.2 Storks (Ciconiidae)

Four (4) stork species of conservation concern are expected to be present on the study area, which include the regionally vulnerable Black Stork (*Ciconia nigra*), regionally near-threatened Abdim's Stork (*C. abdimii*), regionally near-threatened Marabou Stork (*Leptoptilos crumeniferus*) and the regionally endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*). The Black, Abdims and Saddle-billed Storks were only observed once in the area during SABAP2 along with two observations of Abdim's Storks during SABAP1. It clearly indicates that the occurrence of these species is highly dependent on the presence of surface water at habitat features such as pans and dams.

The pans and dams (when inundated) as observed on Farm Du Toit provide important ephemeral foraging habitat for stork taxa, especially Black and Saddle-billed Storks (both observed during the site survey) (refer **Figure 42** and **Figure 43**).

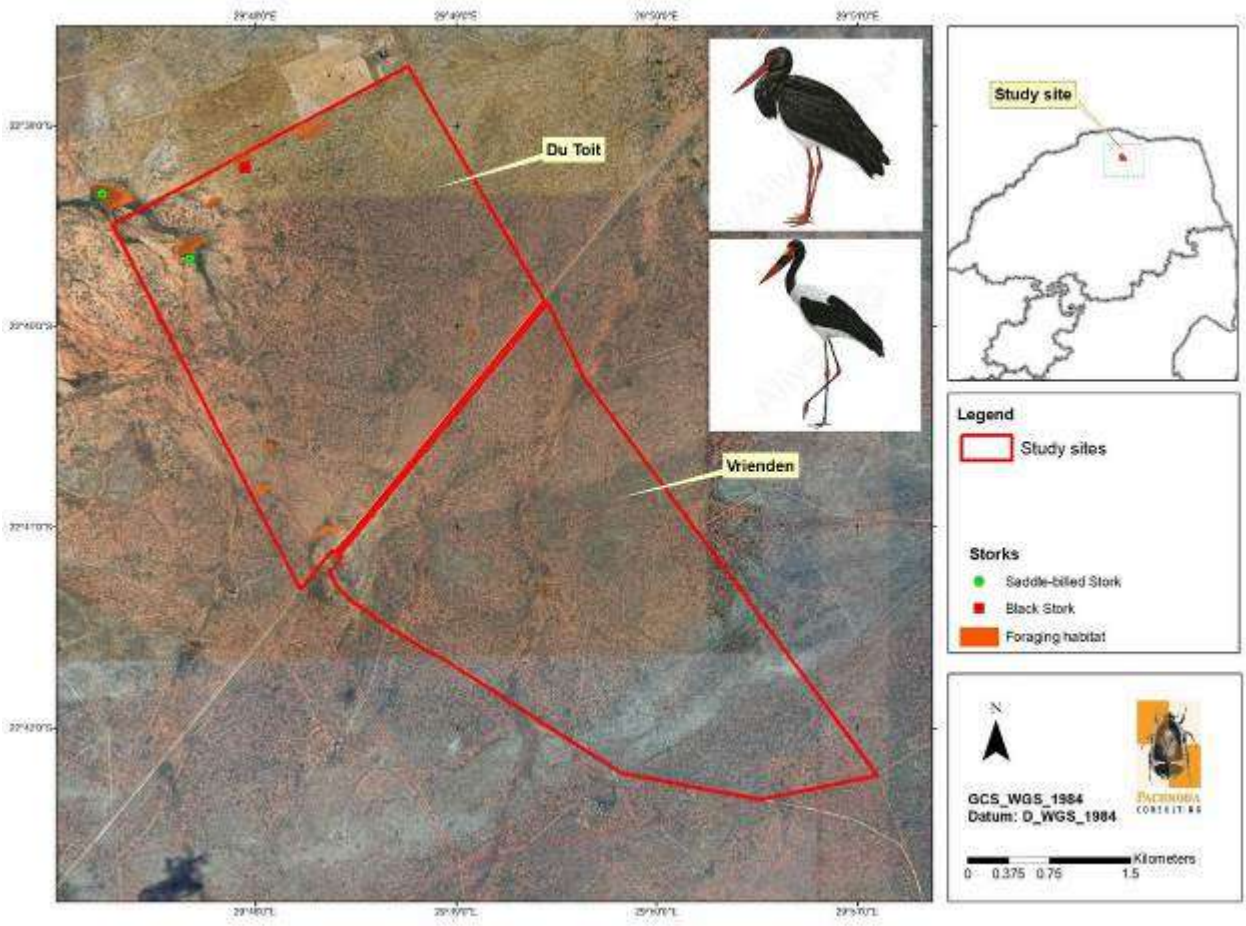

Figure 42: A map illustrating the occurrence of threatened stork taxa on the study area

Figure 43: An example of a pair of endangered Saddle-billed Storks (*Ephippiorhynchus senegalensis*) captured by trail cameras at a dam on the Farm Du Toit

31.7.3 Martial Eagle (Polemaetus bellicosus) - globally vulnerable and regionally endangered

P. bellicosus is globally listed as vulnerable (BirdLife International, 2013b) while a recent conservation assessment has upgraded it from regionally vulnerable to endangered (Taylor et al., 2015) due to rapid declines in South Africa during the last 10 years (owing to habitat loss and poisoning; Taylor et al., 2015). Although it has an extensive range across most of sub-Saharan Africa, it is nowhere common and generally occurs at low densities. *P. bellicosus* is a large and charismatic species that is more numerous in large conservation bodies although it also occurs on large game farms, or areas where human densities and activities remain sparse. It was not observed in the region during SABAP2 although it is known from three records during SABAP1.

However, it is regarded as an uncommon foraging visitor on the study area. It requires exceptionally large home ranges in excess of 130 km^2 (Brown et. al., 1982) and sometimes even up to 1 000 km^2, accentuating the importance of additional foraging habitat for the long-term survival of this species.

31.7.4 Scavenging Birds of Prey

Five species of large-bodied scavenging raptors are expected to be present. All of these were formerly listed as vulnerable or near threatened in South Africa (Barnes, 2000), but evidence according to regional declining trends has upgraded their status to the endangered and critically endangered categories (Taylor et al, 2015). Of these, only the White-backed Vulture (*Gyps africanus*) is considered as regular foraging visitors to the study area (refer **Figure 44**). The remaining species (Cape Vulture - *Gyps coprotheres*, Lappet-faced Vulture - *Torgos tracheliotos,* Bateleur - *Terathopius ecaudatus* and Tawny Eagle - *Aquila rapax*) are irregular and opportunistic since their occurrences are best explained by the presence of carcasses. In addition, only the White-backed Vulture was recently observed in the area (2018) and none of the species have been observed more than four times in the QDS during SABAP1.

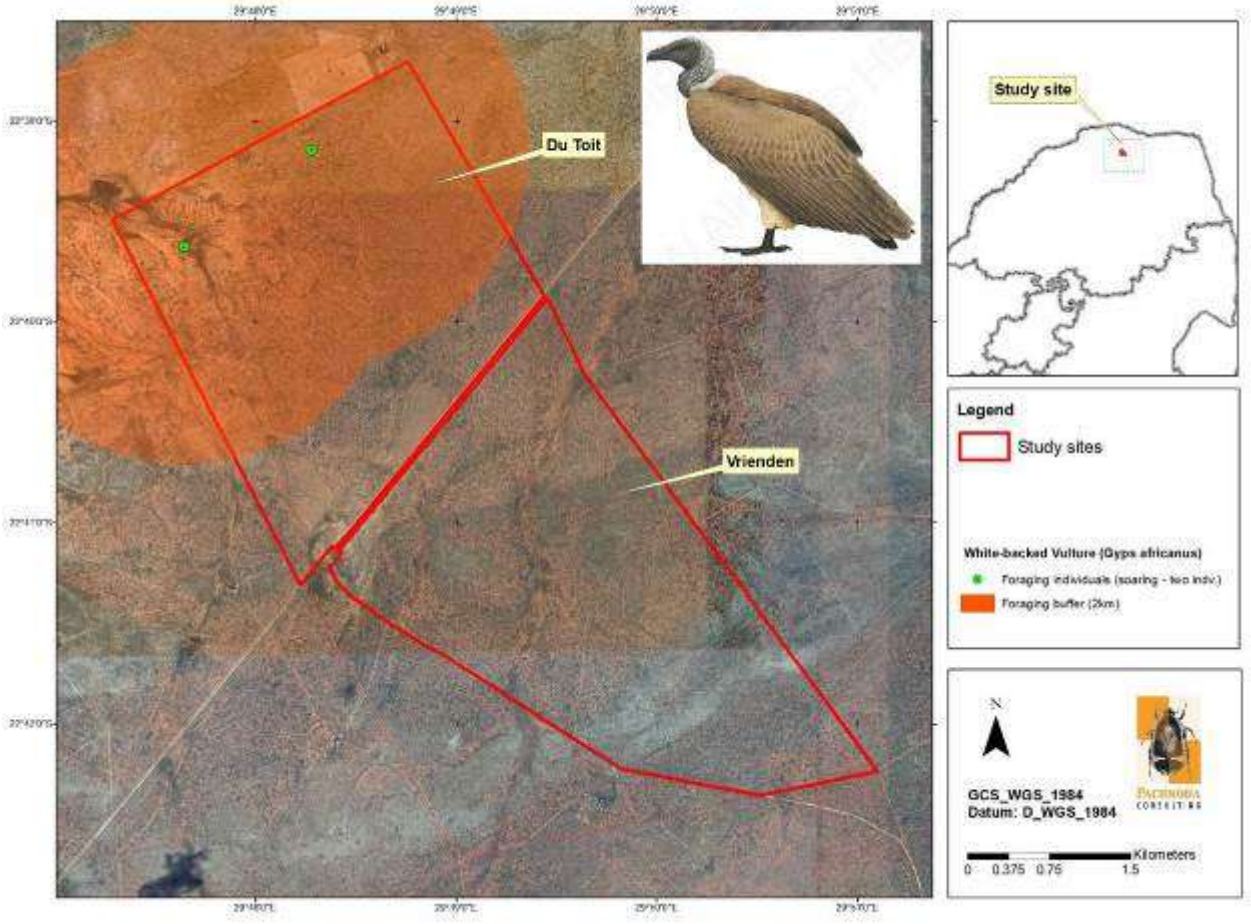

Figure 44: A map illustrating the occurrence of soaring White-backed Vultures (*Gyps africanus*) on the study area.

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31.7.5 Secretarybird (Sagittarius serpentarius) - globally and nationally vulnerable

This species was recently upgraded from near threatened to vulnerable (Taylor et al, 2015) since recent evidence suggests that it has experienced rapid declines across its entire range due to habitat loss, anthropogenic disturbances and intensive grazing. Secretarybirds are widespread in Africa south of the Sahara but have declined over most of their geographic distribution range. They prefer open areas, in particular open savanna and grassland, but tend to avoid areas of dense bush or very rocky areas. It was only observed from the study region during SABAP1 (4 records).

Although not observed during SABAP2, *S. serpentarius* is considered a regular foraging visitor on the study area. Owing to its preference for open and secondary woodland units, it is predicted to share a habitat in common with the Kori Bustard (*Ardeotis kori*).

31.7.6 Lanner Falcon (Falco biarmicus) - nationally vulnerable

F. biarmicus is a fairly common species within its global distribution range, where it occurs from south-eastern Europe to the Middle East, south-west Asia and across most of Africa (Jenkins, 2005). The global population consists of more than 30 000 breeding pairs with approximately 1 400 pairs confined to the eastern parts of South Africa (Tarboton & Allen, 1984). It was recently upgraded from Near threatened to Vulnerable in South Africa due to persistent transformation of suitable foraging habitat (open areas) to make way for agricultural land.

This species is often associated with ridges and mountain ranges where it prefers to nest on cliffs. It prefers to forage over open terrain and will hunt indiscriminately on almost any open area with suitable prey (mainly other terrestrial birds such as francolins and lapwings), although pans/water holes located within open woodland are preferred. It was only recorded once (2014) in the area during SABAP2 and only once during SABAP1. Its occurrence on the study area is regarded as occasional.

Iconic Birds of Prey

The occurrence frequency of iconic birds of prey (e.g. birds of prey larger than members of the genus *Accipiter*) can often be used to provide a general impression of the sensitivity of an area. In most instances, birds of prey are K-selected and therefore show extended breeding periods, extended periods before reaching sexual maturity and often produces small clutch sizes. They also live very long and often show high nesting site fidelities.

The Wahlberg's Eagle (*Hieraaetus wahlbergi*) is the most abundant raptor on the study site during the wet season. However, it was more frequently observed on Farm Du Toit, which also provided foraging habitat for a juvenile African Hawk-eagle (*Aquila spilogaster*). Foraging occurrences were less frequent on Farm Vrienden, although it provided foraging and roosting habitat for Brown Snake-eagle (*Circaetus cinereus*), while an active nest of a Dark chanting

Goshawk (*Melierax metabates*) occurs on the southern extent of the farm. Part of the snake-eagle foraging habitat also overlaps with that of Farm Du Toit (refer **Figure 45**).

