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Strategic Terrestrial Biodiversity & Ecology

EIA Report for the proposed

Mokopane Integration Project

submitted by

Bathusi Environmental Consulting

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I SPECIALIST INVESTIGATORS

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).

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II DECLARATION OF INDEPENDENCE

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

- We act as independent specialists for this project.
- We consider ourselves bound to the rules and ethics of the South African Council for Natural Scientific Professions.
- At the time of completing this report, we did not have any interest, hidden or otherwise, in the proposed development as outlined in this document, except for financial compensation for work done in a professional capacity, in terms of the Environmental Impact Assessment Regulations, 2006.
- We will not be affected in any manner by the outcome of the environmental process of which this report forms part of, other than being part of the public.
- We do not have any influence over decisions made by the governing authorities.
- 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.
- Undertake to disclose to the National Department of Environmental Affairs and Tourism, any material information that have or may have the potential to influence its decision or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006;
- Will provide the National Department of Environmental Affairs and Tourism 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 to be in conflict with any of the above declarations, we shall formally submit a Notice of Withdrawal to all relevant parties and formally register as an Interested and Affected Party.

III GLOSSARY OF TERMS

Alternatives: A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

Biome: Any major ecological community of organisms, usually characterized by a dominant vegetation type.

Cumulative impacts: The combined or additive effects on biodiversity or ecosystem services over time or in space. They may seem to be insignificant when seen in isolation, but collectively they have a significant effect

Direct impacts: Those that take place at the same time and in the same space as the activity, e.g. clearing of natural vegetation for agriculture.

Direct, indirect and cumulative impacts: Decision makers need to know the direct, indirect and cumulative impacts of a proposed activity on the environment, if they are to take informed decisions in line with sustainable development.

Ecologically sensitive ecosystem: One where relatively even minor disturbances may result in substantial and significant changes.

Ecosystems: Include living (e.g. plants, animals) and non-living (e.g. minerals, soil, water) components, which can be defined in terms of distinguishing characteristics (e.g. a wetland ecosystem, a freshwater ecosystem, a terrestrial ecosystem, a forest ecosystem, etc.).

Endemic or range-restricted species or ecosystem: One whose distribution is confined to a particular and often very limited geographical region.

Environment: Broadly covers our surroundings and the characteristics of those surroundings that influence our health and wellbeing. That is, the environment includes all living organisms (plants, animals and other life), the physical environment (land, water and air), as well as social, economic and cultural conditions. Sometimes we speak of 'the natural environment' and 'the built environment', to differentiate between natural and man-made systems.

Habitat: The place or type of site where an organism or population naturally occurs.

Indigenous: Native to a particular area.

Impact assessment: A process that is used to identify, predict and assess the potential positive and negative impacts of a proposed project (including reasonable alternatives) on the environment and to propose appropriate management actions and monitoring programmes. Impact assessment is used to inform decision-making by the project proponent, relevant authorities and financing institutions. The process includes some or all of the following components: screening, scoping, impact assessment and decision-making.

Indirect impacts: Occur later in time or at a different place from the activity, e.g. extraction of groundwater for irrigation leads to changes in the water table and affects distant water users.

Irreplaceable loss: When it results in the loss of a resource without substitute, and which cannot be replaced. An impact leading to irreplaceable loss of biodiversity is, by definition, irreversible

Irreversible impact: One that arguably cannot be reversed in time (e.g. decrease in area of a specific vegetation type, loss of genetic diversity through reduction in size of populations of a particular species). Some, but not all, irreversible impacts will lead to irreplaceable loss of biodiversity. They may, or may not, be acceptable to society or stakeholders in terms of their current values

Issue: A context-specific question that asks "what, or how severe, will the impact of some activity/aspect of the development be on some element of the environment?"

Natural resources: Include living and non-living materials that can be exploited or used by people. Natural resources form part of ecosystems, and our living natural resources contribute to biodiversity. Some people use 'natural resources' to mean the same thing as biodiversity or ecosystem services.

Precautionary Principle: States that "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Protected area: As defined by National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003).

Protected species or ecosystem: One that is protected by law from particular activities and land uses.

Red Data Book' or 'Red List': Provides information on threatened species.

Significance: A term used to evaluate how severe an impact would be, taking into account objective or scientific data as well as human values. A specific significance rating should not be confused with the acceptability of the impact (i.e. an impact of low significance is not automatically "acceptable").

Species: A group of plants, animals, micro-organisms or other living organisms that are morphologically similar; that share inheritance from common ancestry; or whose genes are so similar that they can breed together and produce fertile offspring.

Sustainable development: Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations, or improving the quality of human life while living within the carrying capacity of supporting ecosystems".

Threatened species or ecosystem: Species/ Ecosystems that are at risk of going extinct in its natural range. It may be 'critically endangered' at extremely high risk, 'endangered' at very high risk, or 'vulnerable' at high risk. Species or ecosystems at low or no risk are not 'threatened', and fall into the 'Near Threatened' or 'Least Concern' categories

IV DEFINING BIODIVERSITY

Biological diversity - or "biodiversity" - is generally described as the number and variety of living organisms on earth, the millions of plants, animals, and micro organisms, the genes they contain, the evolutionary history and potential they encompass, and the ecosystems, ecological processes and landscapes of which they are integral parts. Biodiversity thus refers to the life-support systems and natural resources upon which we depend. There are three main components of biodiversity, namely:

- **Genetic diversity**

Genes are the biochemical packages that are passed on by parents to their offspring, and which determine the physical and biochemical characteristics of offspring. Genetic diversity refers to the variation of genes within species, making it possible to develop new breeds of crop plants and domestic animals, and allowing species in the wild to adapt to changing conditions.

- **Species diversity**

A species is a group of plants, animals, micro organisms, or other living organisms that are morphologically similar; that share inheritance from common ancestry; or whose genes are so similar that they can breed together and produce fertile offspring. Usually different species look different.

Species diversity refers to the variety and abundance of species within a geographic area. Often the term "species richness" is used as a measure of species diversity, but this refers only to the number of species within a region, and thus technically only one component of diversity.

- **Ecosystem diversity**

An ecosystem consists of communities of plants, animals and micro organisms, and the soil, water, and air on which they depend. These all interact in a complex way, contributing to processes on which all life depends such as the water cycle, energy flow, the provision of oxygen, soil formation and nutrient cycling. Ecosystem diversity can refer to the variety of ecosystems found within a certain political or geographical boundary, or to the variety of species within different ecosystems.

Another level of diversity which is sometimes included in the definition of biodiversity is 'Landscape Diversity'. A landscape is a collection of elements which consists of defined assemblages of plants, animals, abiotic substrata such as rocks, land-use patterns, as well as cultural or scenic features and socio-economic and political dynamics. For example, wetlands, fragments of forest, mountains, or rocky shores may comprise landscapes, as may the presence of croplands or religious structures. The boundary of a landscape will vary according to the scale being used and the purpose of the investigation. Landscape diversity refers to the number of landscapes in the geographical area being studied.

For the purpose of this report biodiversity is therefore purposely defined as the diversity of flora and fauna species within the study area, how these species are distributed within their habitat, their interaction with the biophysical environment and temporal changes to the compositional, functional and spatial patterns.

V BIODIVERSITY OF SOUTH AFRICA

The remarkable richness of South Africa's biodiversity is largely as a result of the variation in climates and habitats occurring in the country. South Africa ranks as the third most biologically diverse country in the world, and as such is of major global importance for biodiversity conservation.

Table 1: Biodiversity of South Africa

Taxa	Described species in South Africa	% of the Earth's species
Mammals	227	5,8%
Birds	718	8%
Amphibians	84	2,1%
Reptiles	286	4,6%
Freshwater fish	112	1,3%
Marine fish	2,150	16%
Invertebrates	77,500	5,5%
Vascular plants	18,625	7,5%

Human activity has been changing South African ecosystems for thousands of years, but the pace and extent of change increased rapidly with agricultural and industrial development during the recent past. Present estimates suggest that a substantial proportion of natural habitat has been transformed largely by agriculture, urban developments, forestation, mining, and dams. In addition to habitat loss and degradation, the overexploitation of certain species, the introduction of exotic species, and the pollution or toxification of the soil, water and atmosphere are having major effects on South Africa's terrestrial, freshwater and marine biodiversity.

Already 3,435 (15%) of South Africa's plant species, 102 (14%) bird species, 72 (24%) reptile species, 17 (18%) amphibian species, 90 (37%) mammal species and 142 (22%) butterfly species are listed as threatened. In addition, many important ecosystems have been degraded, and ecological processes impaired. Trends indicate that this situation is not improving, and that growing human populations and unsustainable rates of resource consumption will result in increasing negative impacts on biodiversity.

VI LEGISLATION

Compliance with provincial, national and international legislative aspects is recommended in the planning, assessment, authorisation and execution of this particular project. Relevant legislation includes, but is not necessarily limited to the following:

- Biodiversity Act (No. 10 of 2004);
- Conservation of Agricultural Resources Act 43 of 1983;
- Constitution of the Republic of South Africa (Act 108 of 1996);
- Convention on Biological Diversity, 1995;
- Convention on International Trade in Endangered Species of Wild Life and Fauna;
- Environment Conservation Act (No. 73 of 1989);
- National Environmental Management Act (No. 107 of 1998);
- National Forests Act, 1998 (No 84 of 1998);
- Protected Areas Act (No. 57 of 2003); and
- White Paper on the conservation and sustainable use of South Africa's biological diversity.

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1 EXECUTIVE SUMMARY

The aim of this report is to provide the reader an overview of the terrestrial ecology, regional biodiversity and inherent ecological sensitivity of the study area, highlighting specific areas or aspects that are likely to be affected adversely by the proposed development on a regional- or local scale. Results of the respective biophysical, floristic and faunal investigations are incorporated into the biodiversity EIA in order to ascertain the significance of identified impacts on the terrestrial ecology and biodiversity of the region resulting from the construction and operation of the proposed power lines and substation.

The two proposed 400kV power lines will be located between the new Delta Substation and the existing Witkop Substation, comprising a distance of approximately 200km. A new substation near Mokopane will be constructed to integrate lines into the transmission netword from the new Medupi Power Station towards the Mokopane region.

1.1 Biophysical Attributes

The western and central parts of the study area are largely untransformed, comprising natural and pristine woodland savanna, while the eastern parts are characterised by a relative high degree of transformation, comprising urban and settlement areas as well as agricultural areas that are mainly restricted to the eastern areas and in close vicinity of larger rivers where irrigation is practised. The transformation of land reflects the land use and topography of the region. Areas that are topographically heterogeneous are generally not suited for intensive land use categories such as urbanisation or agriculture and comprise extensive land uses such as game farming, eco-tourism and cattle farming. Remaining natural habitat within these parts comprise relatively large tracts that are characterised by low isolation and fragmentation factors. Conversely, areas that are characterised by plains and gently undulating topography is generally densely populated and also characterised by fairly intensive utilisation factors. Remaining natural habitat within these parts comprise small areas that are characterised by high isolation and fragmentation factors.

A GIS analysis of contours in the study area revealed that the central parts of the study area are topographically heterogeneous, comprising extensive areas where slopes exceed 5° (8.8%). All areas that were identified as mountains or ridges (with slopes exceeding 5°) are regarded highly sensitive; these parts are frequently associated with certain morphological classes, such as escarpments, high mountains and table lands.

A number of declared conservation areas are situated within the study area. While few of these areas are likely to be affected directly by some of the proposed corridors, the proximity of the proposed power lines to some conservation areas will contribute to extensive cumulative impacts, increasing existing fragmentation and isolation levels.

Areas of surface water are present throughout the study area, mostly in the form of rivers, perennial and non-perennial streams and numerous smaller drainage lines. All areas of surface water are regarded highly sensitive as it contributes significantly towards the local and regional biodiversity of an area due to the atypical habitat that is present within the interface of terrestrial and aquatic habitat types. Rivers also represent important linear migration routes for a number of fauna species as well as a distribution method for plant seeds.

Land cover categories were categorised into classes that represent natural habitat or categories that constitute habitat degradation and transformation. In terms of the importance for biodiversity on a local and regional scale the assumption is made that landscapes that exhibit high levels of transformation are normally occupied by plant communities and faunal assemblages that do not reflect the original or pristine status of an area or region.

A total of 10 regional vegetation types are represented within the proposed power line corridor alternatives, two of which is ascribed a Vulnerable conservation status, namely Central Sandy Bushveld and Makhado Sweet Bushveld.

Biophysical habitat sensitivities were calculated by means of a GIS analysis of overlaying databases of biodiversity attributes. The southern and central areas are regarded more sensitive, mainly as a result of the presence of important biophysical attributes as well as several conservation areas. The general lower sensitivities of areas in the northern part of the study area is mainly the result of high fragmentation and isolation factors caused by the presence of agricultural areas, urban developments, settlement areas and road infrastructure.

In terms of biophysical sensitivities, the combination of Corridor 7 (west) with either Corridor 2 or Corridor 8 Deviation (middle) and Corridor 5 (east), are regarded the least sensitive in terms of biophysical sensitivity attributes of the region. The proposed substation site alternatives are situated within areas of moderate or moderate-high biophysical habitat sensitivity. However, the proximity of Substation Site 1 to transformed and degraded areas, as well as the recommended use of Corridor 2, renders this site the most preferred option. Substation Site 4 is regarded the least suitable option as the required turn-in lines will inevitably result in localised impacts on natural vegetation.

1.2 Floristic Attributes

The aim of this section is to provide the reader with an overview of floristic attributes and sensitivity of the study area. The compilation of detailed species lists for the study area was not perceived as part of the scope of this environmental impact assessment due to the size of the study are and the time that would be required for a study of such a nature. Available information indicates a range of between 22 and 961 plant species within the ¼ degree grids within which the study area falls, with an average of 184 species per grid, with an estimated total of 1,656 species. Of the 22 ¼ degree grids in the study area, only 5 grids are present where the total number of known species exceeds 300. The existing database is therefore not regarded an accurate reflection of the actual floristic diversity of the region.

The vegetation of the study area, considering the diversity, primary status and availability of habitat types, is regarded diverse on a local and regional scale. A basic dissemination of the growth forms occurring in the study area revealed a prominence of shrub and tree species, which is also reflectd by the woodland physiognomy of the region.

All areas of natural vegetation that are regarded to be in a primary status are considered moderately suitable for the presence of Red Data flora species. It is regarded likely that numerous Red Data flora species are present within areas of natural/ pristine vegetation. Available data indicates the presence of 319 Red Data plant species within the Limpopo Province. A total of approximately 35 flora species with conservation importance are known to occur in the study area, summarised in Appendix 1 (excluding Least Concern taxa). Habitat types where Red Data species typically occur include the following:

- Pristine/ well managed grassland and woodland habitat;
- Riparian/ wetland habitat, particularly ecotonal zones;
- Ridges, mountains and outcrops; and
- Formal and informal conservation areas.

A total of 14 tree species included in the national list of declared protected tree species are known to occur in the study area. While this list may not be comprehensive, it provides a good indication of the presence of protected tree species within the study area. A particularly high density of Baobab (*Adansonia* digitata) individuals is present in the central southern part of the study area (Corridor 1).

Results of the floristic habitat sensitivity calculations indicate the following:

Corridor 7:	Low floristic sensitivity (suitability not relevant, western section);
Corridor 1:	High floristic sensitivity (least suitable, middle section);
Corridor 2:	Low floristic sensitivity (most suitable, middle section);
Corridor 8A:	Moderate floristic sensitivity (moderately suitable, middle section);
Corridor 8B	Moderate floristic sensitivity (moderately suitable, middle section);
Corridor 8 Deviation	High floristic sensitivity (low suitability, middle section);

Corridor 4: High floristic sensitivity (least suitable, eastern section);
Corridor 5: Low floristic sensitivity (most suitable, eastern section); and
Corridor 6: Moderate floristic sensitivity (moderately suitable, eastern section).

Results indicate the presence of extensive Medium-High vegetation types within Corridors 1 and 8 Deviation, resulting in high floristic sensitivity values of both these corridors. It is evident that the extent of High sensitivity habitat (Waterberg Mountain Bushveld) within Corridor 1 is a main reason for the High floristic sensitivity of this particular corridor. In comparison, the presence of extensive areas of Medium-High habitat within Corridor 8 Deviation is a reflection of the length of this corridor, comprising Roodeberg Bushveld and Makhado Sweet Bushveld in particular. The extent of High sensitivity habitat within this particular corridor is relative low, comprising the second lowest total. However, Corridors 1 and 8 Deviation are regarded the least preferred options in terms of floristic sensitivity.

Floristic sensitivity calculations indicate that the combination of Corridor 7 with Corridor 2 and Corridor 5 or 3 are regarded the least sensitive in terms of floristic attributes.

The proximity of Substation Site 1 to transformed and degraded areas and the moderately transformed status of the proposed site render this option the least sensitive in terms of natural vegetation. Options 3 and 4 are situated in areas where the vegetation is regarded natural and are therefore regarded less suitable for the proposed development.

1.3 Faunal Attributes

The aim of this section is to provide the reader with an overview of faunal attributes and inherent faunal habitat sensitivity of the study area. Due to the size of the study area, and a high level of habitat variation and information biases in the available databases, the focus of this faunal assessment is on landscape– or habitat diversity conservation. As a result, no lists of observed species or species likely to occur (other than Red Data fauna predictions) are presented. Such lists would have no real purpose or add significant value to the comparative sensitivity analyses or impact assessments. Also, only free roaming fauna species are considered in this assessment. Impacts of the proposed project on introduced fauna species, Red Data breeding programmes in particular, represent an economic impact and not an impact on biodiversity. The presence of these species in an area does not contribute to the biodiversity of the region and these impacts do not form part of this particular assessment.

The following numbers of Red Data species are listed for the Limpopo Province:

- 7 butterfly species;
- 2 frog species;
- 8 reptile species; and
- 72 mammal species.

The following statuses are ascribed to these species:

- 26 species are listed as Data Deficient (DD);
- 29 species are listed as Near Threatened (NT);
- 22 species are listed as Vulnerable (VU);
- 8 species are listed as Endangered (EN);
- species are listed as Critically Endangered (CR); and
- 1 species is listed as Extinct (EX).

Probabilities of occurrence in the study area for Red Data fauna species are as follows:

- 50 species are estimated to have a low likelihood of occurring in the study area;
- 11 species are estimated to have a moderate likelihood of occurring in the study area; and
- 28 species are estimated to have a high likelihood of occurring in the study area.

Based on the methodology and results discussed above, the following sensitivities and preferences in terms of the proposed project are assigned to the seven corridors and three alternative lines:

Corridor 7:	Low faunal sensitivity (preference not relevant, western section);
Corridor 1:	High faunal sensitivity (least preferred, middle section);
Corridor 2:	Low faunal sensitivity (most preferred, middle section);
Corridor 8A:	Moderate faunal sensitivity (second least preferred, middle section);
Corridor 8B	Moderate faunal sensitivity (second least preferred, middle section);
Corridor 8 Deviation	Moderate/ Low faunal sensitivity (moderate suitability)
Corridor 4:	High faunal sensitivity (least preferred, eastern section);
Corridor 5:	Moderate faunal sensitivity (most preferred, eastern section); and
Corridor 6:	Moderate faunal sensitivity (second least preferred, eastern section).

The proximity of Substation Site 1 to transformed and degraded areas and the moderately transformed status of the proposed site render this option the least sensitive in terms of natural vegetation. Options 3 and 4 are situated in areas where the vegetation is regarded natural and are therefore regarded less suitable for the proposed development.

1.4 Ecological Sensitivity Integration & Recommendations

Results of the ecological integration of the biophysical-, floristic- and faunal habitat sensitivity calculations indicate the following:

Corridor 7:	Low ecological sensitivity (preference not relevant, western section);
Corridor 1:	High ecological sensitivity (least preferred, middle section);
Corridor 2:	Low ecological sensitivity (most preferred, middle section);
Corridor 8A:	Moderate ecological sensitivity (second least preferred, middle section);
Corridor 8B	Moderate ecological sensitivity (second least preferred, middle section);

Corridor 8 Deviation	Moderate ecological sensitivity (suitable, middle section);
Corridor 4:	High ecological sensitivity (least preferred, middle section);
Corridor 5:	Low ecological sensitivity (most preferred, middle section); and
Corridor 6:	Moderate-high ecological sensitivity (second least preferred, middle section);

Calculations in the respective disciplines reflect the eventual integrated results. From the integration of the respective biophysical-, floristic- and faunal habitat sensitivity calculations and ratings it is evident that Corridors 1 (middle section) and 4 (eastern section) are not regarded suitable for the proposed project. Conversely, Corridors 2 (middle section) and 5 (eastern section) are regarded the least sensitive in terms of ecological attributes and is therefore recommended for the proposed project.

Although Corridors 8A and 8B are existing lines and would normally represent lower levels of impacts, it was indicated by Eskom that technical constraints in certain areas will not allow the construction of new lines directly adjacent to the current lines. These space constraints are mainly the result of topographical diversity of landscape features. New lines will therefore have to deviate from existing lines in certain areas to allow for sufficient space for the servitude. Inevitably, where such topographical constraints occur, ecological sensitivity is invariably high and the expected impacts of construction and operation of power lines in these parts are regarded extremely high, similar to Corridor 1.

The moderate suitability of Corridor 8 Deviation is strongly biased by the Floristic sensitivity. As indicated in the relevant section, this sensitivity reflects the presence of extensive areas of Medium-high floristic sensitivity which is the result of the length of the alignment. The extent of High floristic sensitivity habitat within this alignment is actually lower than in other corridors. The suitability of this line for the proposed project is also strongly influenced by the presence of an existing line for much of the alignment, rendering this option also suitable for the project. It should be mentioned that this statement only holds true where the approved servitude follows the existing line. Should the servitude deviate from the existing line outside the deviation, the sensitivity will increase proportionally and suitability will decrease. Impacts in areas where new lines deviate from the existing corridor are regarded as a ‘new’ impact, in spite of the presence of an existing line in the nearby vicinity. Effects of construction and operation will therefore not be lessened or masked by the presence of existing lines in these areas.

Results of the respective disciplines indicate the moderate-high sensitivity of Substation sites 3 and 4 and the suitability of Substation site 1 for the proposed project.

1.5 Ecological Impact Assessment

Rating of impacts in this section is based on the estimated effect that construction and operation of power lines, proposed substations and associated turn-in lines will have on biodiversity attributes in the study area. No impacts were identified that could lead to a beneficial impact on the ecological environment of the study area since the proposed development is largely destructive.

Potential impacts include the following, but are not necessarily limited to:

- Direct impacts:
  - Destruction of threatened flora species;
  - Destruction of protected tree species;
  - Direct impacts on threatened fauna species;
  - Direct impacts on common fauna species;
  - Destruction of sensitive/ pristine regional habitat types;
- Indirect Impacts:
  - Floristic species changes within the servitudes;
  - Faunal interactions with structures, servitudes and personnel;
  - Impacts on surrounding habitat/ species;
- Cumulative Impacts:
  - Impacts on SA's conservation obligations & targets;
  - Increase in local and regional fragmentation/ isolation of habitat; and
  - Increase in environmental degradation.

Results of the impact assessment generally indicate the high significance of expected impacts associated with development in pristine woodland areas in the southern and central parts of the study area. These impacts are regarded extremely high and the use of these areas for the proposed project is not recommended. Conversely, compared to the central and southern areas, the northern part of the study area is lower in general ecological sensitivity and is more suitable for the proposed development.

Mitigation of impacts is mainly aimed at limiting the effects of construction and servitude maintenance activities.

2 INTRODUCTION

When natural systems are rezoned for development, indigenous flora are replaced by exotic species and converted to sterile landscapes with no dynamic propensity or ecological value. Additionally, developments rarely focus on decisive planning to conserve natural environments, while little thought is normally given to the consequences on the ecological processes of development in highly sensitive areas.

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

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

Bathusi Environmental Consulting (BEC) was appointed by Savannah Environmental (Pty) Ltd as independent ecological specialists to compile a strategic ecological impact assessment report for the proposed development.

3 PROJECT BACKGROUND

In order to evacuate the power generated at the new Medupi Power Station, support the upsurge in demand for the platinum group metals in the Mokopane area, and to improve the reliability of electricity supply to the Polokwane area, Eskom Transmission is proposing the introduction of the Mokopane Integration project, which includes the construction of a new substation in the Mokopane area and associated transmission line infrastructure to integrate this substation into the transmission network.

The existing transmission power lines from the Lephalale area will not be able to evacuate the additional 4,500MW of power from the new Medupi Power Station without compromising network reliability and integrity during both operation and maintenance activities. Eskom have investigated various options for optimisation of the transmission system and is planning the construction of new alternating current (AC) transmission power lines as an effective and efficient way to transport electricity from the Medupi Power Station to transmission substations in the Limpopo Province. Witkop Substation is currently the only nodal point in the Polokwane area that is supporting platinum group metals load growth. The load forecast shows a shift of load towards the Mokopane area with several customer applications and the proposed load cannot be supplied from the Witkop Substation alone as there are thermal, voltage stability and space constraints. In total, an estimated 410km of new power lines are proposed.

Therefore, Eskom Transmission proposes the introduction of the following components:

- Construction of a new 400/132kV substation near Mokopane;
- Integration of the new substation into the transmission system by looping in and out of one of the existing Matimba-Witkop 400kV transmission lines (i.e. two lines in parallel for a distance of approximately 10km);
- Construction of a new 400kV transmission power line between the Delta Substation and the new Mokopane Substation, a distance of approximately 150km;
- Construction of a new 400kV transmission power line between the new Mokopane Substation and the existing Witkop Substation, a distance of approximately 60km;
- Construction of a new 400kV transmission power line between the Delta Substation and the existing Witkop Substation, a distance of approximately 200km; and
- Associated works to integrate the new substation into the Transmission grid (such as access roads, communication tower, etc) and accommodate the new lines at existing substations (such as the construction of new feeder bays within the existing substation site).

The following line alternatives will be investigated in this assessment:

- Delta – Medupi 1 (Corridor 7);
- Matimba – Witkop (Corridor 8, existing line);
- Medupi – Mokopane 1 (Corridor 1);
- Medupi – Mokopane 2 (Corridor 2);
- Mokopane – Witkop 1 (Corridor 4);
- Mokopane – Witkop 2 (Corridor 5);
- Mokopane – Witkop 3 (Corridor 6); and
- Medupi – Mokopane Deviation (Corridor 8 Deviation).

4 SCOPE OF WORK

- Compile a report on the regional biodiversity sensitivities of the study area;
- Assess the status of biophysical attributes within the study area that have a bearing on biodiversity of the study area;
- Obtain relevant Red Data flora information and evaluate Red Data taxa probabilities;
- Obtain PRECIS data in order to highlight existing knowledge of the species richness of the region;
- Compile a ecological sensitivity map that will highlight areas of ecological importance as it relates to the construction and operation of power lines;

- Assess the status of biodiversity attributes in areas identified as sensitive to the construction and operation of power lines;
- Identify any areas that may be considered 'no-go' areas from an ecological perspective;
- Provide a description of the general ecological status of recommended corridors and substation site alternatives and evaluate the status of Red Data flora and fauna habitat and probabilities of occurrence for Red Data species;
- Assess the nature and extent of the potential impacts that are likely to result from the construction and operation of identified power lines and substation on the ecological integrity of identified corridors and substation sites during the construction and operational phases;
- Assess the ecological sensitivity of identified corridors and substation sites to the construction and operation of the identified power lines and substation subsequent to the implementation of suitable mitigation measures; and
- Assess and propose potential mitigation measures that can be applied during the construction and operational phases that will minimise impacts on the biodiversity of the recommended corridors and substation site.