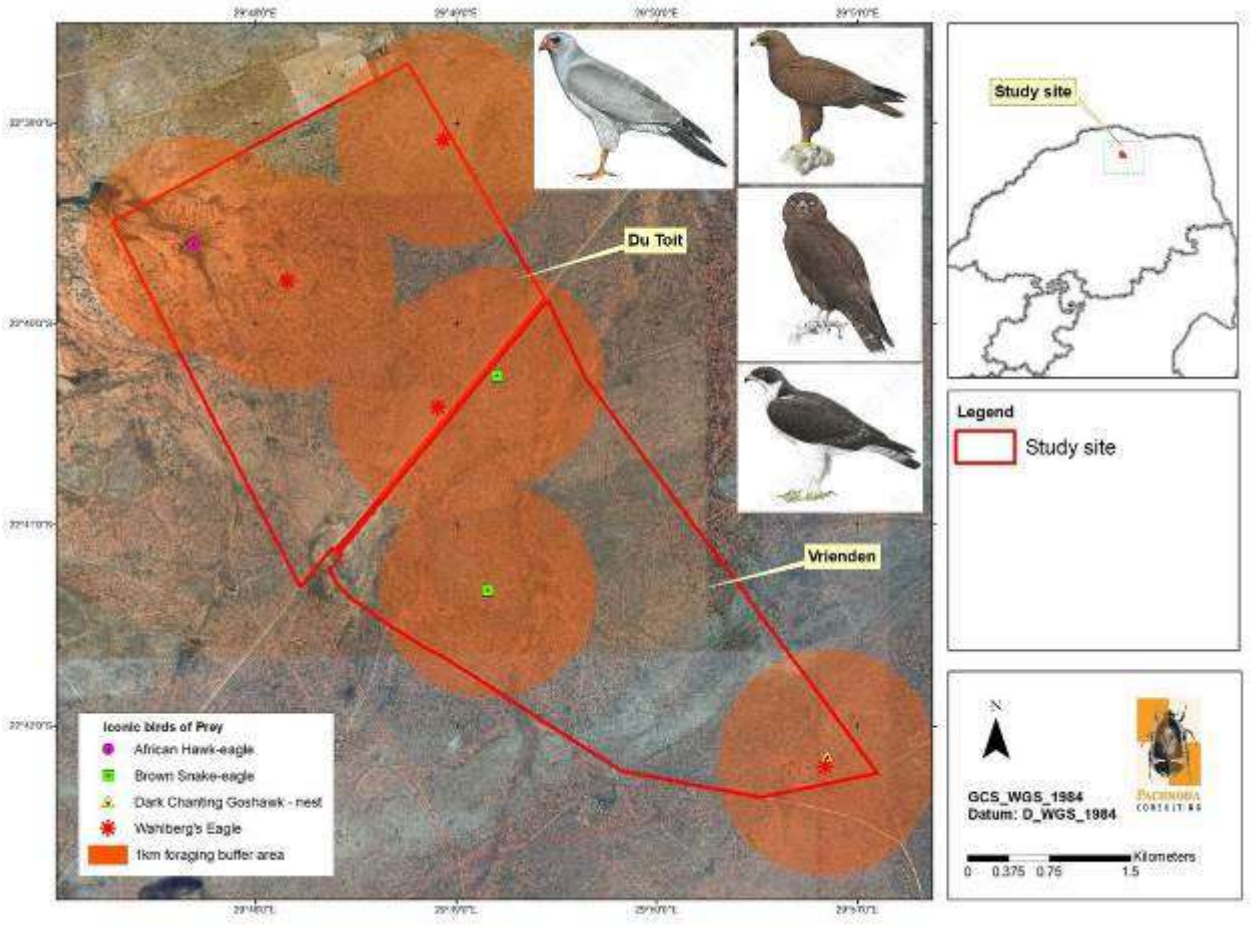

Figure 45: Foraging occurrences of birds of prey (non-threatened) on the study site.

31.8 Avifaunal Sensitivity

31.8.1 Areas with Very High Sensitivities

Areas with *Very High* sensitivities include all the natural depressions, pan, man-made dam features as well as focal roosting areas containing large trees (refer **Figure 46**):

» The natural depression pans on the study area provide ephemeral foraging habitat for wading bird species (including regionally threatened stork taxa) when inundated. These taxa are often absent from the surrounding dryland habitat types. They therefore contribute towards the regional avifaunal diversity.

» The natural depressions and dams (when inundated) provide essential breeding habitat for woodland waterfowl such as Knob-billed Duck (*Sarkidiornis melanotis*) which is dependent on these habitat types for reproduction.

» The tree layer surrounding the depressions and dams provide potential roosting habitat for regionally threatened scavenging birds of prey, and when inundated provide potential "bathing" opportunities for scavenging bird species and contribute toward avifaunal hygiene.

» Certain parts of Farm Du Toit contains open late-successional woodland that provide foraging habitat for the near threatened Kori Bustard (*Ardeotis kori*).
» The large *Adansonia digitata* trees provide nesting structure for many cavity-nesting species, Red-billed Buffalo Weavers as well as the localised Brown-headed Parrot. It also provides roosting and nesting opportunities for birds of prey.
» All seasonal watercourses are sensitive since they facilitate avian dispersal across the landscape, especially the passage of Palearctic migrants.

31.8.2 Areas with High Sensitivities

Areas with *High* sensitivities include all the seasonal watercourses (refer **Figure 46**):
» All seasonal watercourses are sensitive since they facilitate avian dispersal across the landscape, especially the passage of Palearctic migrants.
» Part of this habitat also provides optimal foraging habitat large terrestrial birds.

31.8.3 Areas with Medium-High Sensitivities

Areas with *medium-high* sensitivities include calcrete plains and outcrops (in part) (refer **Figure 46**):
» This habitat provides potential optimal foraging habitat for the near threatened Kori Bustard (*Ardeotis kori*) and vulnerable Secretarybird (*Sagittarius serpentarius*).

31.8.4 Areas with Medium Sensitivities

Areas with *medium* sensitivities include all other natural habitat including the secondary microphyllous woodland units (refer **Figure 46**):
» This habitat is widespread in the region and supports high numbers of bird species, including species restricted to the Kalahari-Highveld biome;
» These habitat units are natural and intact in the region, and sustain avifaunal species with widespread distribution ranges; and
» These habitat types maintain a high ecological connectivity with adjacent habitat types of similar floristic structure in the region.

31.8.5 Areas with Very Low Sensitivities

Areas with *Very Low* sensitivities include all anthropogenic habitat which include mainly infrastructure.

31.9 Key Avifaunal Features & Synthesis

Based on the results, the avifauna community on the study area is summarised in terms of the following key features:

» The study area supports a high diversity of bird species representing approximately 65 % of the regional richness (on a QDS level).

» In general, habitat diversity and heterogeneity were relatively low, and the woodland structure was monotonous across the area.

» This avifaunal community is not unique and poorly represented by South African endemics. The dominant composition is widespread in the region although it consists of many species with high affinities to the Kalahari-Highveld biome.

» Several threatened and near threatened species are expected to be present. The majority of these species requires large home range sizes, with many species occupying low densities. Noteworthy species include the regionally near-threatened Kori Bustard (*Ardeotis kori*), the regionally endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*) and the regionally vulnerable Black Stork (*Ciconia nigra*).

» The depressions, pans and dams have benefitted the colonisation of "specialised" bird taxa (mainly wader and wading bird species) that are of local importance and contribute towards the regional avifaunal diversity when inundated.

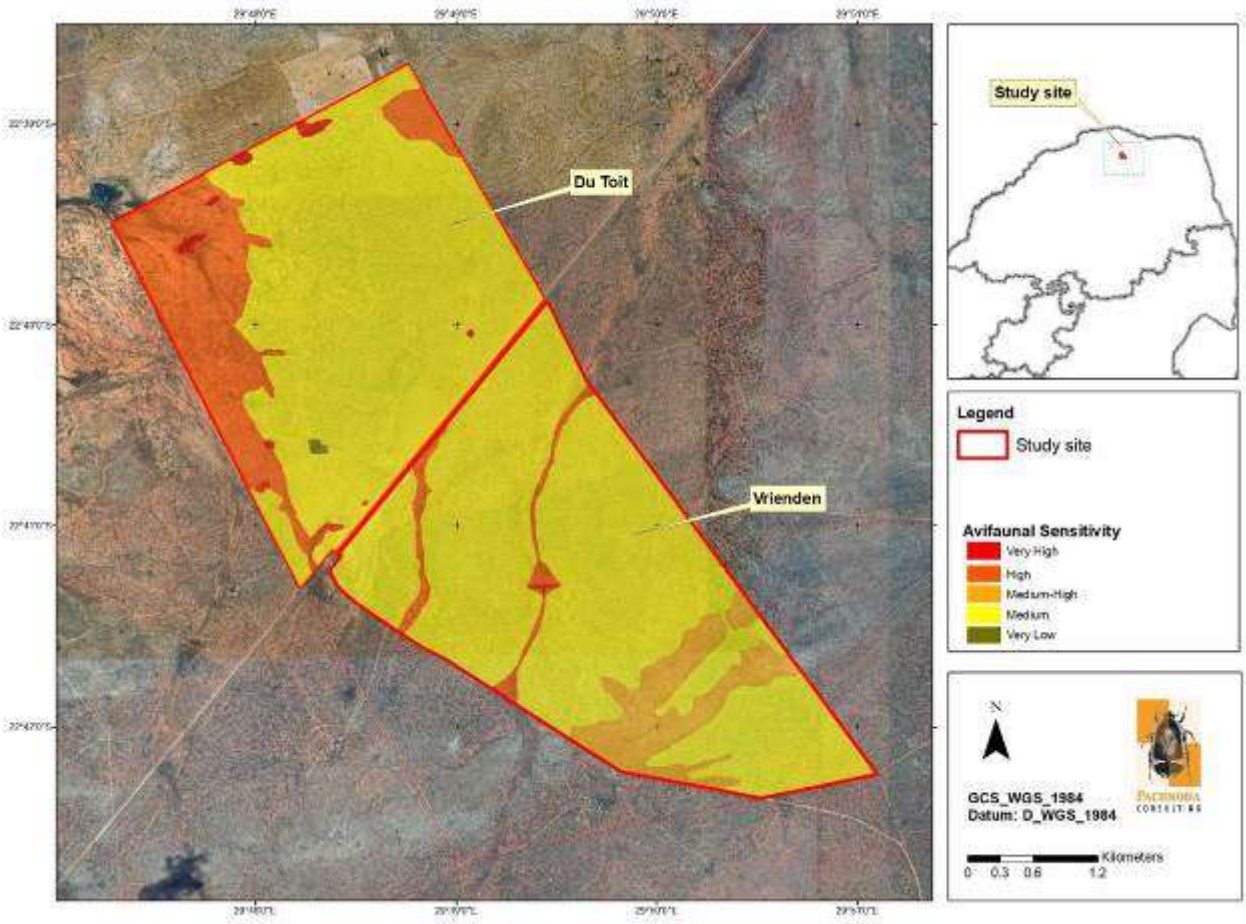

Figure 46: A sensitivity map of the study area based on the avifaunal habitat types and composition

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31.10 Analysis of Alternatives

Three alternatives in terms of the proposed infrastructure are proposed, which include a preferred (Option 1), second preferred (Option 2) and third or least preferred option (Option 3). The proposed infrastructure includes the following:

» an Ash dump totalling 120 ha in extent;
» an Ash dump run-off dam;
» a power plant of 30 ha;
» a plant run-off dam and raw water storage dam;
» a new access road and pipeline servitude;
» a new rail line;
» a new rail siding;
» a coal conveyer and ash conveyer; and
» a new transmission line feeding from the power plant into a nearby new transmission substation.

The alternatives differ from each other in terms of the spatial arrangement of the infrastructure, with most of the footprints located on Farm Vrienden, while one of the options (c. second preferred option) having 60 ha of the proposed ash dump also on Farm Du Toit.

31.11 Farm Du Toit vs Farm Vrienden: Bird richness and sensitivity

The habitat diversity on Farm Du Toit is higher when compared to Farm Vrienden, which also contain more azonal habitat types in the form of dams and ephemeral depressions. The latter were rare or absent on Vrienden. The higher number of habitat types is directly proportional to bird richness as evidenced by the higher number of bird species present on Du Toit in comparison to Vrienden (refer **Table 31**).

In addition, Du Toit also provides habitat for more habitat specialists (e.g. waterbirds and storks) and foraging birds of prey, thereby the surface area of sensitive habitat on Farm Du Toit is regarded to exceed those on Farm Vrienden. *Therefore, the Option 2 is less preferred from an avifaunal perspective since part of the ash dump is located on Du Toit*.