5 LIMITATIONS OF THIS INVESTIGATION

- This report is based on a strategic investigation and selective sampling of some parts of the study area.
- 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 to them, obtained from these strategic assessments or requests made to them for the purpose of this report.
- Additional information may come to light during a later stage of the process for which no allowance could have been made at the time of this report.
- No definite conclusions may be drawn with regards to biological diversity or conservation strategies as far as this report or the study area is concerned.
- BEC withholds the right to amend this report, recommendations and/ or conclusions at any stage of the project should significant or additional information comes to light.
- Information contained in this report cannot be applied to any other area, however similar in appearance or any other aspect, without proper investigation.

6 APPROACH TO THE STUDY

While a proper knowledge of the biodiversity of the region is not negotiable for the ultimate success of this project, an attempt was made to remove subjective opinions that might be held on any part of the study area as far as possible. Inherent characteristics of a project of this magnitude and nature implies that no method will be foolproof in all instances as a result of the shortcomings in available databases and lack of site specific detail that could be obtained from site investigations in a short period of time.

It is an unfortunate fact that inherent sensitivities of certain areas are likely to exist that could not be captured or illustrated during the process. This is a shortcoming of every scientific study that has ever been conducted; it simply is not possible to know everything or to consider aspects to a level of molecular detail. However, the approach followed in this study is considered effective in presenting objective comments on the comparison of biodiversity sensitivity of parts in the study area that are frequently separated by vast distances. In order to present an objective opinion of the biodiversity sensitivity of the study area and how this relates to the suitability/ unsuitability of a specific area in terms of the proposed development, all opinions and statements presented in this document are based on three aspects, namely:

- Specialist interpretation of available data, or known sensitivities of certain aspects;
- Augmentation of existing knowledge by means of field surveys and site specific information; and
- An objective mathematical calculation of results obtained from the process.

6.1 Background Information

All species have certain habitat preferences and specific requirements in terms of nutrient/ food requirements, shelter, moisture, etc. in order to successfully live and propagate. These specific requirements are only known for a few species on earth; the remainder remains mostly unknown. The ability to withstand changes to the environment in which species occur is generally known as the tolerance levels of species. These tolerance levels have plastic and elastic characteristics which complicate the process of impact assessments, as the long-term reaction of species to forced changes is mostly not known, or cannot be predicted to an acceptable level of accuracy.

Common species are generally characterised by high tolerance levels and these species are able to adapt to changing and varying habitat types. In contrast, most of the threatened species have extremely low tolerance levels to habitat changes and other impacts, which is one of the main reasons for having a threatened status. Slight changes to the environment in which these species occur might result in catastrophic impacts on the community.

Identification of areas in which these species occur represents a major objective of this study. The overall goal of this particular investigation is therefore to assess the biodiversity sensitivities of the region by means of the Ecosystem Approach or Landscape Ecology. The Ecosystem Approach is advocated by the Convention on Biological Diversity. It recognises that people and biodiversity are part of the broader ecosystems on which they depend, and these ecosystems should therefore be assessed in an integrated way by means of a study of spatial variation in landscapes at a variety of scales. Principles of the Ecosystem Approach include the following:

- The objectives of ecosystem management are a matter of societal choice.
- Ecosystem managers should consider the effects of their activities on adjacent and other systems.
- Conservation of ecosystem structure and functioning, to maintain ecosystem services, should be a priority target.
- Ecosystems must be managed within the limits of their functioning.
- The approach must be undertaken at appropriate spatial and temporal scales.
- Objectives for ecosystem management should be set for the long-term.
- Management must recognise that change is inevitable.
- The approach should seek an appropriate balance between, and integration of, conservation and use of biodiversity.
- All forms of relevant information should be considered.
- All relevant sectors of society and scientific disciplines should be involved

For the purpose of this particular study a regional scale was selected as suitable in terms of the size of the study area. The approach of Landscape Ecology includes the assessment of biophysical and societal causes, consequences of landscape heterogeneity and factors that cause disturbance to these attributes. In laymen's terms it implies that if sensitive habitat types/ ecosystems (frequently associated with biodiversity elements of high sensitivity or conservation importance) are protected, the species that are highly sensitive to changes in the environment will ultimately be protected. Species conservation is therefore replaced by habitat conservation. This approach is regarded as being effective since the protection of sensitive ecosystems will ultimately filter down to species level.

It is inevitable that the Landscape Ecology Approach will not function effectively in all instances since extremely localised and small areas of sensitivity do occur scattered in the study area, which are not captured on available databases or might have been missed during the regional assessments. The interaction of landowners that are intimately familiar with their land plays an important role in this regard and the information that is provided by them will serve to append existing knowledge where information gaps might exist. A safeguard in this regard is also represented by the final phase of the project that will involve a detailed walkthrough of the final surveyed routes, should the project be authorised. During this phase these small and localised areas can be avoided by means of localised deviations of sections of the power line. Every effort will be made to ensure that all sensitive floristic and faunal attributes are removed from the proposed substation sites prior to the commencement of construction activities, or to include pertinent recommendations in the EMP.

The compilation of exhaustive species lists and the identification and description of localised ecological habitat types did not represent objectives of this study, mainly as a result of the extreme size of the study area and time constraints that a study of such detail would imply. It was therefore regarded important to identify areas of sensitivity on a regional scale and, where possible, communities or species that are considered sensitive in terms of impacts that are likely to result from the proposed development. Results obtained from this approach are regarded effective in establishing broad sensitivities of extensive areas. In most cases these sensitivities are employed effectively in avoidance of significant environmental impacts on the biological environment. The final walk-through phase represents the final effort of avoiding localised impacts on the biological environmenta by means of slight readjustments of corridors and tower placements.

This ecological investigation therefore aims to:

- determine the sensitivity of the receiving natural environment as it relates to the construction and operation of the proposed power lines and substation in a natural environment;
- highlight the known level of biodiversity;
- highlight flora and fauna species of conservation importance that are likely to occur within the study area;
- estimate the level of potential impacts of the construction and operation of proposed power lines and substation on the biological resources of the study area;
- make contributions in the route and substation site nomination in order to prevent or minimise unacceptable adverse impacts on the biological environment; and
- apply the Precautionary Principal throughout the assessment[1].

6.2 Assessment of Biophysical Attributes

6.2.1 Data Selection Process

Available databases of biophysical attributes are implemented to identify regional areas of importance as it relates to biodiversity. Biophysical attributes that are known to be associated with biodiversity aspects of importance, conservation potential or natural status of the environment were implemented to compile the ecological sensitivity analysis of the study area. These attributes include the following:

- Areas of conservation (National Parks, Nature Reserves, Biospheres, etc.);
- Areas of known floristic or faunal importance;
- Areas of surface water;
- Degradation classes (ENPAT Land Cover Classes);
- Morphological attributes;

[1] (www.pprinciple.net/the_precautionary_principle.html).

- Regional vegetation types (VEGMAP); and
- Ridges (as classified by GIS analysis, slopes exceeding 5° or 8.8%).

The first step in assessing the biophysical aspects of importance is the delineation of natural habitat, or the exclusion of transformed or degraded habitat. Areas that are transformed as a result of human activities, including agriculture, mining, urban development, etc, constitute parts of the study area where no natural habitat remains and where natural biodiversity is entirely compromised, to the extent that any recovery to a previous, pristine status is regarded as being impossible. These areas are regarded most suitable for the purpose of construction and operation of power lines and substation since any impact on important biological resources is regarded unlikely. Ultimately, areas that are characterised by high levels of transformation or degradation or which are characterised by low occurrences of biophysical aspects of biodiversity importance, will be considered more suitable for the proposed development than areas constituting large tracts of untransformed and sensitive habitat types.

Secondly, sensitivity values are ascribed to biophysical attributes based on how these contribute to biological diversity or sensitivity. Ultimately all the information is compiled to present a holistic picture of the areas where biophysical aspects of importance occur, presenting a map that depicts regional biodiversity sensitivities based on biophysical attributes.

6.2.2 Biophysical Sensitivities - GIS Analysis

The method that is described below is believed to present a holistic view of the biodiversity sensitivity of an area, based on available data as well as the specialist's interpretation of the sensitivity of aspects that are contained in the databases. In specific cases an adjustment of sensitivity of certain areas were made based on information that was obtained from field surveys as well as information that was presented from landowners and interested parties.

The GIS analysis of data was compiled in three stages, namely:

- As a first approximation an assessment was compiled during which available databases were assessed for suitability of use in this particular project. Every attempt was made to utilise the most recent available data; databases were replaced as newer information became available even during late stages of the assessment. Each database was separated into different aspects in terms of how it affects biodiversity sensitivity on a local and regional scale:
    - o A certain biodiversity sensitivity was ascribed to respective attributes of each database, for example, the 'Land Cover' database was separated into respective classes in the manner in which it affects the local and regional biodiversity sensitivity, i.e. classes such as 'Agricultural', 'Urban Developments' and 'Degradation' was grouped and ascribed a LOW value;

- Care was taken to avoid duplicity between the various databases, for instance, aspects such as 'Woodland' and 'Grassland' was omitted from the 'Land Cover' database as these classes are adequately represented by the VEGMAP database;
- Care was also taken of existing gaps of information in available databases, for example; while the ENPAT database of rivers does reflect larger rivers on a national scale, additional data is available in other databases that are not necessarily captured in the ENPAT database;
- Where a single database contains different classes of sensitivity, these databases were split in the respective classes for layering;
- Available databases were subsequently layered in the manner to reflect the maximum biodiversity sensitivity of an area, i.e. all transformed classes were placed on top to present the extent of degraded habitat. Subsequent layers were placed in order from high to low biodiversity sensitivity, aspects such as 'Slopes' and 'Rivers' (HIGH sensitivity) enjoyed preference to aspects such as 'VEGMAP Units with MEDIUM-HIGH sensitivity', which on turn enjoyed preference to aspects such as 'VEGMAP Units with MEDIUM sensitivity, ultimately enjoying preference to aspects of lower sensitivity such as Morphology classes of MEDIUM-LOW sensitivity;
- The resultant map provided a basic assessment of the potential sensitivity on a local and regional scale;

* Subsequent analysis of the databases used in the first step was conducted by a GIS specialist:
  - Shapefiles of databases that were used were transformed to a 'Rastar' image of data and overlaid in the same order as the initial assessment. Every pixel represents an area of approximately 30m by 30m;
  - Every pixel of the respective databases were ascribed a biodiversity sensitivity value, ranging from 0 – No Significance (for example 'Transformed Habitat') to 5 – High Significance ('Rivers'),
  - The respective databases were then condensed to present a single image in which the maximum biodiversity value of the respective databases is accepted as representative of the biodiversity value of that particular area. For example, a pixel might be represented by the following aspects: 'Conservation Area' (5), 'River Buffer' (4), 'VEGMAP – Central Sandy Bushveld' (3) and 'Morphology – Slightly Irregular Plains' (2). The pixel sensitivity would therefore be accepted as (5), being represented by the biodiversity sensitivity of the highest value. This is described as Mutual Exclusivity;
  - The only exception to this rule is in the case of transformed habitat were a 0 value is attributed to the pixel, based on the assumption that all transformed habitat does not contain any significance in terms of biodiversity. For example, a pixel might be represented by the following aspects: 'Slopes' (5), 'VEGMAP – Moot Plains Bushveld' (3) and 'Urban Development (0). The pixel sensitivity would therefore be accepted as (0) since it is assumed that the 'Urban

Development' class implies that all natural habitats have been transformed and no natural habitat remains;

- The last step in the analysis represents the calculation of sensitivity classes within the proposed corridors. The compiled raster image of the biodiversity sensitivity map was 'clipped' with each of the corridors and the extent (in hectares) of each sensitivity class (0 – 5) was calculated and subjected to further analysis (please refer Section 15 of this document, for calculation procedures).

6.3 Assessment of Floristic Attributes

6.3.1 Floristic Patterns & Regional Diversity

In order to obtain an overview of the status of the vegetation within the study area, a selection of sample plots was investigated throughout the study area. Strategic investigation into the status of the vegetation included the following:

- Comments pertaining to general floristic diversity;
- General status of vegetation;
- Presence and status of primary vegetation;
- General land transformation and degradation status;
- Habitat suitability for Red Data flora species;
- General sensitivity pertaining to the construction and operation of power lines;
- Baseline PRECIS data obtained from SANBI was obtained to present an overview of the regional diversity of plants; and
- Data and information obtained from landowners during interviews as well as information presented during the public participation process.

6.3.2 Floristic Sensitivity

The floristic sensitivity of the respective corridors is a subjective assessment of habitat types, implementing the regional vegetation types, as described in the VEGMAP database. Sensitivities are based on the following criteria:

- Delineation of all remaining natural vegetation (exclusion of all transformed and degraded habitat);
- A subjective assessment of the primary status of the vegetation during the field surveys;
- The likelihood of an area occupying a community of Red Data flora species based on habitat attributes, also considering the list of Red Data species known to occur in the area;
- The presence of protected tree species; and
- General physiognomic attributes.