Table 32: Summary of the observed species richness on Farm Du Toit and Farm Vrienden

Farm	*Number of species*	*Mean number of individuals*	*H'*
Du Toit	80	31.92	3.76
Vrienden	66	31.75	3.70

H' – Shannon-Weaver diversity index (H_{loge})

31.12 Analysis of Options

31.12.1 Avifauna Sensitivity

The respective options are superimposed over the avifaunal sensitivity with the following outcomes (refer **Figure 47**):

» **Option 1**: The infrastructure is contained on Farm Vrienden (as opposed to Du Toit, see aforementioned section) and contravene mainly natural habitat of medium avifaunal sensitivity. However, concerns regarding Option 1 include the geographic placement of the new access road and rail and the natural drainage patterns of the ash dump area.

The new access road and rail will transverse an area of calcrete plains that are often utilised by Kori Bustards (*Ardeotis kori*) during foraging bouts. In addition, the road and rail will also displace the nesting site/breeding success of a Dark Chanting Goshawk (*Melierax metabates*). In addition, the road will facilitate habitat fragmentation. *Please note that the location of the road and rail is constant across all proposed options and the impacts related to the road will remain the same for all three proposed options*.

The proposed ash dump locality corresponds to a number of ill-defined drainage lines which could contribute towards accidental pollution of the main drainage line located west of the proposed ash dump locality.

» **Option 2**: The infrastructure is contained on Farm Vrienden with part of the ash dump located on Du Toit.

The new access road and rail will transverse an area of calcrete plains that are often utilised by Kori Bustards (*Ardeotis kori*) during foraging bouts. In addition, the road and rail will also displace the nesting site/breeding success of a Dark Chanting Goshawk (*Melierax metabates*). In addition, the road will facilitate habitat fragmentation. *Please note that the location of the road and rail is constant across all proposed options and the impacts related to the road will remain the same for all three proposed options*.

The ash conveyer encompasses a large surface area, which also traverses natural open woodland. Assuming that the conveyer is to be fenced, it is possible that the fence will induce a "barrier effect" on animal dispersal while large terrestrial bird species such as bustards may even collide with the fence structure.

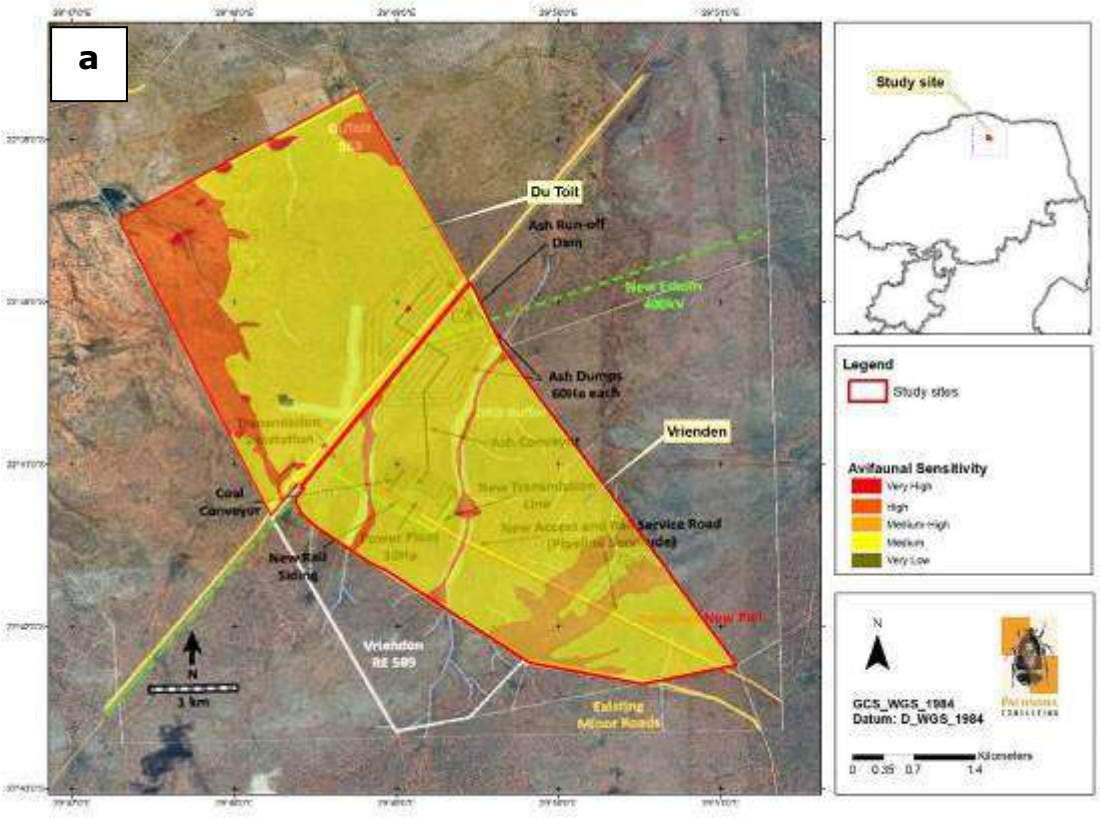
This option is least preferred from an avifaunal perspective, mainly due to the high richness of birds and habitat types on Farm du Toit, and also owing to the potential loss of a small pan corresponding to the ash dump locality on Du Toit.

» **Option 3**: The infrastructure is contained on Farm Vrienden (as opposed to Du Toit, see aforementioned section) and contravene mainly natural habitat of medium avifaunal sensitivity. However, concerns regarding Option 3 include the geographic placement of the new access road and rail service.

The new access road and rail will transverse an area of calcrete plains that are often utilised by Kori Bustards (*Ardeotis kori*) during foraging bouts. In addition, the road and rail will also displace the nesting site/breeding success of a Dark Chanting Goshawk (*Melierax metabates*). In addition, the road will facilitate habitat fragmentation. *Please*

note that the location of the road and rail is constant across all proposed options and the impacts related to the road will remain the same for all three proposed options.

The proposed ash dump is located between two drainage lines of which the ash conveyer will be positioned on the ash dump, thereby limiting potential fragmentation and barrier effects.



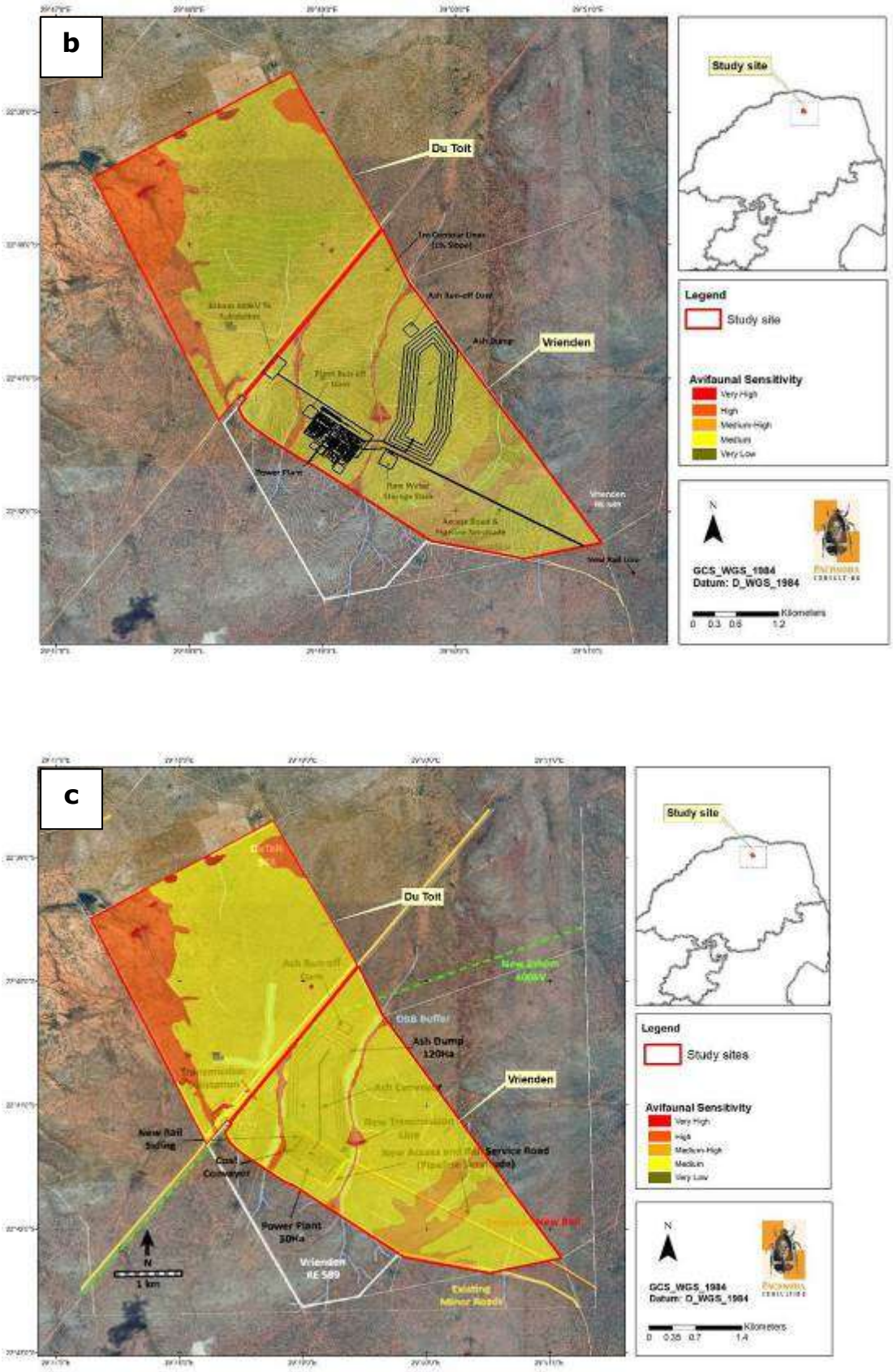
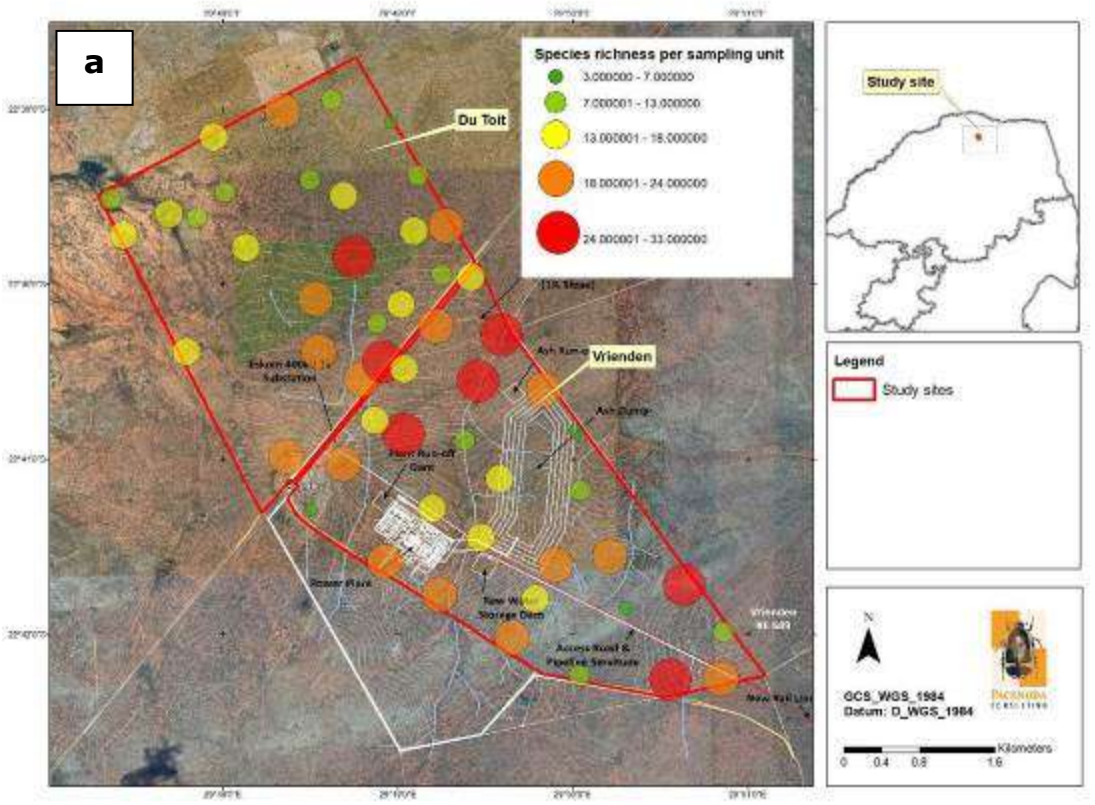