The total area of remaining natural vegetation occupied within the respective corridors was calculated by GIS analysis and estimated floristic sensitivities ascribed to each vegetation type, as follows:

No/ Zero Floristic Sensitivity	0
Low Floristic Sensitivity	1
Medium Floristic Sensitivity	3
Medium-High Floristic Sensitivity	4
High Floristic Sensitivity	5

These sensitivity values are used as weighting values and simply multiplied by the extent of remaining natural habitat within each of the alternative corridors in order to obtain an estimated floristic sensitivity for each line based on the extent of sensitive habitat and the sensitivity thereof present within each of the corridors. Values are divided by 1,000 for comparison with other disciplines.

6.3.3 Red Data Flora Assessment

A list of Red Data flora species that occur within the study area was obtained from SANBI. In most cases very little information is available about the habitat preferences of these species. However, habitat types in which these species normally occur are highlighted in the sensitivity analysis of the study area.

6.4 Assessment of Faunal Attributes

The association of faunal assemblages and vegetation communities is well known and the regional vegetation types are therefore used as an indication of the potential distribution of fauna species, taking the habitat preference and general requirements of fauna species into consideration.

6.4.1 Ground Truthing

A total of fifty-one (51) randomly selected sample plots were used to assess the validity of the databases used in the data analyses. The objective of these sample plots was to ascribe a ‘visual sensitivity value’ to the general environment as observed at the point, ultimately comparing this value to the result obtained from the GIS analysis. The descriptions of the habitat sensitivity as viewed at these waypoints are not only a reflection on the accuracy of the data itself, but also of the data analyses, results thereof and the validity of assumptions. In addition, various visual observations were made at the proposed substation sites as well as at all possible locations where corridors cross roads or at possible access points. Data obtained from interviews with landowners and during the public participation process were taken into consideration in ascribing sensitivity values to certain areas.

6.4.2 Faunal Sensitivity Analysis

Proposed substation sites were compared by means of visual observations and GIS analysis of available data. Respective corridors were compared statistically, based on the surface area of selected environmental features within the corridors. The extent (hectares) of attributes within each line is calculated by means of GIS analysis and weightings are applied to the extent of areas, depending on which attribute is used. Values are divided with 1,000 and added in order to present a faunal sensitivity value which can be compared to other corridors in the same section of the study area. Please note that faunal sensitivity values of corridors in separate sections of the study area cannot be compared as it is based on surface area between two specific points.

- **Transformation**

Land-cover was used to determine level of transformation. Areas of cultivated land (commercial and subsistence), mines and quarries, bare rock and eroded land, built-up areas and degraded habitat (forest, woodland, thicket and bushland) were considered to be transformed and not considered natural or sensitive faunal habitat. The following weightings were applied to attributes:

Transformed Areas	0
Untransformed Areas	1

- **Terrain Morphology**

Morphological classes were used to discern between steep faunal habitat and relatively flat habitat. The importance of topographical heterogeneous areas will be discussed in later chapters. The following weightings were applied to attributes:

Escarpments	2
Hills	1
Low Mountains	2
Lowlands with Mountains	1
Plains	0
Strongly Undulating Plains	1
Tablelands	2

- **Formal Conservation Areas**

The following weightings were applied to attributes:

Conservation Areas	5
Buffer Zones	3
Not Conservation Areas	0

- **Rivers**

All riparian habitats, with an additional 100m buffer zone, are regarded important faunal habitat and a high sensitivity is ascribed to these particular parts of the study area. The following weightings were applied to attributes:

Rivers	5
Not Rivers	0

- **Specific fauna habitat (as indicated by ENPAT)**

The following weightings were applied to attributes:

General faunal habitat	0
Special faunal habitat	3
Red Data faunal habitat	5

6.4.3 Red Data Fauna Probabilities

Red Data fauna of the Limpopo Province of South Africa were assessed in terms of known geographical ranges and habitat requirements. Based on available data, the probability of their occurrences in the study area, and within the corridors of each of the lines were estimated. Please note that **only** free-roaming animals were included in this assessment. The following groups were assessed:

- Invertebrates, mainly butterflies (IUCN 2003, http://sabca.adu.org.za);
- Amphibians (Minter *et al* 2004);
- Reptiles (http://sarca.adu.org.za); and
- Mammals (Endangered Wildlife Trust, 2004).

Three parameters were used to assess the Probability of Occurrence for Red Data species:

- Habitat requirements (HR) - Red Data animals have specific habitat requirements and the presence of these habitat characteristics in the study area is evaluated.
- Habitat status (HS) - The status or ecological condition of available habitat in the study area is assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water quality plays a major role); and
- Habitat linkage (HL) - Movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to surrounding habitats and adequacy of these linkages are evaluated for the ecological functioning of Red Data species within the study area.

The estimated Probability of Occurrence is presented in five categories, namely:

- very low;
- low;
- moderate;
- high; and
- very high.

6.5 Impact Evaluation

Direct, indirect and cumulative impacts of issues will be assessed in terms of the following criteria.

6.5.1 Nature of the Impact

A description of what causes the effect, what will be affected and how it will be affected.

6.5.2 Magnitude of the Impact

Quantified between the scales of small (will have not effect on the environment) and very high (will result in complete destruction of patterns and permanent cessation of processes).

0 None (where the aspect will have no impact on the environment);
1 Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected);
2 Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected);
3 Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way);
4 High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
5 Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).

6.5.3 Reversibility of the Impact

1 Reversible (regenerates naturally);
3 Recoverable (requires human input); or
5 Irreversible

6.5.4 Duration of the Impact

Determines the expected duration of the impact in terms of years.

1 Immediate (less than 1 year);
2 Short term (1-5 years);
3 Medium term (5-15 years);
4 Long term (the impact will cease after the operational life span of the project); or
5 Permanent (no mitigation measures of natural process will reduce the impact after construction).

6.5.5 Spatial Extent of the Impact

Determines whether the impact will of local (limited to the immediate area or site of development) or regional.

1 Limited to the site and its immediate surroundings;
2 Local/ Municipal extending only as far as the local community or urban area;
3 Provincial/Regional;
4 National i.e. South Africa; or
5 Across International borders.

6.5.6 Probability of Occurrence

Describes the likelihood of the impact actually occurring.

0 None (impact will not occur);
1 Improbable (the possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures);
2 Low probability (there is a possibility that the impact will occur);
3 Medium probability (the impact may occur);
4 High probability (it is most likely that the impact will occur); or
5 Definite / do not know (the impact will occur regardless of the implementation of any prevention or corrective actions or it the specialist does not know what the probability will be based on too little published information).

6.5.7 Status of the Impact

- Negative effect (i.e. at a cost to the environment);
- Positive effect (i.e. at a benefit to the environment); or
- Neutral effect on the environment.

6.5.8 Reversibility of the Impact

The degree to which the impact can be reversed.

6.5.9 Mitigation of the Impact

The degree to which the impact can be mitigated.

6.5.10 Consequence of the Impact

Derived from the following formula:
Consequence = Severity + Reversibility + Duration + Spatial Scale

6.5.11 Significance of the Impact

Based on a synthesis of the information contained in the points above and can be described as low, medium or high. Significance is determined using the following formula:
Significance of environmental impact = Consequence X Probability

- More than 60 significance points indicate HIGH environmental significance;
- Between 30 and 60 significance points indicate MODERATE environmental significance; and
- Less than 30 points indicate LOW environmental significance.

Relevant mitigation measures will be considered and impacts will then be ranked again according to the significance results after mitigation.

7 BACKGROUND TO THE REGIONAL ECOLOGY

South Africa is the third most biologically diverse country in the world, after Indonesia and Brazil. Occupying only about 2% of the global land area, South Africa contains almost 10% of the world's plant species and 7% of the reptile, bird and mammal species.

The study area is situated within the Savanna (Bushveld) Biome, which is the largest Biome in southern Africa, occupying 46% of its area, and over one-third of the area of South Africa. It is well developed over the lowveld and Kalahari region of South Africa and is also the dominant vegetation in Botswana, Namibia and Zimbabwe. It is characterised by a grassy ground layer and a distinct upper layer of woody plants. Where this upper layer is near the ground the vegetation may be referred to as Shrubveld, where it is dense as Woodland, and the intermediate stages are locally known as Bushveld.

Environmental factors delimiting the biome are complex; altitude ranges from sea level to 2,000m; rainfall varies from 235 to 1,000 mm per year, frost may occur from 0 to 120 days per year; and almost every major geological and soil type occurs within the biome. A major factor delimiting the biome is the lack of sufficient rainfall which prevents the upper layer from dominating, coupled with fires and grazing, which keep the grass layer dominant. Summer rainfall is essential for the grass dominance, which, with its fine material, fuels near-annual fires. In fact, almost all species are adapted to survive fires, usually with less than 10% of plants, both in the grass and tree layer, killed by fire. Even with severe burning, most species can resprout from the stem bases.

The shrub-tree layer may vary from 1 to 20m in height, but in Bushveld typically varies from 3 to 7m. The shrub-tree element may come to dominate the vegetation in areas which are being overgrazed. Most of the savanna vegetation types are used for grazing, mainly by cattle or game.

Conservation of savanna is good in principle, mainly due to the presence of the Kruger and Kalahari Gemsbok National Parks within the biome. Similarly, in neighbouring countries, large reserves occur, such as Etosha, Gemsbok, Chobe, Hwange National Parks and the Central Kalahari Game Reserve. However, this high percentage area conserved in South Africa belies the fact that half of savanna vegetation types are inadequately conserved, in having less than 5% of their area in reserves. However, much of the area is used for game-farming and can thus be considered effectively preserved, provided that sustainable stocking levels are maintained. The importance of tourism and big game hunting in the conservation of the area must not be underestimated.

Surprisingly few studies have been done in the central bushveld of South Africa, with most of those that have been done taking place in nature reserves or on game farms, for management planning. Savanna pasturalists often refer to sweet and sour bushveld. This refers to the nutritional value and acceptability of the predominant grasses to grazing animals. Sweet grass occurring on the fertile savanna soils is preferred and selected by animals, and has a high nutritional value throughout the year. Sour grass, on the other hand, occurs on infertile soils and is often avoided by animals, and loses its nutritional value during winter.

The thorny, small-leaved vegetation on the fertile soils is often dominated by *Acacia* species and when the vegetation becomes over utilised, these thorny species tend to increase at the expense of the grass layer, to form dense, impenetrable thickets. This results in serious management problems for game and cattle farming in the area.

Savanna systems and the antelope have developed side by side. Grasses have become well adapted to defoliation, as much a defensive response to constant pressure by grazers as to the regular veld fires that raze through the savanna in the dry seasons. The success of grasses has been a constantly renewed vast reservoir of food upon which herds of grazers flourish. The savanna is also habitat of large animals such as elephant and white rhinoceros. These species are an integral component of savanna, but many browsers, such as kudu, black rhinoceros and giraffe, are adapted to exploit the woody component. 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 grass layer provides diverse sources of food and shelter for birds.

Threats to the savanna regions include rapidly expanding development of settlements for impoverished human populations and the associated need for firewood and building materials, diminishing water supply, agriculture (especially sugar cane and subtropical products) and overgrazing.

In South Africa, savannas support more than 5,700 plant species, exceeded only by the fynbos ecoregion. In respect of animal biodiversity, savannas are richer than any other ecoregion. Flagship species for the grassland include the following:

- Starburst Horned Baboon Spider (*Ceratogyrus bechuanicus*)
- Ground Hornbill (*Bucorvus leadbeateri*)
- Cape Griffon (*Gyps coprotheres*)
- Wild Dog (*Lycaon pictus*)
- Short-Eared Trident Bat (*Cloeotis percivali*)
- White Rhinoceros (*Ceratotherium simum*)

8 THE BIOPHYSICAL ENVIRONMENT

While many biophysical aspects, such as geology, soils and climate, have an influence on the development of the ecology of a region, it is beyond the scope of this report to present a detailed description of each and every aspect and how these relate to potential impacts from the construction and operation of the proposed power lines and substation in the natural environment. Only aspects that have a direct bearing on the current status of the ecology of a region will therefore be assessed.

8.1 Location

The proposed power lines are proposed to be located between the new Delta Substation and the existing Witkop Substation, comprising a distance of approximately 200km. A new substation near Mokopane will form part of the proposed project. Figure 1 illustrates the regional setting of the proposed lines and substations, also indicating the various alternatives that will be considered in this assessment.

8.2 Land Transformation Effects – Habitat Transformation

Figure 2 provides an indication of the remaining untransformed areas within the study area when roads are not taken into consideration. It is evident that the western parts of the study area are largely untransformed and that a high degree of transformation is present in the eastern areas, particularly around urban areas and within areas where agriculture constitutes an important land use activity. Agriculture is mainly restricted to the eastern areas and in close vicinity of larger rivers where irrigated agriculture is practised. The transformation status of natural habitat within the study area reflects the land use and topography of the region. Areas that are topographically diverse are generally not suited for intensive land use categories such as urbanisation or agriculture. Extensive land uses such as game farming, eco-tourism and cattle farming are practiced within these parts. Areas that are characterised by plains and gently undulating topography is generally inhabited and intensively utilised.

Habitat fragmentation is the emergence of discontinuities (fragmentation) in an organism's preferred environment/ habitat and can be caused by geological processes that slowly alter the layout of the physical environment or by human activity such as land conversion, which can alter the environment on a much faster time scale. The former is suspected of being one of the major causes of speciation, while the latter is causative in extinctions of many species.

Habitat fragmentation caused by humans occurs when native vegetation is cleared for human activities such as agriculture, rural development or urbanisation. Remaining habitat fragments are therefore rarely representative samples of the initial landscape. Habitats which were once continuous become divided into separate fragments. After intensive clearing, the separate fragments tend to be very small islands isolated from each other by crop land, pasture, pavement, or even barren land. The term habitat fragmentation includes six discrete phenomena:

- Reduction in the total area of the habitat;
- Increase in the amount of edge;
- Decrease in the amount of interior habitat;
- Isolation of one habitat fragment from other areas of habitat;
- Breaking up of one patch of habitat into several smaller patches; and
- Decrease in the average size of each patch of habitat.

One of the major ways that habitat fragmentation affects biodiversity is by reduction in the amount of available habitat for plants and animals. Plants and other sessile organisms in these areas are usually directly destroyed while mobile animals (especially birds and mammals) retreat into remnant patches of habitat, leading to crowding effects and increased competition.

Species that can move between fragments may use more than one fragment while others must make do with what is available in the single fragment in which they ended up. Area is the primary determinant of the number of species in a fragment. The size of the fragment will influence the number of species which are present when the fragment was initially created, and will influence the ability of these species to persist in the fragment. Small fragments of habitat can only support small populations of plants and animals and small populations are more vulnerable to extinction. Minor fluctuations in climate, resources or other factors, that would be unremarkable and quickly corrected in large populations can be catastrophic in small, isolated populations. Fragmentation of habitat is therefore an important cause of species extinction.

Population dynamics of subdivided populations tend to vary asynchronously. In an unfragmented landscape a declining population can be "rescued" by immigration from a nearby expanding population, but in fragmented landscapes the distance between fragments may prevent this from happening. Additionally, unoccupied fragments of habitat that are separated from a source of colonists by some barrier are less likely to be repopulated than adjoining fragments.

Additionally, habitat fragmentation leads to edge effects. Microclimatic changes in light, temperature, and wind can alter the ecology around the fragment, and in the interior and exterior portions of the fragment. Fires become more likely in the area as humidity drops and temperature and wind levels rise. Exotic and pest species may establish themselves easily in such disturbed environments, and the proximity of domestic animals often upsets the natural ecology. Also, habitat along the edge of a fragment has a different climate and favours different species from the interior habitat.

The existence of viable habitat is critical to the survival of any species, and in many cases the fragmentation of any remaining habitat can lead to difficult decisions for conservation biologists. Given a limited amount of resources available for conservation is it preferable to protect the existing isolated patches of habitat or to buy back land to get the largest possible continuous piece of land. It is however an ongoing debate and is often referred to as SLOSS (Single Large or Several Small).

8.3 Land Transformation Effects - Habitat Isolation

Figure 3 illustrates the categories of isolation when roads are taken into consideration. This figure was compiled by calculating portion sizes of uninterrupted, natural habitat in-between roads, developed areas, urban areas and agricultural areas. Please note that this figure and the inherent assumptions upon which it is compiled are not based on habitat requirements or migration potential of any specific species, but are presented to illustrate the existing level of fragmentation within the general region.

Habitat isolation is defined as the extent to which a parcel of land or habitat of a certain species, or community of species, is separated from other similar habitat, species or communities, where the distance of separation might be larger than what is acceptable for species that occupy an area in order to successfully navigate in order to feed, propagate or inhabit.

The degree of habitat isolation experienced by individuals of a given species depends on many factors. For example, above a particular level of habitat loss the physical distances between habitats patches increase exponentially. For many species, rate of movement between patches of suitable habitat can be reduced as a result. Spatial scale, mobility and mode of movement (e.g. flying versus crawling) are key issues associated with considerations of the impacts of habitat subdivision and habitat isolation. The spatial scales of which a species moves and over which it perceives its environment will strongly influence the extent to which a given modified landscape is, or is not, negatively subdivided or isolated for that taxon. For example, for some small mammal and flightless insect species, a road may effectively subdivide and isolate the populations on either side of it, whereas such a road would have very limited or no impact on more mobile species.

Many of the warnings associated with the themes of habitat loss and habitat degradation are also relevant to considerations of habitat subdivision and habitat isolation. This is because, like habitat loss, what constitutes habitat subdivision and habitat isolation will be species specific. For example, the isolation of vegetation patches defined from a human perspective may not lead to habitat isolation from the perspective of some species. Even in a landscape that is extensively modified by humans, the matrix may be highly permeable for some species. Hence, actual levels of habitat isolation might therefore actually be relatively low for these taxa and recolonisation rates of patches can be high. For other species, the same matrix may be ‘hostile’, meaning that neighbouring patches, although being located relatively close together, are actually very isolated for the specific species.

The spatial isolation of habitat can impair dispersal movements between the natural territory and suitable habitat patches, which are typically made by juvenile or sub-adult animals attempting to establish new territories. This interruption to dispersal can reduce the genetic size of populations through impaired patterns of gene flow. Importantly, effective dispersal involves not only the movement of an individual, but also its successful reproduction in the receiving population. In some cases, males and females of a given species do not respond in the same way to habitat isolation. In addition, the recolonization of vacant territories in some habitat patches by individuals originating from other habitat patches is critical for maintaining the overall demographic size of a given species population. By affecting patterns of dispersal between patches, habitat isolation can have significant effects on the occupancy of otherwise suitable habitat patches, including protected areas like nature reserves. For example, population recovery after disturbance may be imparts by habitat isolation.

Habitat isolation may shift a formerly contiguous and interacting population into a series of loosely connected subpopulations (i.e. metapopulation). A metapopulation is defined as a set of local populations which interact via individuals moving between local populations. However, patchily distribution of populations of a species does not always conform to a true metapopulation structure.