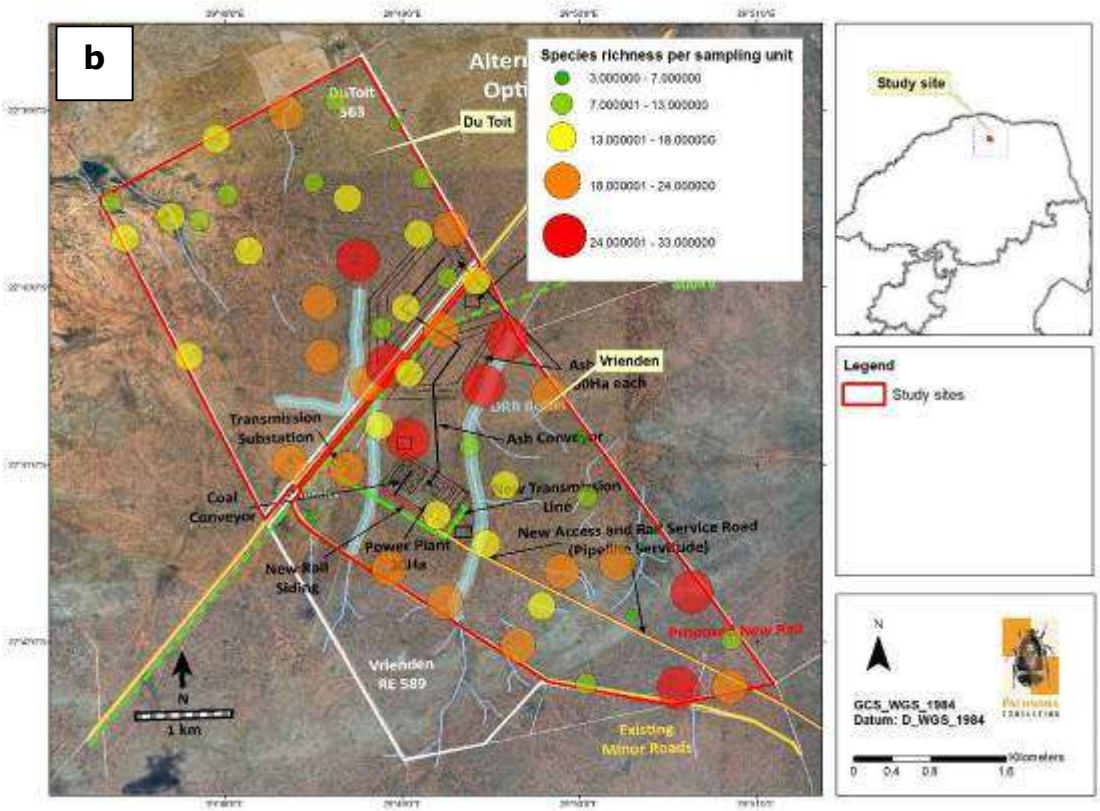
Figure 47: Collage of the spatial position of the proposed alternatives (options) in relation to avifaunal sensitivity: (a) Option 1, (b) Option 2 and (c) Option 3

31.12.2 Avifauna Richness and Abundance

The respective options are superimposed over the relative avifaunal richness (mean number of bird species per sampling unit) and relative abundance (mean number of individuals per sampling unit) with the following outcomes (refer **Figures 48 and 49**).

» **Option 1**: Option 1 corresponds to an area/habitat with lower richness and abundance values when compared to Option 2 and Option 3.
» **Option 2**: Option 2 cumulatively corresponds to an area/habitat with higher richness and abundance values when compared to Option 1 and Option 3.
» **Option 3**: Option 3 corresponds to an area/habitat with higher richness and abundance values when compared to Option 1 although cumulative values are less when compared to Option 2.


a
Species richness per sampling unit
3.000000 - 7.000000
7.000001 - 13.000000
13.000001 - 18.000000
18.000001 - 24.000000
24.000001 - 33.000000
Du Toit
Vrienden
Study site
Legend
Study sites
GCS_WGS_1984
Datum: D_WGS_1984
Kilometers
0 0.4 0.8 1.6


b
Species richness per sampling unit
3.000000 - 7.000000
7.000001 - 13.000000
13.000001 - 18.000000
18.000001 - 24.000000
24.000001 - 33.000000
Du Toit
Vrienden
Transmission Substation
Coal Conveyor
Power Plant
New Rail Siding
Vrienden RE 589
Existing Minor Roads
N
1 km
Study site
Legend
Study sites
GCS_WGS_1984
Datum: D_WGS_1984
Kilometers
0 0.4 0.8 1.6

Section E

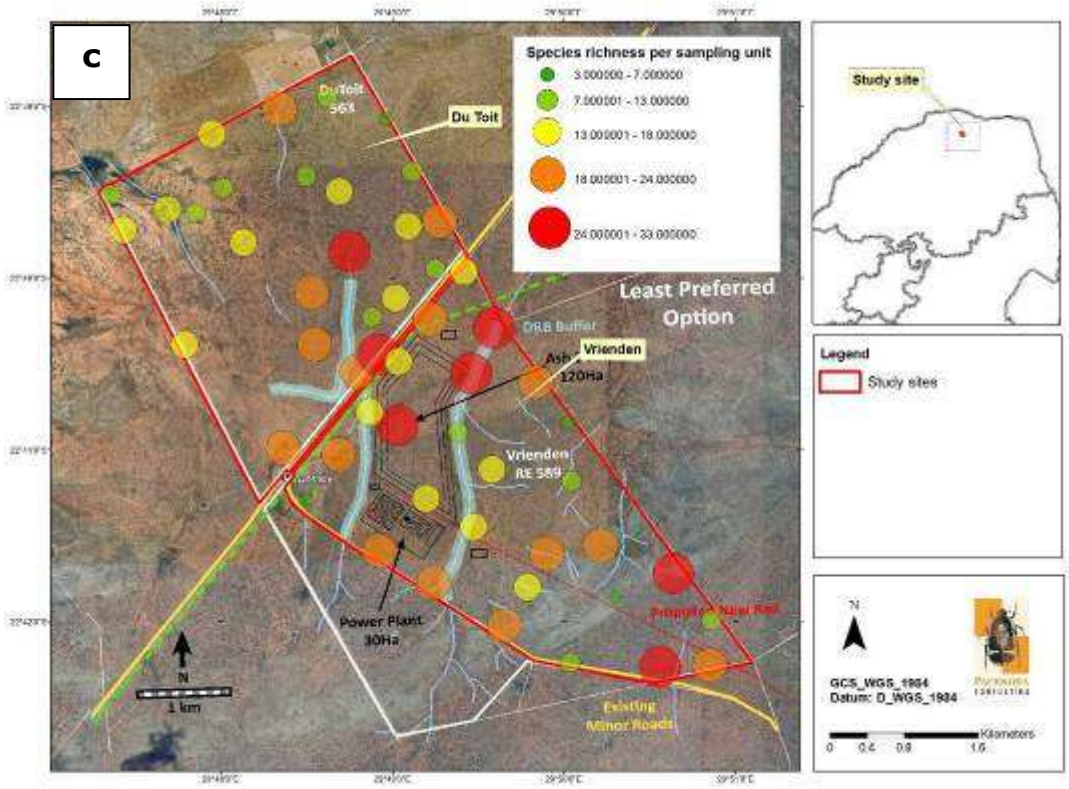
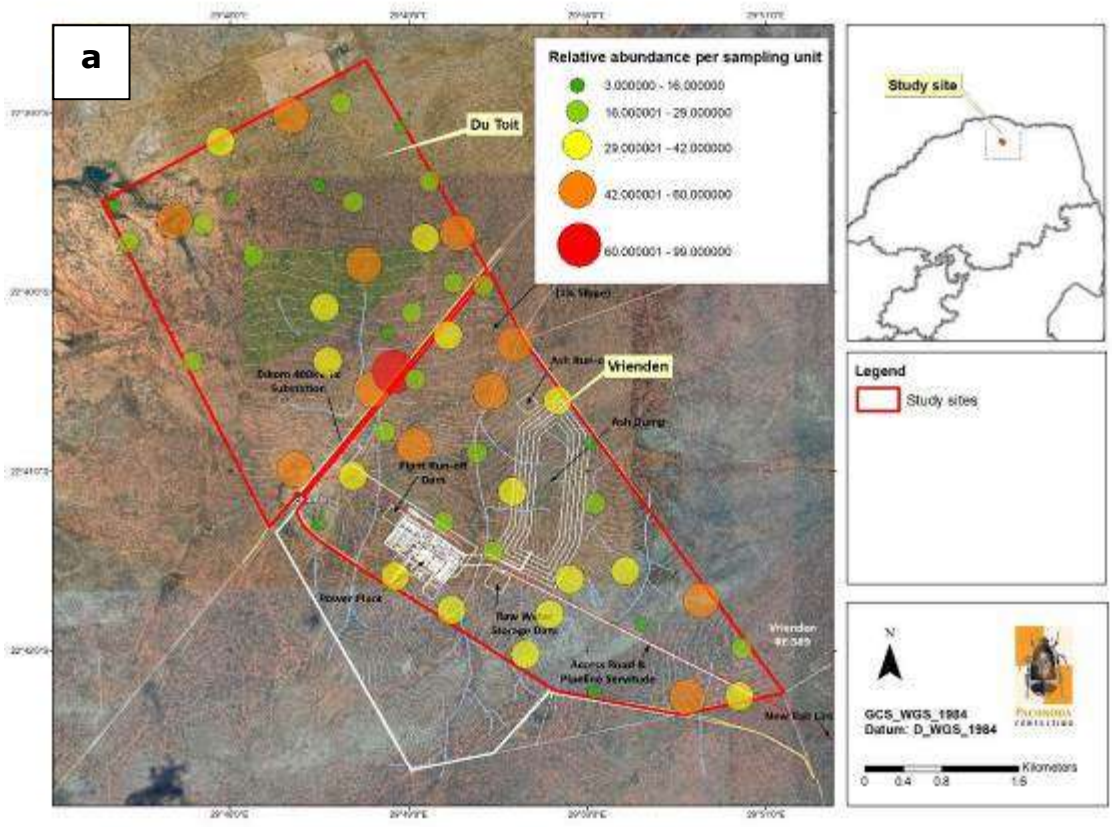


Figure 48: Collage of the relative bird richness (mean number of bird species) per sampling unit: (a) Option 1, (b) Option 2 and (c) Option 3



Section E

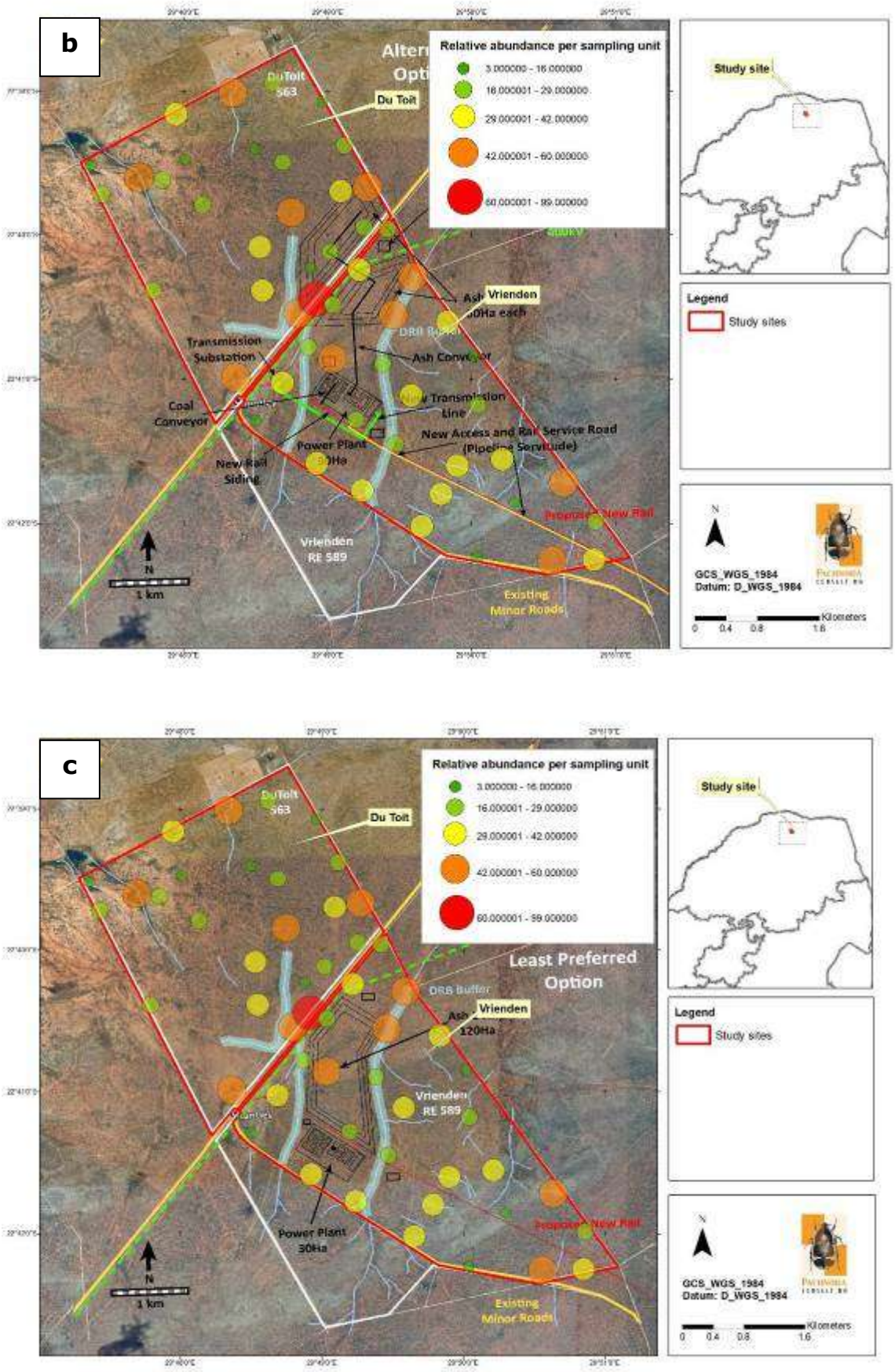


Figure 49: Collage of the relative bird abundance (mean number of bird individuals) per sampling unit: (a) Option 1, (b) Option 2 and (c) Option 3.