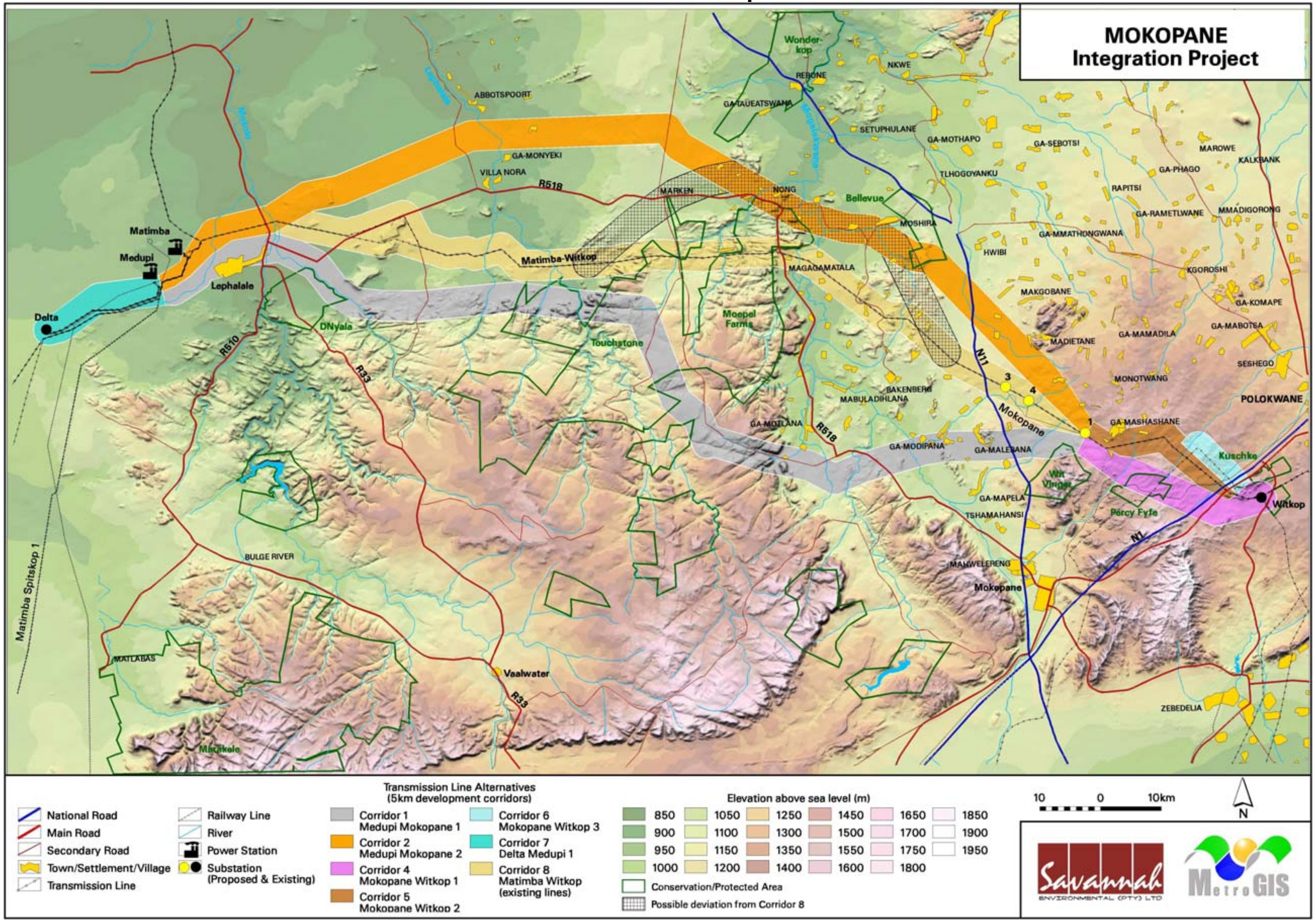

Figure 1: Location of the study area

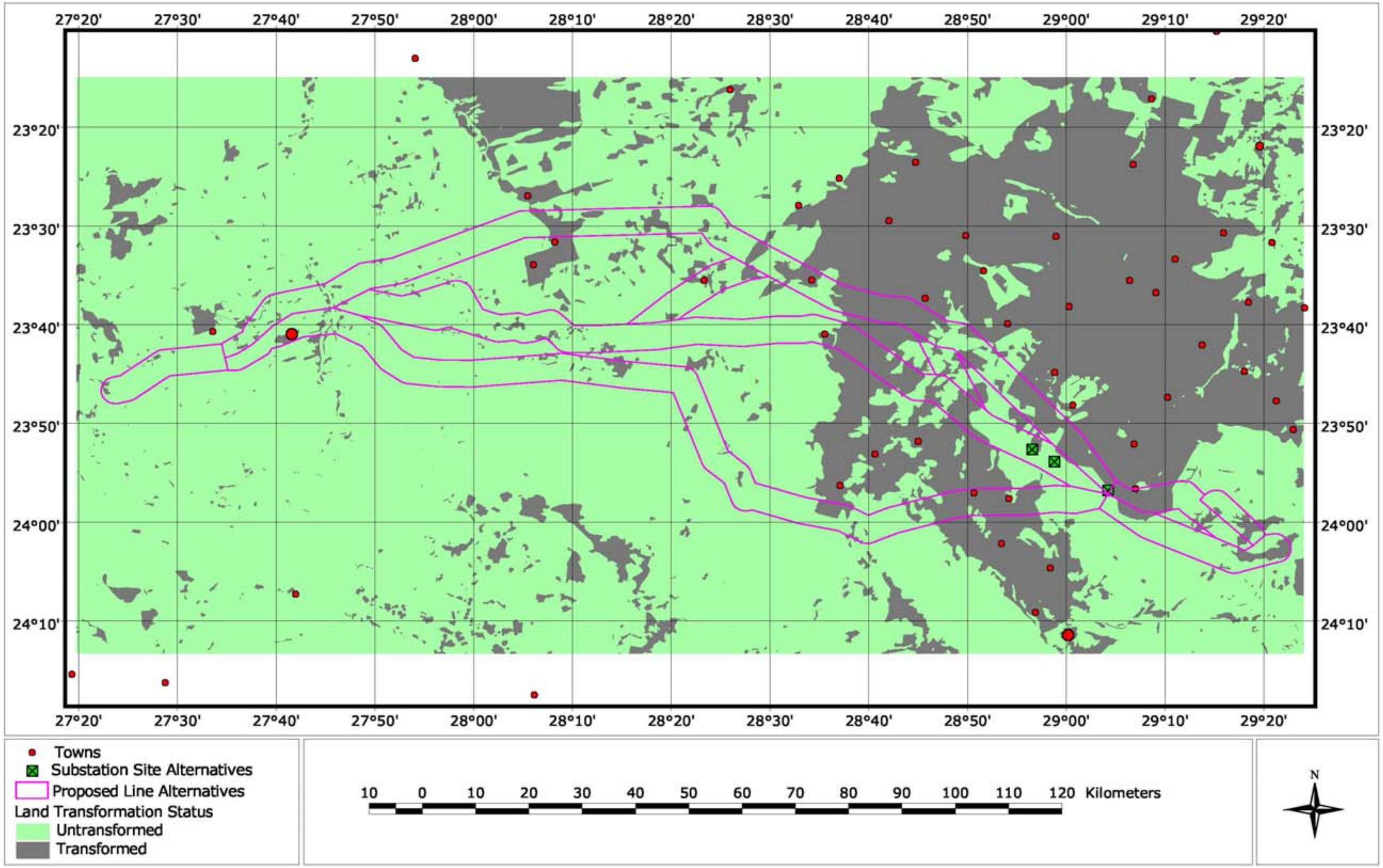

Figure 2: Remaining untransformed areas within the study area

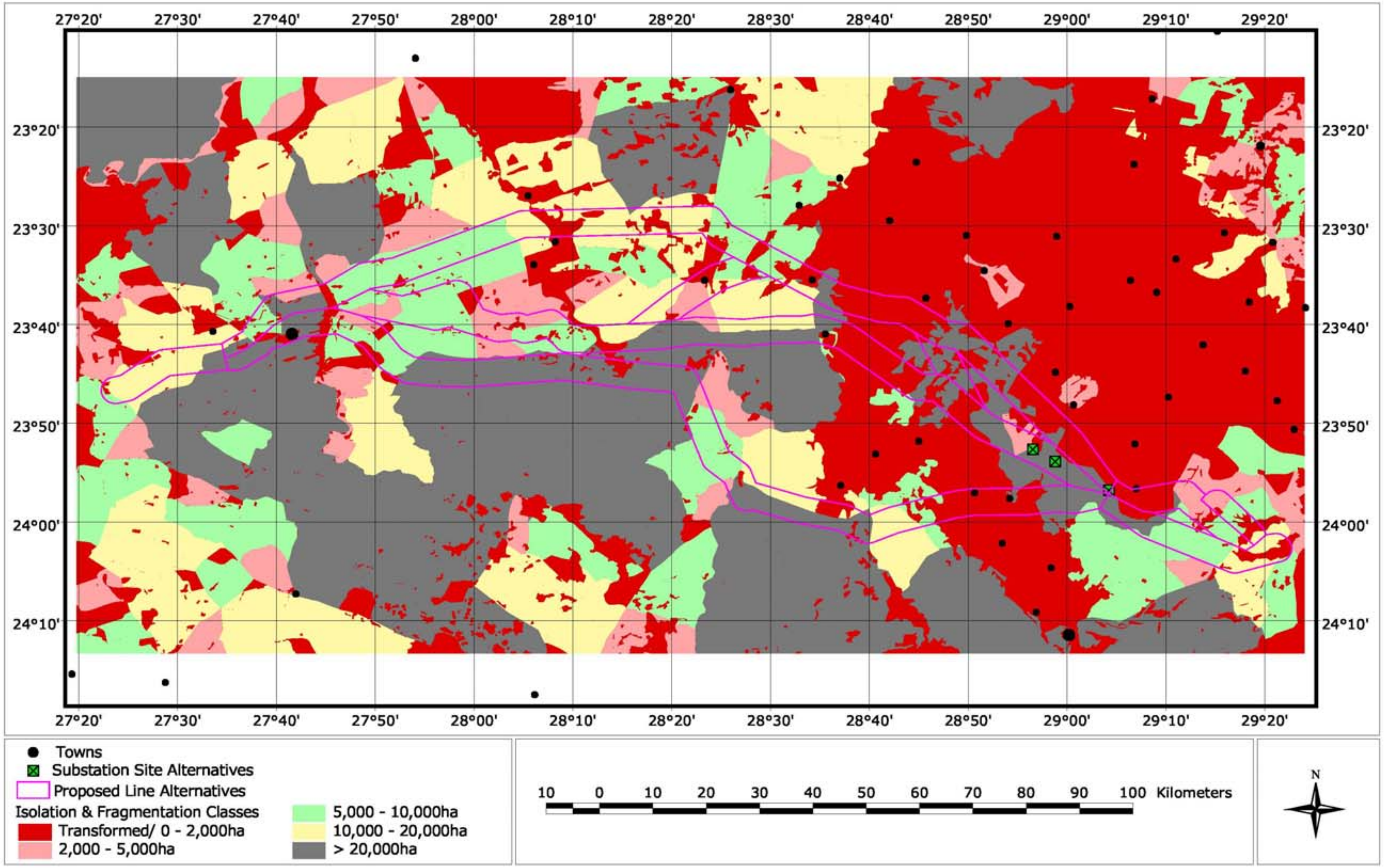

Figure 3: Isolation categories within the study area

8.4 Topography and Slopes

Varied topography is recognised as one of the most powerful influences contributing to the high biodiversity of southern Africa. The interplay between topography and climate over a long period of time has led to the evolution of a rich biodiversity. Landscapes composed of spatially heterogeneous abiotic conditions provide a greater diversity of potential niches for plants and animals than do homogeneous landscapes. The richness and diversity of flora has been found to be significantly higher in sites with high geomorphological heterogeneity and it can reasonably be assumed that associated faunal communities will also be significantly more diverse in spatially heterogeneous environments.

Ridges are characterised by high spatial heterogeneity due to the range of differing aspects (north, south, east, west and variations thereof), slopes and altitudes all resulting in differing soil (e.g. depth, moisture, temperature, drainage, nutrient content), light and hydrological conditions. The temperature and humidity regimes of microsites vary on both a seasonal and daily basis. Moist cool aspects are more conducive to leaching of nutrients than warmer drier slopes. Variation in aspect, soil drainage and elevation/altitude has been found to be especially important predictors of biodiversity. It follows that ridges will be characterized by a particularly high biodiversity; as such their protection will contribute significantly to the conservation of biodiversity in the country. Many Red Data / threatened species of plants and animals inhabit ridges. Due to their threatened status, Red Data species require priority conservation efforts in order to ensure their future survival. As such, the conservation of ridges and other areas of significant topographical variations will contribute significantly to the future persistence of these species.

Natural corridors, which are present in unfragmented landscapes, such as rivers, riparian zones and linear topographic features, should be retained following fragmentation. Such corridors may remain relatively self-sustaining after fragmentation as they continue to be essentially isolated in a larger matrix, unlike remnant corridors that require substantial management to counteract the external effects of the surrounding matrix. Remnant corridors only become corridors when the surrounding landscape is fragmented and until that time had been part of the overall matrix.

Ridges may have a direct effect on temperature/radiation, surface airflow/wind, humidity and soil types. Ridges also influence fire in the landscape, offering protection for those species that can be described as “fire-avoiders”. As a consequence of the influence of topography on rainfall, many streams originate on ridges and control water inputs into wetlands. The protection of the ridges in a natural state will thus ensure the normal functioning of ecosystem processes. In contrast, impacts on the physical status of ridges will alter these major landscape processes. For example, water runoff into streams and wetlands will increase.

A GIS analysis of contours in the study area revealed that extensive parts of the study area, particularly in the central parts, are characterised by topographical areas where the general slopes exceed 5° (8.8%) (Figure 4)[2]. All areas that were identified where the general slopes exceed 5° are regarded as highly sensitive. The study area slopes in a western direction, from approximately 1,400m in the east to approximately 900m in the west.

Areas of significant slopes are frequently associated with certain morphological classes, such as escarpments, high mountains and table lands (Figure 5). This does not preclude the absence of areas of significant slopes from morphological classes such as plains, lowlands or undulating areas, but rather that areas of significant slopes in these parts are not a prominent feature of the landscape and scattered occurrences of hills and ridges or koppies will be noted in other landscapes where little topographical variances occur. These localised areas do play a significant role in the regional biodiversity as it represents islands of atypical habitat and the likelihood of these areas being occupied by an atypical species composition is high.

[2] It should be noted that this particular slope analysis was compiled using a contour interval of 100m. Numerous smaller areas of significant slopes will in all likelihood be identified with the use of a higher level of detail, such as 20m or 10m contour intervals. This particular dataset does however provide sufficient detail to identify areas of regional importance. Smaller localised areas of importance, as pertaining to slopes and morphology, will be identified and avoided during the final walkthrough phase.

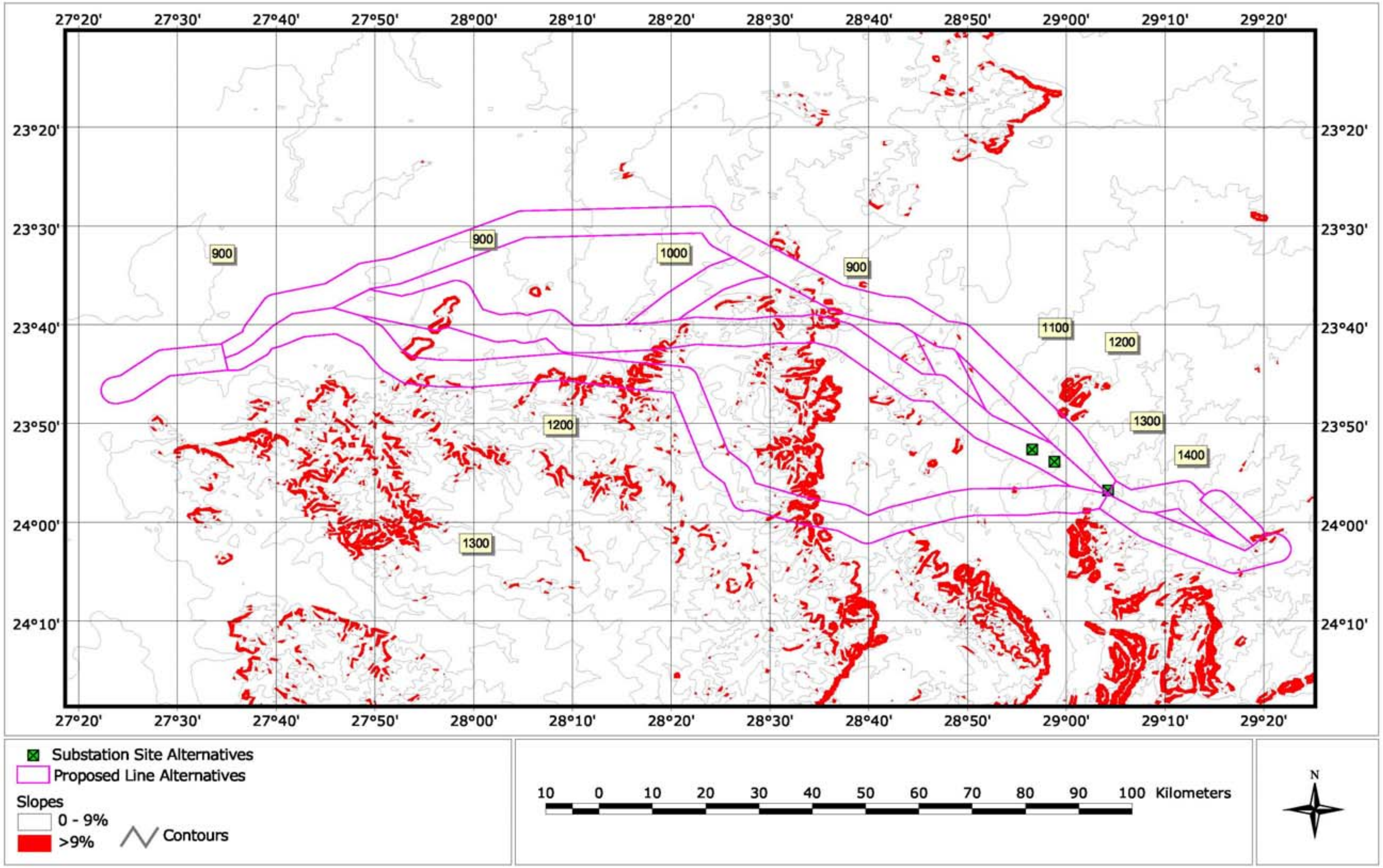

Figure 4: Distribution of areas of significant slopes in the study area

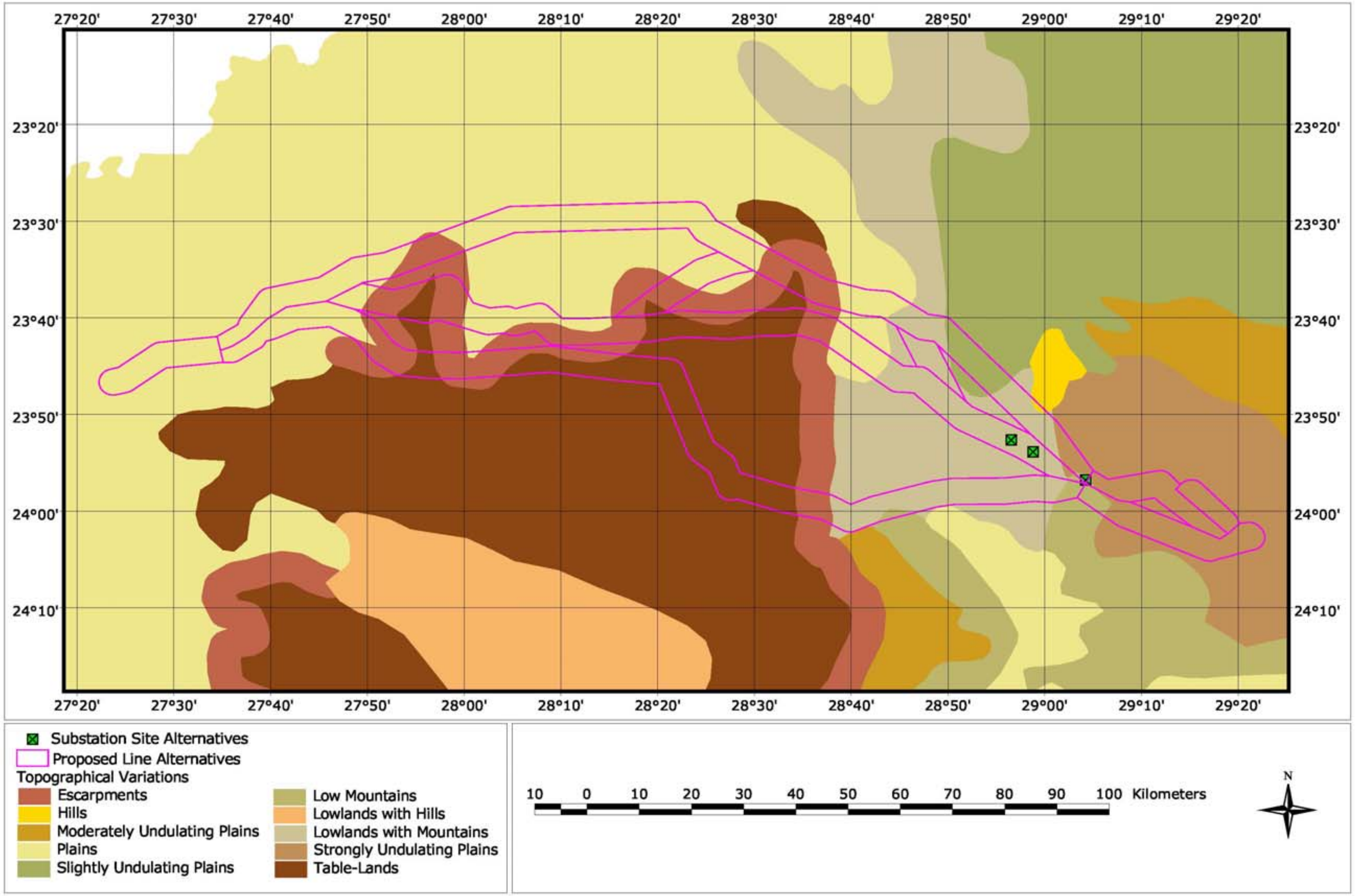

Figure 5: Topographical characteristics of the study area

8.5 Areas of Conservation

A number of declared conservation areas are situated within the study area (Figure 6). Some are likely to be affected directly by some of the proposed corridors and the proximity of some of the proposed corridors to these areas will in all likelihood contribute to cumulative impacts within the general surrounds of these conservation areas. The Waterberg Biosphere is situated within the study area.