31.12.3 Synthesis

From the analysis of alternatives, in particular when taking bird richness and abundance into account, it would appear that Option 1 is regarded as being more feasible when compared to Option 2 and 3. However, Option 1 is not failsafe from other impacts related to potential pollution run-off and localised fragmentation. In addition, the location of the service road remains perpetual on all three of the proposed Options. To minimize potential impacts of the service road, it is proposed that all linear infrastructure be consolidated.

An independent avifaunal impact assessment report should be conducted to evaluate the location of the substation and the powerline infrastructure that would be required for the development, with particular emphasis on the nearby dam located on Du Toit.

31.13 Direct and Indirect Impacts on the Avifaunal Environment

The construction and operation of the proposed power plant and associated infrastructure is expected to have negative impacts on the avifaunal community of the study area and its immediate surroundings. Direct, indirect and cumulative adverse impacts on the bird community are expected during the construction and operation of the proposed power station.

Direct impacts represent those that are a result of the proposed project and unequivocally influencing the avifauna of the region. Anticipated impacts include:

1. Loss of habitat and displacement of bird species, especially large-bodied birds of prey and large terrestrial bird species requiring large home ranges (so-called K-selected species);
2. Loss of sensitive habitat (e.g. trees used as breeding platforms, pans and depressions) and subsequent loss of threatened and near-threatened species;
3. Loss of habitat containing high avifaunal diversity and unique species compositions;
4. Subsequent habitat transformation and loss in habitat quality of adjacent habitat due to inappropriate management procedures;
5. Changes in the bird community structure due to habitat fragmentation (e.g. roads, loss of continuous woodland patches) and habitat loss;
6. Increased exploitation of natural resources due to increased human presence and resource requirements;
7. Electrocution of large-bodied birds due to the use of inappropriate tower design; and
8. Loss of daily migration/foraging corridors. 8

31.13.1 Quantification of Direct and Indirect Impacts on the Avifaunal Environment

Table 33: Quantification of direct and indirect impacts of the Power Plant on the avifaunal environment		
1. Nature of impact:	Direct impacts on/ losses and displacement of bird species of conservation importance and concern, and habitat associated with these species, with particular reference to large-bodied birds of prey and large terrestrial bird species. Impacts are unavoidable because of land clearing activities and the particular large home range size of focal bird species. This impact is restricted to the construction and operational phase, but is permanent	
	Without mitigation	***With mitigation***
Extent	National (4)	Regional (3)
Duration	Permanent (5)	Long term (4)
Magnitude	High (8)	Moderate (6)
Probability	Definitive (5)	Definitive (5)
Significance	***High (85)***	***High (65)***
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes, however unavoidable impacts on bird species will occur, irrespective of mitigation measures, albeit restricted to local footprint. Aim to avoid construction on important and sensitive bird habitat (e.g. habitat with high and medium-high avifaunal sensitivities)	
Mitigation Measures:	• Extent of impact likely to be restricted to site only, restrict impacts to development footprint; • Avoid areas of very high, high or medium-high avifaunal sensitivities by applying changes to the layout plan where necessary	
Residual Impacts:	Sterilised landscapes with no propensity for species of conservation concern, decline in population sizes and numbers, continual decline in habitat availability	
2. Nature of impact:	Losses of natural habitat through physical transformation, modifications, removals and land clearance. Also includes the loss of habitat containing high avifaunal diversity on a local scale and reduction in species richness and diversity	
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Definitive (5)	Definitive (5)
Significance	***High (65)***	**Medium (55)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, to some extent	
Can impacts be mitigated?	Yes, to a limited extent, representative habitat types are widespread and cover large surface area of proposed site	
Mitigation Measures:	• Restrict losses of natural habitat to footprints; • Avoid peripheral or unnecessary losses of natural habitat; • Ensure proper rehabilitation and landscaping practices; • Ensure nodal/clustering of developments by grouping developments structures, avoid the uncontrolled spread of infrastructure;	
Residual Impacts:	Decreased species richness, low evenness values, subsequent loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat	

3. Nature of impact:	Direct impacts on/ losses of azonal habitat types or ecosystems of particularly restricted occurrence containing unique avifaunal compositions on a local scale - many of these areas also provide habitat for threatened and near threatened bird species	
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Long term (4)
Magnitude	High (8)	Moderate (6)
Probability	Highly probable (4)	Probable (3)
Significance	***High* (60)**	**Medium (36)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes	
Mitigation Measures:	• Restrict losses of natural habitat to footprints; • Avoid placement of infrastructure at or in close proximity to habitat with very high avifaunal sensitivities - for examples pans and dams; • Avoid peripheral or unnecessary losses of natural habitat; • Ensure proper rehabilitation and landscaping practices; • Ensure nodal/clustering of developments by grouping developments structures, and avoid the uncontrolled spread of infrastructure; • Remove prominent large dead trees and re-instate during rehabilitation (where necessary); • Re-instate and re-locate artificial watering holes/points if impacted by the project	
Residual Impacts:	Increase in habitat fragmentation and isolation, local decrease in bird richness, increased competition between bird species and individuals of the same species for natural resources, sterilised landscapes, increased fragmentation of habitat	
4. Nature of impact:	Impact on surrounding areas of natural habitat, such as habitat changes, surface water runoff, fragmentation and habitat isolation, etc. It is generally expected to be of moderate significance due to a moderate sensitivity of surrounding areas, although areas of high/medium-high sensitive occur nearby (drainage lines and open woodland)	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (56)**	**Medium (33)**
Status (positive or negative)	Negative	
Reversibility	Moderately reversible, the nature of impacts is such that activities on the development site can be adapted to avoid impacts in surrounding areas	
Irreplaceable loss of resources?	Low	
Can impacts be mitigated?	Yes	
Mitigation Measures:	• Implement generic monitoring programme and mitigation measures that will identify and prevent uncontrolled spread of impacts into adjacent areas of natural habitat; • Avoid an overspill of activities into adjacent habitat by creating exclusion zones which are off limits to personnel; • Implement awareness programmes to inform labour and personnel about the biodiversity of the area.	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	

5. Nature of impact:	Impacts on ecological connectivity and ecosystem functioning. Although the site is regarded homogenous in nature, it does contribute towards local ecological functionality in providing in the life requirements for many bird species and bird associations along drianage lines.	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definitive (5)	Probable (3)
Significance	***High* (70)**	**Medium (30)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	• Limit development to footprint area; • Avoid impacts in adjacent habitat; • Implement biodiversity monitoring programmes and maintain ecological connectivity with habitat of similar structure	
Residual Impacts:	Fragmented, isolated portions of natural habitat, sterile landscapes, increased anthropogenic pressures on natural resources and reduced species richness relating to loss of specialised species and increased colonisation by unspecialised (generalist) species	

6. Nature of impact:	Increased exploitation of natural resources due to increased human presence and resource requirements	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (42)**	**Medium (33)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	• Create and implement public awareness programmes with the aim to protect natural resources. Apply measures which include penalties to personnel if found with "bush meat"; • Implement biodiversity monitoring protocols; • Avoid development on areas of very high, high and medium- high avifaunal sensitivity; • Implement monitoring initiatives to monitor area for snares and illegal firewood collection. • Cluster development and avoid "spread" of settlements across landscape	
Residual Impacts:	Low bird diversity, and continued displacement of bird species. Potential colonisation of feral (alien) species resulting in increased competition and localised displacement of native bird species	

7. Nature of impact:	Bird collisions with proposed overhead power lines	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Long term (4)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Probable (3)

Significance	**High (80)**	**Medium (36)**
Status (positive or negative)	Negative	
Reversibility	Yes	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	1. Avoid spanning of watercourses and open woodland habitat where a high incidence of large bodied terrestrial birds or birds of prey are evident. 2. Avoid spanning areas in close proximity to pans, dams or artificial watering holes or areas where game tend to congregate, or areas holding large trees that are used for roosting sites. 3. Fit "Double loop flight diverter (BFD) to earth wire at the following: (a) spanning drainage lines, dams or depressions, (b) when in close proximity (within 100 m of alignment) to dams, depressions or drainage lines, (c) spanning arable lands, old cultivated land or open woodland. 4. Where possible, placement of the power line alongside existing power lines will increase the visibility of the earth wires.	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	
8. Nature of impact:	Electrocution of large-bodied birds due to the use of inappropriate tower design	
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Moderate (6)
Probability	Highly probable (4)	Probable (3)
Significance	**High (64)**	**Medium (39)**
Status (positive or negative)	Yes	
Reversibility	No	
Irreplaceable loss of resources?	Yes, to some extent	
Can impacts be mitigated?	Yes	
Mitigation Measures:	1. For transmission lines (275 kV or more), use cross rope suspension tower. 2. For distribution lines (<275 kV, use a monopole design that allow for enough clearance between the live conductors (being positioned in an offset manner to each other) to eliminate the risk of electrocution. In addition, perching of large bird species should be discouraged by the addition of diagonal crossbars or by doing away with the crossbars that holds the conductors in place. Bird "streamers" are also eliminated by fitting the poles with bird guards/spikes above the insulators. However, safe perching is facilitated by the fitment of a horizontal bar on top of the pole structure without the risk of electrocution (due to the perpendicular orientation of the bar relative to the conductors). 3. Fit metal bird guards above the insulators of self-supporting towers. 4. The conductors at each tower shall be spaced more than 140 cm apart (this increases to the clearances between the live components). In case spacing of 140 cm is not possible, it is assumed that power lines shall be insulated with thick plastic/metal tubing at least 130 cm in length on both sides of the insulators. This will prevent birds with large wingspans (e.g. Martial eagles, vultures) from "bridging" the gap between the live components when flying off, or attempting to perch on the tower structure, thereby reducing the risk of electrocution. It is also advised to minimise potential bird "streamers" (e.g. when a perching bird is excreting) by discouraging birds from perching directly above the insulators. 5. Re-align alignment away from large drainage lines or areas where roosting is eminent.	
Residual Impacts:	Yes	

31.14 Cumulative Impacts on the Avifaunal Environment

Considering the interest and expansion of power plants in South Africa, especially in the Limpopo Province, it is anticipated that these structures could cumulatively have an impact on the surrounding ecological integrity and bird compositions. Therefore, it is anticipated that an increase in surface activity and infrastructure, herewith composed of power plant infrastructure could result in additional ecological impacts. These will be the same as those explained earlier, although the magnitude and severity of the impacts are elevated (or enhanced) due to the addition of these structures to the landscape. Therefore, more surface area will become lost, entailing the following:

9. Additional loss of dispersal corridors owing to habitat alteration;
10. Subsequent habitat changes and changes to the local avifaunal community structure and composition (colonisation by generalists and secondary species); and
11. Urban sprawl based on "job-seeking" opportunities leading to the localised depletion of natural resources and direct persecution of bird taxa.

Of these, **the latter is probably the most important impact anticipated in the region**, and any major loss of habitat is likely to affect the home range size of large-bodied bird species especially where the ranges of these species overlap with the proposed activities. In addition, a cumulative increase in the surface area of associated electrical infrastructure could also increase the risk of bird collisions with overhead powerlines.

31.14.1 Quantification of Cumulative Impacts on the Avifaunal Environment

Table 34: Quantification of Cumulative Impacts on the avifaunal environment

9. Nature of impact:	Additional loss of bird dispersal corridors owing to habitat alteration.	
	Cumulative contribution of proposed project	Cumulative impact without proposed project
Extent	Regional (4)	Regional (4)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	High (8)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**High (64)**	**High (64)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, to some extent	
Confidence in findings	Moderate	
Mitigation Measures:	Avoid development near drainage lines and in close proximity to rivers, streams and topographical features. Provide buffers to habitat with a high potential to be used as dispersal corridors in the landscape.	
10. Nature of impact:	Subsequent habitat changes and changes to the local avifaunal community structure and composition (colonisation by generalists and secondary species) owing to rehabilitation practice.	
	Cumulative contribution of proposed project	Cumulative impact without proposed project
Extent	Local (2)	Local (2)

Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (36)**	**Low (20)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Loss of resources?	Moderate	Low
Can impacts be mitigated?	Yes, to some extent	
Confidence in findings	Moderate	
Mitigation Measures:	Implement rehabilitation strategies to enhance habitat structure and habitat diversity on pertubated landscapes. Monitoring should be conducted to evaluate rehabilitation effort (where it occurs).	
11. Nature of impact:	Urban sprawl based on "job-seeking" opportunities leading to the localised depletion of natural resources and direct persecution of bird taxa	
	Cumulative contribution of proposed project	Cumulative impact without proposed project
Extent	Regional (4)	Regional (4)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	High (8)
Probability	Definite (5)	Probable (3)
Significance	**High (80)**	**Medium (48)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	High
Loss of resources?	High	Low
Can impacts be mitigated?	Yes, to some extent	
Confidence in findings	High	
Mitigation Measures:	The most feasible solution is to develop and implement a regional programme/ framework at local government and Provincial level that identifies areas of concern, typically such as an Environmental Management Framework, that takes development opportunities and constraints into consideration on a regional scale and aims to identify ecological sensitive areas of local diversity. Consider nodal development regions to avoid uncontrolled spread of developments and restrict development within urban areas.	

31.15 Summary of Impact Quantification on the Avifaunal Environment

Table 35: Summary table for impact significance in the avifaunal environment		
Impact	*Power Station*	
	Without Mitigation	With mitigation
1. Loss of sensitive/important bird habitat and subsequent displacement/loss of threatened and near threatened bird species	High (85)	High (65)
2. Loss of natural habitat (physical modifications, removal, damage) containing high avifaunal diversity	High (65)	Medium (55)
3. Loss of azonal, and important habitat types or ecosystems of restricted abundance containing unique bird compositions (on a local scale)	High (60)	Medium (36)
4. Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc., also including Impacts on habitat types utilised by threatened or near-threatened bird species	Medium (56)	Medium (33)
5. Changes in the community structure due to habitat fragmentation (e.g. roads, loss of closed-canopy woodland) and altered habitat quality	High (70)	Medium (30)
6. Increased "urban sprawl" and exploitation of natural resources due to increased human presence and resource requirements	Medium (42)	Medium (33)
7. Bird collisions with proposed overhead power line	High (80)	Medium (36)
8. Electrocution of large-bodied birds due to the use of inappropriate tower design	High (64)	Medium (39)
9. Additional loss of dispersal corridors owing to habitat alteration	High (64)	High (64)
10. Subsequent habitat changes and changes to the local avifaunal community structure and composition (colonisation by generalists and secondary species)	Medium (36)	Low (20)
11. Urban sprawl based on "job-seeking" opportunities leading to the localised depletion of natural resources and direct persecution of bird taxa	High (80)	Medium (48)

31.16 Mitigation

Although mitigation measures were provided (see section above), the following three steps are of cardinal importance during the planning of infrastructure and activities (e.g. power stations and electricity generation), and should form an integral part of the decision-making process:

1. *Avoidance: avoid or prevent the ecological impact from happening.* Avoidance measures are the first prize during any ecological planning. Examples will include not to proceed with the proposed development at all or to avoid disturbing areas that are considered to be of high sensitivity.
2. *Mitigate: minimize the ecological impact.* Where avoidance is not possible, the impact on the ecological environment should be minimized by a suite of mitigation measures. These are not always practical and not often possible to implement due to the nature of the terrain.
3. *Compensate: provide an equivalent amount of ecological improvement in the region of the impact to balance the impact where it cannot be avoided or mitigated.* Compensation (synonymous to offsets) is a last resort and implies an improvement in the area that is normally larger than the affected or impacted area. In addition, compensation measures should be applied in close proximity to where the proposed impact is likely to occur. Improvement should only happen in areas where similar ecological conditions prevail as to the impacted area (e.g. "a like for like or better" scenario). Typical examples of compensation include: the proclamation of conservation areas larger than the impacted area, the restoration of altered habitat (through proper scientific conduct), the establishment of appropriate corridors and stepping stones to enhance animal movement and the enhancement of habitat that will facilitate the re-colonization of rare and threatened species that used to occur naturally in the impacted area.

31.17 Avifaunal Management Action Plans

These Action Plans are by no means regarded as comprehensive and should be elaborated and detailed as needed during the various phases of the proposed development.

Loss of habitat associated with conservation important birds and important bird congregations		
Objective:	Ensure the preservation and enhancement of important bird habitat within remaining natural habitats that provide habitat for conservation important species and significant congregations of bird species	
Project Components	Any infrastructure development that will cause loss of natural habitat or deterioration of natural habitat where conservation important birds and bird congregations occur	
Potential Impacts	Loss of habitat associated with conservation important birds and important bird congregations	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Ensure the preservation and enhancement of important bird habitat within remaining natural habitat that provide habitat for conservation important species and significant congregations of bird species	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify and delineate areas suitable for important birds and bird congregations and provide for the preservation and enhancement (management) of these areas	Environmental Team, Environmental Officer, Ecologists, Avifaunal specialists	Prior to site preparation activities
2. Ensure all activities that result in destruction of natural habitat are contained within the authorized footprint and do not spread beyond the boundaries of the site		Site preparation, Construction Phase
3. Identify habitat that can be retained within the development footprint in order to aid with preservation of diversity		Prior to site preparation activities
Performance Indicator	Retain avifaunal diversity in remaining areas of natural habitat, with specific reference to conservation important species	
	High avifaunal diversity, presence of diverse bird congregations	
Monitoring	Annual avifaunal monitoring, presence/ absence monitoring for duration of the project and at least five years after decommissioning.	
Direct impacts on birds of conservation importance		
Objective:	Limit/ manage impacts on bird species of conservation importance	
Project Components	Any infrastructure development that will cause loss of natural habitat where conservation important species are likely to occur or activities that could cause the disturbance of populations or individuals of these species	
Potential Impacts	Loss of habitat suitable for populations of conservation important species or direct impacts and losses of populations or individuals of these species	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Limit the impact on conservation important animals and birds, prevent impacts on these animals and birds in remaining areas of natural habitat	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Map/determine the occurrence of conservation important birds	Construction Contractors, Environmental Team, Environmental Officer	Prior to site preparation activities
2. Implement awareness programmes for all contractors and workers on site about the occurrence of conservation important bird species in the area		Site preparation, Construction Phase
3. Compile Standard Operational Procedures to deal with foraging, roosting and/or breeding threatened or near threatened or any important population of birds species (e.g. large colonies of breeding birds) birds, should they be threatened by construction/ operational activities and/or identification/marking and barricading of active nesting and		Prior to site preparation activities

roosting sites of iconic/charismatic bird species (e.g. raptors) storks or bustards when encountered		
4. Adapt operational activities to prevent direct impacts on birds, including personnel presence in areas of natural habitat and vehicular movements/ speeds		Prior to site preparation activities
Performance Indicator	No significant loss of conservation important bird breeding/roosting sites (e.g. successful breeding and rearing of fledglings during breeding activities) as a result of construction or operational activities	
	The persistence of individuals and populations of protected or conservation important animals and birds in natural habitat surrounding the development	
Monitoring	Yearly monitoring of presence/ abundance of conservation important birds as part of biomonitoring programme	
Facilitating effective management of potential direct impacts on the avifaunal component of development areas		
Objective:	Facilitate effective displacement of animals and birds from the development site, prevent continuous impacts on animals and birds surrounding the development	
Project Components	All activities that will result in decimation of natural habitat occupied by animal species, activities that are likely to result in deaths of animals, activities that might attract animals to development/ construction sites	
Potential Impacts	Uncontrolled/ accidental death or displacement of animals and birds that occupy natural habitat within the development site or temporarily occupy parts of the site/ infrastructures	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Limit the direct impacts on animals and birds occupying natural habitat where development will take place, limit the presence/ occurrence of animals and birds within construction/ operational areas, effect removal and relocation to suitable areas	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify animals and birds present within the development footprint, with particular reference to spiders, snakes, scorpions, large mammals, etc. and roosting and breeding sites of large birds of prey, bustards and storks	EO, appointed specialist	Prior to site preparation activities
2. Compile and implement a capture and relocation programme prior to construction phase and/ or implement buffer areas to active nesting and roosting sites of storks, birds of prey (including vultures) and bustards		Prior to site preparation activities
3. Compile Standard Operating Procedures for the capture and relocation of animals during the construction phase and the implementation of buffer areas to ensure the preservation of active roosting and breeding sites of birds of prey/storks/bustards		Site preparation, construction and operational phases
Performance Indicator	No significant losses of animals, successful relocation and release of animals captured on site and successful breeding and rearing of fledgling during breeding activities)	
	Continued presence of a high diversity of animals and birds in immediate surrounds	
Monitoring	Development and implementation of biomonitoring programme	
Mitigating human – animal conflict situations		
Objective:	Minimize human-animal conflict situations	
Project Components	The presence of personnel within a development area that is occasionally occupied by opportunistic species, the presence of personnel remaining areas of natural habitat occupied by animals	

Potential Impacts	Uncontrolled/ accidental death of animals caused by uninformed and/or deliberate actions of personnel	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Limit adverse human-animal conflict opportunities, promote high awareness of personnel with accurate and constructive information	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Identify target species likely to result in conflict situations	EO, appointed specialist	Prior to site preparation activities
2. Compile and implement a capture and relocation programme		Prior to site preparation activities
3. Compile Standard Operating Procedures for the capture and relocation of animals during the construction phase		Site preparation, construction and operational phases
4. Compile and implement awareness programmes to prevent accidental and/ uninformed killing of birds with particular reference to snaring, traditional beliefs, capturing, introduction of pets, etc.		Site preparation, construction and operational phases
Performance Indicator	No significant losses of birds, successful relocation and release of animals captured on site	
	Absence of snares from site fences and trapping of animals	
	Continued presence of a high diversity of birds in immediate surrounds	
Monitoring	Development and implementation of biomonitoring programme	
Minimize bird mortalities associated with power lines		
Objective:	Minimize bird mortalities caused by collision/electrocution by power line/electrical infrastructure	
Project Components	Power line infrastructure development that will cause potential bird mortalities	
Potential Impacts	Bird collision by earth wires and overhead cabling infrastructure and electrocution caused by bird strikes and streamers	
Activity/ Risk Source	Site preparation, construction activities, operational activities	
Mitigation: Target/ Objective	Minimize the impact on passing bird species prevent and mortalities to threatened and near threatened bird species	
Mitigation: Action/ Control	**Responsibility**	**Timeframe**
1. Ensure that a walkthrough of the proposed power line alignment conducted prior to commencement of activities in order to identify areas of high mortality/electrocution risk	Environmental Officer, appointed specialist	Prior to site preparation activities
2. Ensure all activities that result in destruction of natural habitat are contained within the authorized footprint and do not spread beyond the boundaries of the site		Site preparation, Construction Phase
3. Identify areas along power line alignment in need of marking with BFD and/or re-alignment		Prior to site preparation activities
Performance Indicator	No evidence of bird mortalities	
	The presence of foraging/roosting and breeding threatened and near threatened bird species on the study site	
Monitoring	Regular (twice per year) monitoring of entire alignment for dead birds or evidence of bird mortalities	

31.18 Concluding Remarks

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

Based on the results, the avifauna community on the study area is summarised in terms of the following key features:

» The study area supports a high diversity of bird species representing approximately 65 % of the regional richness (on a QDS level).
» In general, habitat diversity and heterogeneity were relatively low, and the woodland structure was monotonous across the area.
» This avifaunal community is not unique and poorly represented by South African endemics. The dominant composition is widespread in the region although it consists of many species with high affinities to the Kalahari-Highveld biome.
» Several threatened and near threatened species are expected to be present. The majority of these species requires large home range sizes, with many species occupying low densities. Noteworthy species include the regionally near-threatened Kori Bustard (*Ardeotis kori*), the regionally endangered Saddle-billed Stork (*Ephippiorhynchus senegalensis*) and the regionally vulnerable Black Stork (*Ciconia nigra*).
» The depressions, pans and dams have benefitted the colonisation of "specialised" bird taxa (mainly wader and wading bird species) that are of local importance and contribute towards the regional avifaunal diversity when inundated.

Although the general habitat heterogeneity of the area is to be low with very few specialised habitat features (e.g. pans and dams) in occurrence, the perceived overall impact of a power station in a relatively non-urbanised environment appears to be marginal. In this case, it is not necessarily the direct impacts on the avifaunal community that is critical, but the cumulative impacts which inter alia could facilitate unnecessary urban sprawl and the spread of informal settlements in the area resulting in the potential loss of natural resources. In addition, the construction of additional linear electrical networks over time may attain higher impact ratings due to the potential for increased mortalities for birds cased by collision with overhead powerlines.