8.6 Surface Water

Areas of surface water are present throughout the study area, mostly in the form of rivers, perennial and non-perennial streams. The study area is situated in the Limpopo Primary Catchment Area (Figure 7). Major rivers that will potentially be affected by the proposed development include the Mokolo-, Tambotie-, Lephalala- and Mogalakwena rivers.

Areas of surface water contribute significantly towards the local and regional biodiversity of an area due to the atypical habitat that is present within the interface of terrestrial and aquatic habitat types. These ecotones (areas or zones of transition between different habitat types) are frequently occupied by species that occur in both the bordering habitat types, and is therefore generally rich in species. In addition, many flora and fauna species is specifically adapted to exploit the temporal or seasonal fluctuation in moisture levels in these areas and exhibits extremely narrow habitat variation tolerance levels. In addition, these areas are also visited on a frequent basis by all terrestrial animals that utilise water sources on a frequent basis. Ecotonal interface areas form extremely narrow bands around areas of surface water and they constitute extremely small portions when calculated on a purely mathematical basis. However, taking the high species richness into consideration these areas are extremely important on a local and regional scale.

Rivers also represent important linear migration routes for a number of fauna species as well as a distribution method for plant seeds. This method of seed distribution is extremely evident in the case of several invasive alien tree species that occur extensively in many of the rivers and streams. The morphology of a region can also be loosely associated with the presence and diversity of aquatic habitat types. Mountainous areas or regions with a high interval of topographical variations is usually associated with the presence of numerous rivers and streams caused by increased run-off and slopes. These aquatic habitat types are usually small and narrow. The accurate depiction of these riparian habitats is generally not possible due to the extremely diverse nature of the habitat. Plains and areas where low slopes prevail are usually characterised by the presence of few, but larger, rivers.

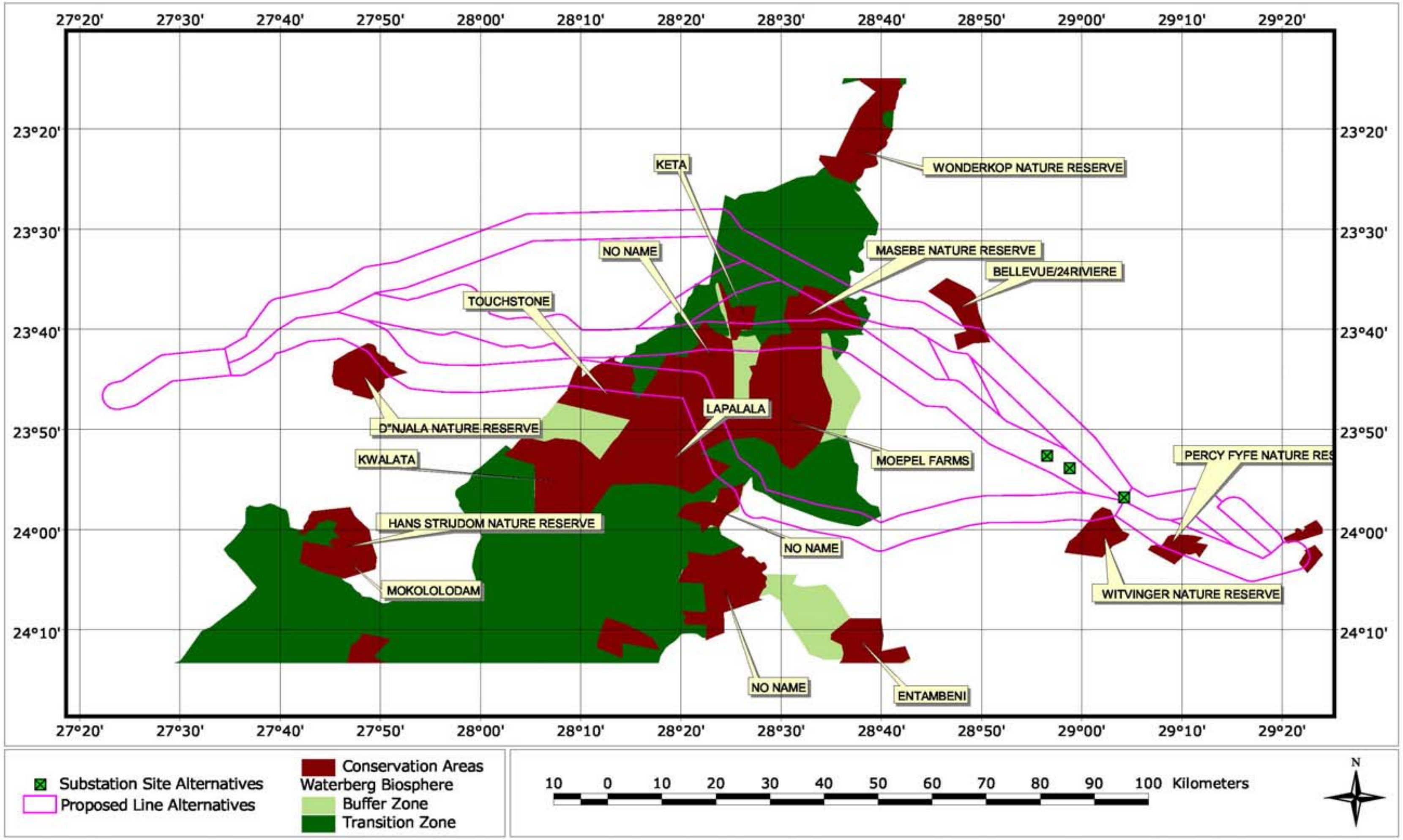

Figure 6: Areas of conservation within the study area

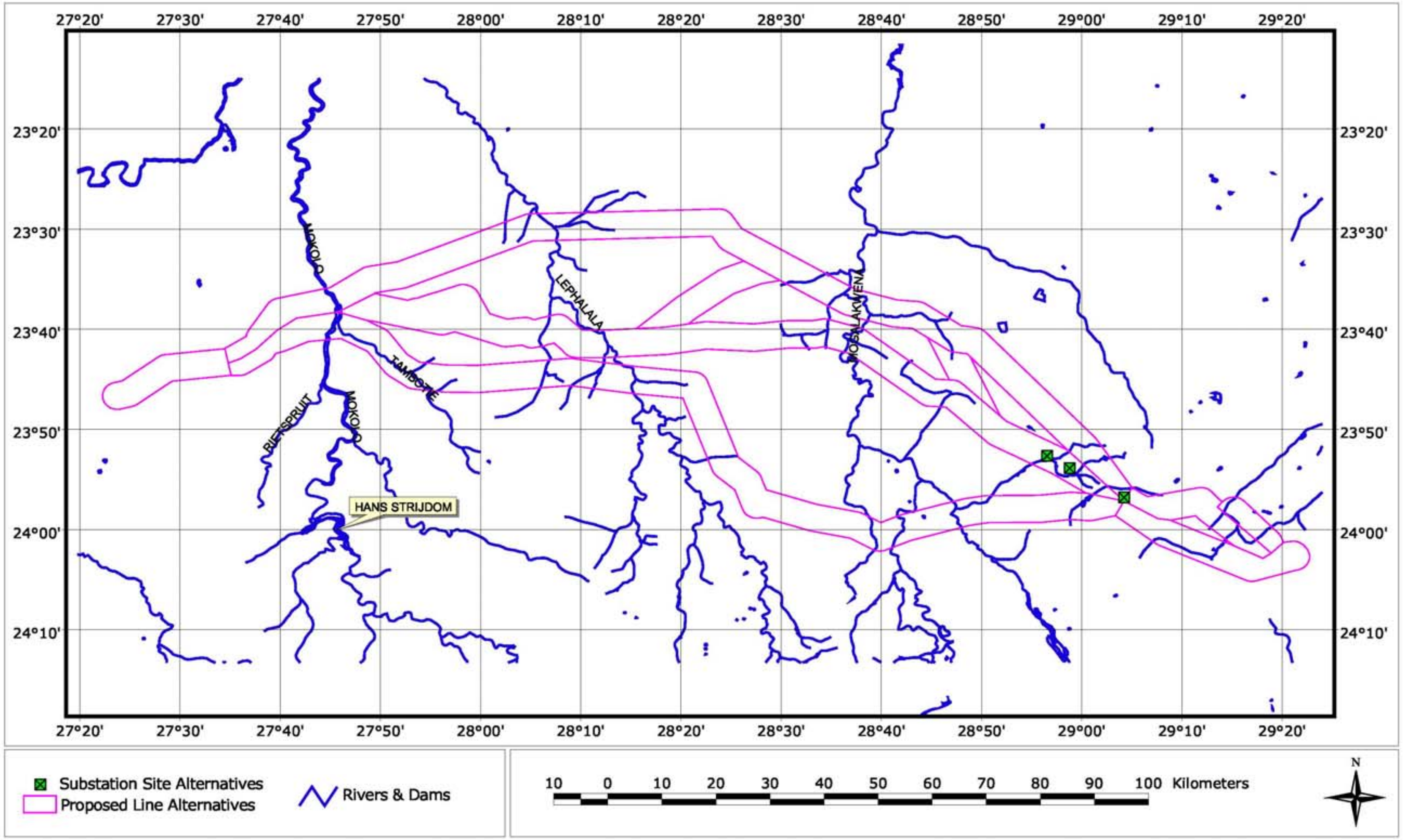

Figure 7: Areas of surface water within the study area

8.7 Land Cover & Land Use

Land cover categories are presented in Figure 8.

For the purpose of this assessment the land cover categories are, to a large extent, divided in to classes that represent natural habitat and land use categories that contribute to habitat degradation and transformation on a regional scale. In terms of the importance for biodiversity on a local and regional scale the assumption is made that landscapes that exhibit high level of transformation are normally occupied by plant communities and faunal assemblages that do not reflect the original or pristine status of an area or region. This is also particularly important in the case of Red Data species as these plants and animals have extremely low levels of disturbance tolerances, which is one of the many reasons for being threatened on a regional scale. Any changes to the status of habitat available to these species are likely to result in significant impacts on these species and their conservation status.

In particular, three important aspects are associated with habitat changes that accompany certain land uses. The decimation of habitat associated with impacts such as agriculture, mining and urban development results in the permanent decrease in available habitat for flora and fauna species in a region as these areas will not return to the original pristine status. A second aspect of habitat transformation or degradation is that it affects species directly, namely the change in species composition of an area resulting from either an exodus of a selection of species that are no longer able to exist in changed habitat conditions (or the decrease in abundance of certain species as a result of decreased habitat) or an influx of species that are not normally associated with the original or pristine habitat, but is suitably adapted to the changed environment. While some, or most, of the species that occupy these changed habitat conditions might be indigenous to a region, they are not endemic to an area. Lastly a larger threat is represented by the influx of invasive exotic species and weeds that can effectively sterilise large tracts of remaining natural habitat for endemic species.

At this stage of the project the actual status of remaining natural habitat is not taken into consideration as it varies on an extremely short interval, but it should be mentioned that grazing by particularly livestock represents a significant impact on natural habitat and numerous areas were noted throughout the study area where poor management strategies have resulted in degradation of the natural habitat, even to the extent that altered habitat no longer represents the original pristine status. The presence of invasive (*albeit* indigenous) shrubs is particularly important in this regard as it sterilises habitat for a number of flora and fauna species that occur naturally in an area.