32 APPENDIX 2 – AVIFAUNAL DIVERSITY OF THE SITE

A shortlist of bird species expected to occur on the study area (including those observed during the surveys). # refers to IOC numbers. Scientific names were used according to Gill & Donsker (2018) and colloquial names were used according to Hockey et al. (2005). Also provided are the global, regional and provincial conservation status of each species (IUCN, 2017; NEMBA, 2014; LEMA, 2003; Taylor et al., 2015). CR - Critically Endangered, EN - Endangered, VU - Vulnerable, NT - Near threatened, PROT - protected, PROT - protected. NEMBA - National Environmental Management: Biodiversity Act (Act No. 10 of 2004) and LEMA - Limpopo Environmental Management Act (No 7 of 2003).

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status	TOPS	LEMA
			Full protocol	Adhoc protocol	Incidentals						
625	Apalis, Yellow-breasted	*Apalis flavida*	5.56			21.54	1				
533	Babbler, Arrow-marked	*Turdoides jardineii*	38.89	6.67		38.10	1				
536	Babbler, Southern Pied	*Turdoides bicolor*	11.11			30.95	1				
432	Barbet, Acacia Pied	*Tricholaema leucomelas*	72.22	6.67		36.92	1				
431	Barbet, Black-collared	*Lybius torquatus*	22.22			50.00					
439	Barbet, Crested	*Trachyphonus vaillantii*	33.33			27.69	1				
151	Bateleur, Bateleur	*Terathopius ecaudatus*				13.51		NT	EN	VU	X
673	Batis, Chinspot	*Batis molitor*	88.89			56.92	1				
404	Bee-eater, European	*Merops apiaster*	38.89	20		33.85	1				
410	Bee-eater, Little	*Merops pusillus*	38.89	6.67		29.23	1				
407	Bee-eater, Southern Carmine	*Merops nubicoides*	22.22	13.33		14.29	1				
411	Bee-eater, Swallow-tailed	*Merops hirundineus*				10.53					
409	Bee-eater, White-fronted	*Merops bullockoides*	16.67			9.52	1				
808	Bishop, Southern Red	*Euplectes orix*				6.06	1				
812	Bishop, Yellow-crowned	*Euplectes afer*				5.26					
709	Boubou, Southern	*Laniarius ferrugineus*	11.11			52.38					
977	Boubou, Tropical	*Laniarius aethiopicus*	5.56	6.67		9.52					
731	Brubru, Brubru	*Nilaus afer*	83.33			21.54	1				
779	Buffalo-weaver, Red-billed	*Bubalornis niger*	44.44	6.67	3/25/2014	36.92	1				
545	Bulbul, Dark-capped	*Pycnonotus tricolor*	44.44	6.67		73.85	1				
872	Bunting, Cinnamon-breasted	*Emberiza tahapisi*	38.89	6.67		32.31	1				
874	Bunting, Golden-breasted	*Emberiza flaviventris*	61.11	6.67		30.77	1				
871	Bunting, Lark-like	*Emberiza impetuani*	27.78	6.67		5.26					

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
723	Bush-shrike, Grey-headed	*Malaconotus blanchoti*	16.67			15.38					
719	Bush-shrike, Orange-breasted	*Chlorophoneus sulfureopectus*	16.67			32.31	1				
217	Bustard, Kori	*Ardeotis kori*	27.78			39.13	1	NT	NT	PROT	X
196	Buttonquail, Kurrichane	*Turnix sylvaticus*				8.93					
144	Buzzard, Lizard	*Kaupifalco monogrammicus*				17.39					
154	Buzzard, Steppe	*Buteo vulpinus*	11.11	6.67		10.77	1				
628	Camaroptera, Grey-backed	*Camaroptera brevicaudata*	38.89	6.67		35.38	1				
860	Canary, Black-throated	*Crithagra atrogularis*				9.23	1				
866	Canary, Yellow	*Crithagra flaviventris*				7.14	1				
859	Canary, Yellow-fronted	*Crithagra mozambicus*	72.22	6.67		53.85	1				
570	Chat, Familiar	*Cercomela familiaris*	11.11			17.86					
630	Cisticola, Desert	*Cisticola aridulus*	16.67			12.12					
642	Cisticola, Rattling	*Cisticola chiniana*	61.11	20		41.54	1				
629	Cisticola, Zitting	*Cisticola juncidis*	11.11	6.67		4.76					
50	Cormorant, Reed	*Phalacrocorax africanus*				7.14					
4131	Coucal, Burchell's	*Centropus burchellii*	22.22			18.46	1				
280	Courser, Bronze-winged	*Rhinoptilus chalcopterus*	5.56			13.04					
277	Courser, Temminck's	*Cursorius temminckii*	5.56			14.29	1				
203	Crake, Black	*Amaurornis flavirostris*				14.29					
621	Crombec, Long-billed	*Sylvietta rufescens*	83.33	6.67		53.85	1				
522	Crow, Pied	*Corvus albus*	11.11	6.67	12/4/2010	7.14	1				
341	Cuckoo, African	*Cuculus gularis*				21.74					
344	Cuckoo, Black	*Cuculus clamosus*	16.67	6.67		12.50	1				
352	Cuckoo, Diderick	*Chrysococcyx caprius*	22.22			21.54	1				
346	Cuckoo, Great Spotted	*Clamator glandarius*				7.69					
348	Cuckoo, Jacobin	*Clamator jacobinus*	16.67			15.38	1				
351	Cuckoo, Klaas's	*Chrysococcyx klaas*	22.22	6.67		18.46	1				
347	Cuckoo, Levaillant's	*Clamator levaillantii*				13.04	1				
343	Cuckoo, Red-chested	*Cuculus solitarius*	5.56			30.36					
513	Cuckoo-shrike, Black	*Campephaga flava*	5.56			17.39	1				
52	Darter, African	*Anhinga rufa*				7.14					
315	Dove, African Mourning	*Streptopelia decipiens*				28.57					
317	Dove, Laughing	*Spilopelia senegalensis*	88.89	26.67		53.85	1				

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
318	Dove, Namaqua	*Oena capensis*	77.78	13.33		35.38	1				
314	Dove, Red-eyed	*Streptopelia semitorquata*				26.15	1				
940	Dove, Rock	*Columba livia*				7.14	1				
517	Drongo, Fork-tailed	*Dicrurus adsimilis*	61.11	6.67		50.77	1				
91	Duck, Knob-billed	*Sarkidiornis melanotos*	11.11			7.14	1				
100	Duck, White-faced	*Dendrocygna viduata*				0.00	1				
136	Eagle, Lesser Spotted	*Aquila pomarina*				7.14					
142	Eagle, Martial	*Polemaetus bellicosus*				17.39		VU	EN	VU	X
134	Eagle, Tawny	*Aquila rapax*				13.04			EN	VU	
137	Eagle, Wahlberg's	*Aquila wahlbergi*	27.78			21.54	1				
368	Eagle-owl, Spotted	*Bubo africanus*	5.56			10.87	1				
61	Egret, Western Cattle	*Bubulcus ibis*	5.56			17.86	1				
59	Egret, Little	*Egretta garzetta*				7.14					
601	Eremomela, Burnt-necked	*Eremomela usticollis*	27.78	6.67		11.90	1				
600	Eremomela, Yellow-bellied	*Eremomela icteropygialis*	27.78			7.84	1				
119	Falcon, Amur	*Falco amurensis*		6.67		14.29					
114	Falcon, Lanner	*Falco biarmicus*	5.56			10.77			VU		
821	Finch, Cut-throat	*Amadina fasciata*	38.89	6.67		15.38	1				
820	Finch, Red-headed	*Amadina erythrocephala*	11.11			13.04					
789	Finch, Scaly-feathered	*Sporopipes squamifrons*	27.78			45.24	1				
835	Firefinch, Jameson's	*Lagonosticta rhodopareia*				23.08					
837	Firefinch, Red-billed	*Lagonosticta senegala*	11.11			21.54	1				
707	Fiscal, Common (Southern)	*Lanius collaris*				39.29					
149	Fish-eagle, African	*Haliaeetus vocifer*	5.56			14.29					
665	Flycatcher, Fiscal	*Sigelus silens*				5.26					
661	Flycatcher, Marico	*Bradornis mariquensis*	61.11			26.15	1				
662	Flycatcher, Pale	*Bradornis pallidus*	5.56			14.29					
664	Flycatcher, Southern Black	*Melaenornis pammelaina*				7.14	1				
654	Flycatcher, Spotted	*Muscicapa striata*	44.44	6.67		23.08	1				
173	Francolin, Coqui	*Peliperdix coqui*				10.71					
174	Francolin, Crested	*Dendroperdix sephaena*	66.67	6.67		47.69	1				
339	Go-away-bird, Grey	*Corythaixoides concolor*	77.78	13.33		52.31	1				
89	Goose, Egyptian	*Alopochen aegyptiacus*	44.44			21.43	1				
163	Goshawk, Dark Chanting	*Melierax metabates*	22.22	6.67		17.39	1				
162	Goshawk, Gabar	*Melierax gabar*	16.67			16.67	1				

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
165	Goshawk, Southern Pale Chanting	*Melierax canorus*	22.22	13.33		30.95	1				
6	Grebe, Little	*Tachybaptus ruficollis*	5.56			0.00	1				
323	Green-pigeon, African	*Treron calvus*				14.29					
550	Greenbul, Yellow-bellied	*Chlorocichla flaviventris*	5.56	6.67		24.62					
263	Greenshank, Common	*Tringa nebularia*				14.29					
430	Ground-hornbill, Southern	*Bucorvus leadbeateri*			12/8/2007	21.74		VU	EN	VU	X
193	Guineafowl, Crested	*Guttera edouardi*			1/14/2018	41.07	1				X
192	Guineafowl, Helmeted	*Numida meleagris*	83.33	13.33	12/7/2009	55.38	1				
72	Hamerkop, Hamerkop	*Scopus umbretta*	11.11			23.21					
171	Harrier-Hawk, African	*Polyboroides typus*	11.11			23.91	1				
127	Hawk, African Cuckoo	*Aviceda cuculoides*				4.35					
141	Hawk-eagle, African	*Aquila spilogaster*	27.78	6.67		7.14	1				
728	Helmet-shrike, Retz's	*Prionops retzii*				10.53					
727	Helmet-shrike, White-crested	*Prionops plumatus*	61.11			26.15	1				
55	Heron, Black-headed	*Ardea melanocephala*	5.56			9.52					
54	Heron, Grey	*Ardea cinerea*	11.11			5.26	1				
443	Honeybird, Brown-backed	*Prodotiscus regulus*				8.11					
440	Honeyguide, Greater	*Indicator indicator*	5.56			10.77	1				
442	Honeyguide, Lesser	*Indicator minor*	11.11			18.46	1				
418	Hoopoe, African	*Upupa africana*	33.33			46.15	1				
424	Hornbill, African Grey	*Lophoceros nasutus*	72.22			38.46	1				
4129	Hornbill, Southern Red-billed	*Tockus rufirostris*	77.78	33.33		24.62	1				
426	Hornbill, Southern Yellow-billed	*Tockus leucomelas*	88.89	33.33		55.38	1				
507	House-martin, Common	*Delichon urbicum*	27.78	6.67		12.31	1				
84	Ibis, Hadeda	*Bostrychia hagedash*	22.22			33.93	1				
849	Indigobird, Dusky	*Vidua funerea*				4.35					
851	Indigobird, Village	*Vidua chalybeata*	5.56			7.14					
228	Jacana, African	*Actophilornis africanus*				7.14					
122	Kestrel, Greater	*Falco rupicoloides*				5.26					
125	Kestrel, Lesser	*Falco naumanni*				11.11					
123	Kestrel, Rock	*Falco rupicolus*				16.67					
402	Kingfisher, Brown-hooded	*Halcyon albiventris*	55.56			49.23	1				
401	Kingfisher, Grey-headed	*Halcyon leucocephala*				42.86					
403	Kingfisher, Striped	*Halcyon chelicuti*	11.11			28.26	1				
399	Kingfisher, Woodland	*Halcyon senegalensis*	27.78			13.85	1				
14189	Kite, Black	*Milvus migrans*				7.14					

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
130	Kite, Black-shouldered	*Elanus caeruleus*	16.67			10.71					
129	Kite, Yellow-billed	*Milvus aegyptius*				10.71	1				
224	Korhaan, Red-crested	*Lophotis ruficrista*	61.11	6.67		33.85	1				
245	Lapwing, Blacksmith	*Vanellus armatus*	22.22			9.09	1				
242	Lapwing, Crowned	*Vanellus coronatus*	50			33.33	1				
464	Lark, Dusky	*Pinarocorys nigricans*	11.11			7.14	1				
459	Lark, Fawn-coloured	*Calendulauda africanoides*	5.56	6.67		11.90	1				
457	Lark, Monotonous	*Mirafra passerina*	27.78	6.67		16.92	1				
488	Lark, Red-capped	*Calandrella cinerea*				7.14					
458	Lark, Rufous-naped	*Mirafra africana*	16.67			21.54	1				
460	Lark, Sabota	*Calendulauda sabota*	55.56	6.67		32.31	1				
823	Mannikin, Bronze	*Spermestes cucullatus*				43.48	1				
792	Masked-weaver, Lesser	*Ploceus intermedius*				12.12					
803	Masked-weaver, Southern	*Ploceus velatus*	77.78			29.23	1				
392	Mousebird, Red-faced	*Urocolius indicus*	66.67			47.69	1				
390	Mousebird, Speckled	*Colius striatus*	5.56			44.62					
734	Myna, Common	*Acridotheres tristis*	11.11	6.67		0.00					
637	Neddicky, Neddicky	*Cisticola fulvicapilla*				15.69	1				
592	Nightingale, Thrush	*Luscinia luscinia*				0.00					
371	Nightjar, European	*Caprimulgus europaeus*				7.14					
373	Nightjar, Fiery-necked	*Caprimulgus pectoralis*	11.11			43.48	1				
372	Nightjar, Rufous-cheeked	*Caprimulgus rufigena*	5.56			16.22	1				
376	Nightjar, Square-tailed	*Caprimulgus fossii*	5.56			13.04	1				
520	Oriole, African Golden	*Oriolus auratus*	11.11			7.14	1				
521	Oriole, Black-headed	*Oriolus larvatus*	38.89	6.67		47.69	1				
519	Oriole, Eurasian Golden	*Oriolus oriolus*	11.11			13.04	1				
359	Owl, Western Barn	*Tyto alba*				9.23	1				
365	Owlet, Pearl-spotted	*Glaucidium perlatum*	38.89	6.67		23.91	1				
748	Oxpecker, Red-billed	*Buphagus erythrorhynchus*	27.78			6.06	1				
387	Palm-swift, African	*Cypsiurus parvus*	11.11			16.67	1				
682	Paradise-flycatcher, African	*Terpsiphone viridis*				29.41	1				
852	Paradise-whydah, Long-tailed	*Vidua paradisaea*	22.22			29.23	1				
328	Parrot, Brown-headed	*Poicephalus cryptoxanthus*	22.22			0.00	1				
327	Parrot, Meyer's	*Poicephalus meyeri*	16.67			14.29	1				
531	Penduline-tit, Cape	*Anthoscopus minutus*				33.33	1				

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
530	Penduline-tit, Grey	*Anthoscopus caroli*	16.67			14.29	1				
788	Petronia, Yellow-throated	*Gymnoris superciliaris*	5.56			8.70	1				
311	Pigeon, Speckled	*Columba guinea*				33.33					
692	Pipit, African	*Anthus cinnamomeus*	5.56			9.52	1				
699	Pipit, Bushveld	*Anthus caffer*				8.70	1				
694	Pipit, Plain-backed	*Anthus leucophrys*				7.14					
695	Pipit, Buffy	*Anthus vaalensis*				0.00	1				
238	Plover, Three-banded	*Charadrius tricollaris*	5.56			5.41	1				
650	Prinia, Black-chested	*Prinia flavicans*	16.67	6.67		25.00	1				
649	Prinia, Tawny-flanked	*Prinia subflava*	27.78			41.54	1				
712	Puffback, Black-backed	*Dryoscopus cubla*	72.22	13.33		55.38	1				
830	Pytilia, Green-winged	*Pytilia melba*	72.22	6.67		26.15	1				
844	Quailfinch, African	*Ortygospiza atricollis*				4.35					
805	Quelea, Red-billed	*Quelea quelea*	66.67		12/4/2010	30.77	1				
606	Reed-warbler, African	*Acrocephalus baeticatus*				4.76					
582	Robin-chat, White-throated	*Cossypha humeralis*	11.11			35.38	1				
412	Roller, European	*Coracias garrulus*	27.78	26.67	3/26/2010	21.43	1				
413	Roller, Lilac-breasted	*Coracias caudatus*	55.56	13.33		36.92	1				
415	Roller, Purple	*Coracias naevius*	16.67	6.67	9/28/2010	20.00	1				
310	Sandgrouse, Double-banded	*Pterocles bicinctus*	22.22			16.67	1				
258	Sandpiper, Common	*Actitis hypoleucos*	5.56			14.29	1				
264	Sandpiper, Wood	*Tringa glareola*	11.11			22.22	1				
421	Scimitarbill, Common	*Rhinopomastus cyanomelas*	66.67	6.67	11/24/2012	30.77	1				
364	Scops-owl, Southern White-faced	*Ptilopsus granti*				28.57					
585	Scrub-robin, Bearded	*Cercotrichas quadrivirgata*				4.35	1				
586	Scrub-robin, Kalahari	*Cercotrichas paena*	27.78	6.67		16.92	1				
588	Scrub-robin, White-browed	*Cercotrichas leucophrys*	83.33	13.33		52.31	1				
105	Secretarybird, Secretarybird	*Sagittarius serpentarius*				21.74		VU	VU		
867	Seedeater, Streaky-headed	*Crithagra gularis*				30.36					
161	Shikra, Shikra	*Accipiter badius*				17.39					
711	Shrike, Crimson-breasted	*Laniarius atrococcineus*	38.89	6.67		35.38	1				
706	Shrike, Lesser Grey	*Lanius minor*	16.67			14.29	1				
724	Shrike, Magpie	*Corvinella melanoleuca*	22.22			21.43	1				
708	Shrike, Red-backed	*Lanius collurio*	44.44	6.67		40.00	1				
730	Shrike, Southern White-crowned	*Eurocephalus anguitimens*	55.56	40	9/28/2010	35.38	1				

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
146	Snake-eagle, Black-chested	*Circaetus pectoralis*	22.22			11.76	1				
145	Snake-eagle, Brown	*Circaetus cinereus*	27.78			13.04	1				
786	Sparrow, Cape	*Passer melanurus*	16.67			10.77					
785	Sparrow, Great	*Passer motitensis*	5.56			0.00					
784	Sparrow, House	*Passer domesticus*	16.67			27.69					
4142	Sparrow, Southern Grey-headed	*Passer diffusus*	72.22	6.67		32.31	1				
780	Sparrow-weaver, White-browed	*Plocepasser mahali*	55.56		9/28/2010	33.85	1				
158	Sparrowhawk, Little	*Accipiter minullus*				8.70					
484	Sparrowlark, Chestnut-backed	*Eremopterix leucotis*	11.11			7.14	1				
183	Spurfowl, Natal	*Pternistis natalensis*	16.67			32.31	1				
185	Spurfowl, Swainson's	*Pternistis swainsonii*	11.11			21.05	1				
737	Starling, Cape Glossy	*Lamprotornis nitens*	61.11	13.33		43.08	1				
738	Starling, Greater Blue-eared	*Lamprotornis chalybaeus*	22.22		12/7/2009	13.85	1				
745	Starling, Red-winged	*Onychognathus morio*	11.11			42.86					
736	Starling, Violet-backed	*Cinnyricinclus leucogaster*	44.44	13.33		29.23	1				
735	Starling, Wattled	*Creatophora cinerea*	16.67			14.29	1				
576	Stonechat, African	*Saxicola torquatus*	5.56			30.36					
78	Stork, Abdim's	*Ciconia abdimii*	5.56			7.14			NT		
79	Stork, Black	*Ciconia nigra*	5.56			9.52	1		VU		
75	Stork, Saddle-billed	*Ephippiorhynchus senegalensis*	5.56			0.00	1		EN	X	
80	Stork, White	*Ciconia ciconia*				8.93					
772	Sunbird, Amethyst	*Chalcomitra amethystina*	22.22	6.67		38.10	1				
755	Sunbird, Marico	*Cinnyris mariquensis*	55.56			23.81	1				
774	Sunbird, Scarlet-chested	*Chalcomitra senegalensis*	5.56			6.25	1				
763	Sunbird, White-bellied	*Cinnyris talatala*	77.78	6.67		52.31	1				
493	Swallow, Barn	*Hirundo rustica*	44.44	26.67	12/4/2010	46.15	1				
502	Swallow, Greater Striped	*Cecropis cucullata*				11.90					
503	Swallow, Lesser Striped	*Cecropis abyssinica*	22.22			38.46	1				
498	Swallow, Pearl-breasted	*Hirundo dimidiata*	5.56			7.14					
501	Swallow, Red-breasted	*Cecropis semirufa*				7.14					
495	Swallow, White-throated	*Hirundo albigularis*				21.43					
496	Swallow, Wire-tailed	*Hirundo smithii*				8.70					
386	Swift, Alpine	*Tachymarptis melba*				33.33					
378	Swift, Common	*Apus apus*	5.56		12/15/2011	7.14	1				
385	Swift, Little	*Apus affinis*	5.56			24.62	1				

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
383	Swift, White-rumped	*Apus caffer*	5.56		12/4/2010	16.07	1				
715	Tchagra, Black-crowned	*Tchagra senegalus*				16.07	1				
714	Tchagra, Brown-crowned	*Tchagra australis*	88.89	6.67		32.31	1				
275	Thick-knee, Spotted	*Burhinus capensis*	22.22			39.13	1				
274	Thick-knee, Water	*Burhinus vermiculatus*				14.29					
557	Thrush, Groundscraper	*Psophocichla litsipsirupa*	11.11			16.92	1				
552	Thrush, Kurrichane	*Turdus libonyanus*	5.56			18.46	1				
437	Tinkerbird, Yellow-fronted	*Pogoniulus chrysoconus*	11.11			29.41	1				
527	Tit, Southern Black	*Melaniparus niger*	88.89	13.33		49.23	1				
658	Tit-babbler, Chestnut-vented	*Sylvia subcaeruleum*	5.56			16.67	1				
657	Tit-flycatcher, Grey	*Myioparus plumbeus*	5.56			0.00					
316	Turtle-dove, Cape	*Streptopelia capicola*	83.33	26.67		52.31	1				
106	Vulture, Cape	*Gyps coprotheres*				12.31		EN	EN	VU	X
108	Vulture, Lappet-faced	*Torgos tracheliotus*				21.43		EN	EN	VU	
107	Vulture, White-backed	*Gyps africanus*	5.56			12.12	1	CR	CR	PROT	
685	Wagtail, African Pied	*Motacilla aguimp*				5.41					
595	Warbler, Garden	*Sylvia borin*				4.35					
607	Warbler, Marsh	*Acrocephalus palustris*	22.22			0.00	1				
597	Warbler, Olive-tree	*Hippolais olivetorum*	5.56			7.14					
599	Warbler, Willow	*Phylloscopus trochilus*	55.56	13.33		24.62	1				
841	Waxbill, Black-faced	*Estrilda erythronotos*	11.11	6.67		33.33	1				
839	Waxbill, Blue	*Uraeginthus angolensis*	100	20		55.38	1				
843	Waxbill, Common	*Estrilda astrild*				26.15					
838	Waxbill, Orange-breasted	*Amandava subflava*				6.06					
840	Waxbill, Violet-eared	*Granatina granatina*	22.22			35.71	1				
793	Weaver, Red-headed	*Anaplectes rubriceps*	55.56	6.67		20.00	1				
797	Weaver, Village	*Ploceus cucullatus*	22.22			10.77	1				
568	Wheatear, Capped	*Oenanthe pileata*				5.26					
1172	White-eye, Cape	*Zosterops virens*				62.75					
846	Whydah, Pin-tailed	*Vidua macroura*	5.56			18.46					
847	Whydah, Shaft-tailed	*Vidua regia*	5.56	6.67		21.43	1				
321	Wood-dove, Emerald-spotted	*Turtur chalcospilos*	72.22			69.23	1				
419	Wood-hoopoe, Green	*Phoeniculus purpureus*	11.11			13.85	1				
451	Woodpecker, Bearded	*Dendropicos namaquus*				14.29					
446	Woodpecker, Bennett's	*Campethera*				28.57					

Ref	Common name	Taxonomic name	SABAP2 Reporting Rate (%)			SABAP1 Reporting Rate (%)	Observed	Global Conservation	Regional Conservation	TOPS	LEMA
		bennettii									
450	Woodpecker, Cardinal	*Dendropicos fuscescens*	27.78			24.62	1				
447	Woodpecker, Golden-tailed	*Campethera abingoni*	50	6.67		23.08	1				
614	Wren-warbler, Barred	*Calamonastes fasciolatus*	66.67	6.67		16.92	1				

33 APPENDIX 3 - PERMIT APPLICATIONS

Protected Trees

Permit applications for the removal / relocation of protected trees must be directed to the Department of Fishery and Forestry (DAFF):

DWAF website: http://www.dwaf.gov.za/Forestry/PTlicence.asp

Protected Plants

The removal or relocation of protected plants is subjected to authorisation (permits) from the Limpopo Department of Economic Development, Environment and Tourism:

CITES and Permit Management
Department of Economic Development, Environment and Tourism
Limpopo
P.O. Box 55464
POLOKWANE
0700

Tel: 015 290 7000
Fax: (015) 295-5018

E-mail: Permits@Ledet.gov.za or
Rosa Moloto: MolotoMR@Ledet.gov.za

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