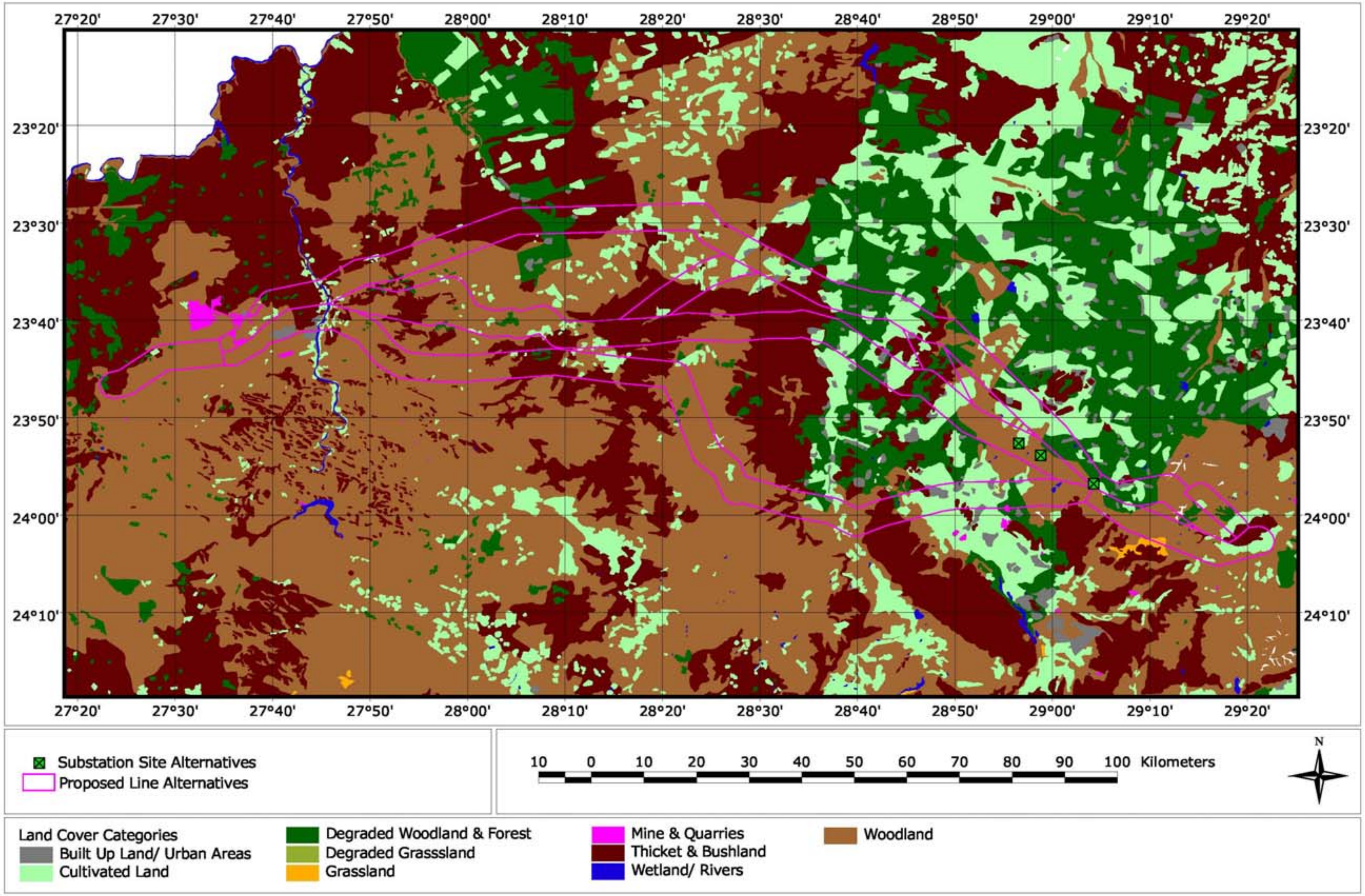

Figure 8: Land cover categories of the study area

8.8 Regional Vegetation - VEGMAP

A total of 10 regional vegetation types are encapsulated within the proposed power line corridor alternatives (Figure 9). The conservation status of these vegetation types are presented in Table 2.

Table 2: VEGMAP Vegetation types in the study area

Vegetation Type	Status	Conserved	Transformed	Protection Status
Central Sandy Bushveld	Vulnerable	3%	24%	Poor
Limpopo Sweet Bushveld	Least Threatened	1%	5%	Hardly
Makhado Sweet Bushveld	Vulnerable	1%	27%	Hardly
Mamabolo Mountain Bushveld	Least Threatened	8%	6%	Poorly
Polokwane Plateau Bushveld	Least Threatened	1%	17%	Poorly
Roodeberg Bushveld	Least Threatened	6%	18%	Poorly
Strydpoort Summit Sourveld	Least Threatened	17%	1%	Moderate
Subtropical Alluvial Vegetation	Least Threatened	71%	16%	Well
Waterberg Mountain Bushveld	Least Threatened	9%	3%	Poorly
Western Sandy Bushveld	Least Threatened	6%	4%	Poorly

8.8.1 Central Sandy Bushveld

This vegetation type is located in undulating terrain, occurring mainly in a broad arc south of the Springbokvlakte from the Pilanesberg in the west through Hammanskraal and Groblersdal to GaMasemola in the east. The habitat conforms to low undulating areas, sometimes between mountains, and sandy plains and catenas supporting tall, deciduous *Terminalia sericea* and *Burkea africana* woodland on sandy soils (with the former often dominant on the lower slopes of sandy catenas) and low, broadleaved *Combretum* woodland on shallow, rocky or gravely soils. Species of *Acacia, Ziziphus* and *Euclea* are found on flats lower slopes on eutrophic sands and some less sandy soils. *A. tortilis* may dominate some areas along valleys. Grass-dominated herbaceous layer with relatively low basal cover on dystrophic soils are noted frequently.

The Central Bushveld endemic grass species *Mosdenia leptostachys* and herb *Oxygonum dregeanum* subsp. *canescens* var. *dissectum* are present within this unit.

This vegetation type is regarded Vulnerable with less than 3% statutorily conserved, spread thinly across many nature reserved, including the Doorndraai Dam and Skuinsdraai Dam Nature Reserves. An additional 2% is conserved in other reserves including the Wallmansthal SANDF Property and a grouping of the Nylsvlei freshwater wetlands. About 24% is transformed, including 19% cultivated and 4% urban and built-up areas. Much of the unit in the broad arc south of the Springbokvlakte is heavily populated by rural communities. Several alien plants are widely scattered by often at low densities, including *Cereus jamacuru, Eucalyptus* species, *Lantana camara, Melia azedarach, Opuntia ficus-indica* and *Sesbania punicea.*

Acacia sieberiana occurs in the transition zone with grassland in the east, while *A. caffra* and *Faurea saligna* are dominant in the transition zone to the Waterberg Mountain Bushveld in the western parts of this unit. The following species are regarded representative of this particular vegetation type:

Tall Trees
Acacia burkei, A. robusta and *Sclerocarya birrea* subsp. *caffra.*

Small Trees
Burkea africana, *Combretum apiculatum*, C. *zeyheri*, *Terminalia sericea*, *Ochna pulchra, Peltophorum africanum* and *Searsia leptodictya.*

Tall Shrubs
Combretum hereroense, Grewia bicolor, G. *monticola* and *Strychnos pungens.*

Low Shrubs
Agathisanthemum bojeri, *Indigofera filipes*, *Felicia fascicularis, Gnidia sericocephala.*

Geoxylic Suffrutex
Dichapetalum cymosum

Woody Climber
Asparagus buchananii

Graminoids
Brachiaria nigropedata, *Eragrostis pallens*, *E. rigidior*, *Hyperthelia dissoluta*, *Panicum maximum*, *Perotis patens*, *Anthephora pubescens, Aristida scabrivalvis* subsp. *scabrivalvis, Brachiaria serrata, Elionurus muticus, Eragrostis nindensis, Loudetia simplex, Schmidtia pappophoroides, Themeda triandra* and *Trachypogon spicatus.*

Herbs
Dicerocaryum encelioides, *Barleria macrostegia, Blepharis integrifolia, Crabbea angustifolia, Evolvulus alsinoides, Geigeria burkei, Hermannia lancifolia, Indigofera daleoides, Justicia anagalloides, Kyphocarpa angustifolia, Lophiocarpus tenuissimus, Waltheria indica* and *Xerophyta humilis.*

Geophytic Herb
Hypoxis hemerocallidea var. *davyana*

Succulent Herb
Aloe greatheadii

8.8.2 Limpopo Sweet Bushveld

This vegetation type extends from the lower reaches of the Crocodile and Marico Rivers down the Limpopo River valley. It is short, open woodland dominated by *Acacia mellifera* and *Dichrostachys cinerea* as well as taller tree species such as *A. robusta*, *A. burkei* and *Terminalia sericea*. The high palatability of the graminoid composition makes this vegetation type highly suitable for game farming practices.

This vegetation type is not threatened (Least Threatened) and although only 1% is formally conserved, much is contained within private nature reserves and game farms. Approximately 5% is transformed by cultivation. Though limited by low rainfall, this is a good area for game and cattle farming due to the high grazing capacity of sweet veld. The Central Bushveld endemic herb *Piaranthus atrosanguinalis* occurs in this vegetation type. Important taxa include the following.

Tall Trees
Acacia robusta and *A. burkei.*

Small Trees
Acacia erubescens, A. fleckii, A. nilotica, A. senegal var. *rostrata, Albizia anthelmintica, Boscia albitrunca, Combretum apiculatum* and *Terminalia sericea.*

Tall Shrubs
Catophractes alexandri, Dichrostachys cinerea, Phaeoptilum spinosum, Rhigozum obovatum, Cadaba aphylla, Combretum hereroense, Commiphora pyracanthoides, Ehretia rigida subsp*. rigida, Euclea undulata, Grewia flava* and *Gymnosporia senegalensis.*

Low Shrubs
Acacia tenuispina, Commiphora africana, Felicia muricata, Gossypium herbaceum subsp*. africanum* and *Leucosphaera bainesii.*

Graminoids
Digitaria eriantha subsp*. eriantha, Enneapogon cenchroides, Eragrostis lehmanniana, Panicum coloratum, Schmidtia pappophoroides, Aristida congesta, Cymbopogon nardus, Eragrostis pallens, E. rigidior, E. trichophora, Ischaemum afrum, Panicum maximum, Setaria verticillata, Stipagrostis uniplumis* and *Urochloa mosambicensis.*

Herbs
Acanthosicyos naudinianus, Commelina benghalensis, Harpagophytum procumbens subsp*. transvaalense, Hemizygia elliottii, Hermbstaedtia odorata* and *Indigofera daleoides.*

Succulent Herbs
Kleinia fulgens and *Plectranthus neochilus.*

8.8.3 Makhado Sweet Bushveld

This vegetation type occurs on the plains south of the Soutpansberg, east of the Waterberg. Altitude varies between 850 and 1, 200m. The topography conforms to slightly and moderately undulating plains sloping generally down to the north, with some hills in the southwest. The vegetation is characterised by short and shrubby bushveld with a poorly developed grass layer. Important taxa include the following:

Small Trees
Acacia erubescens, A. gerrardii, A. mellifera subsp*. detinens, A. rehmanniana, Boscia albitrunca, Combretum apiculatum, Acacia tortilis subsp. heteracantha* and *Terminalia sericea.*

Tall Shrubs
Commiphora pyracanthoides, Dichrostachys cinerea, Grewia flava, Hibiscus calyphyllus, Lycium shawii and *Rhigozum obovatum.*

Low Shrubs
Barleria lancifolia, Hirpicium bechuanense, Indigofera poliotes, Melhania rehmannii and *Pechuel-Loeschea leubnitziae.*

Graminoids
Anthephora pubescens, Aristida stipitata subsp*. graciliflora, Cenchrus ciliaris, Enneapogon scoparius, Brachiaria nigropedata, Eragrostis trichophora, Panicum coloratum, P maximum, Schmidtia pappophoroides* and *Urochloa mosambicensis.*

Herbs
Chamaecrista absus, Corbichonia decumbens, Geigeria acaulis, Harpagophytum procumbens subsp. transvaalense, Heliotropium steudneri, Hemizygia elliottii, Hermbstaedtia odorata, Leucas sexdentata, Osteospermum muricatum and *Tephrosia purpurea* subsp*. leptostachya.*

The Endemic herb *Dicliptera minor* subsp*. pratis-manna* occurs in this vegetation type.

The conservation status of this vegetation type is Vulnerable. About 1% is statutorily conserved, mainly in the Bellevue Nature Reserve. Some 27% transformed, mainly by cultivation, with some urban and built-up areas. The south-western half of the unit has densely populated rural communities.

8.8.4 Mamabolo Mountain Bushveld

This vegetation type is distributed to the east and south of the Polokwane Plateau along the foothills of the west-facing part of the eastern escarpment and of the Strydpoort and Makapan Mountains. Also on main isolated hills and small mountains embedded within the Polokwane Plateau as far as Mogoshi Mountain in the west and De Loskop (near Mogwadi) and Renosterkoppies (around Zandrivierspoort) to the north. Altitude varies between 1,200 and 1,600m.

Typical characteristics include low mountains, lower slopes of Strydpoort and Makapan ranges, and rocky hills. Slopes are moderate to steep, and very rocky, covered by small trees and shrubs. Rock slabs or domes are sparsely vegetated, and then mostly with a mixture of xerophytic or resurrection plants, with several succulents. Important taxa include the following:

Tall Tree
Sclerocarya birrea subsp. *caffra*

Small Trees
Combretum molle, Croton gratissimus, Heteropyxis natalensis, Acacia caffra, A. davyi, A. gerrardii, A. nilotica, Berchemia zeyheri, Cussonia natalensis, C. transvaalensis, Dombeya rotundifolia, Erythrina lysistemon, Lannea discolor, Maytenus undata, Pappea capensis, Searsia leptodictya and *Schotia brachypetala*.

Succulent Trees
Euphorbia cooperi, Aloe marlothii subsp. *marlothii* and *Euphorbia ingens.*

Tall Shrubs
Clerodendrum glabrum, Elephantorrhiza burkei, Acokanthera oppositifolia, A. rotundata, Buddleja saligna, Canthium mundianum, Carissa edulis, Ehretia obtusifolia, Euclea crispa subsp. crispa (short small-leaved form), *Grewia occidentalis, Hibiscus calyphyllus, Olea europaea* subsp. *africana, Pouzolzia mixta, Searsia pentheri, R. rehmanniana, Scutia myrtina* and *Tarchonanthus parvicapitulatus.*

Low Shrubs
Diospyros lycioides subsp. *nitens, Grewia vernicosa, Barleria rotundifolia, Gossypium herbaceum* subsp. *africanum, Gymnosporia glaucophylla, Hermannia floribunda, Heteromorpha stenophylla* var. *transvaalensis, Lantana rugosa, Myrothamnus flabellifolius* and *Plinthus rehmannii.*

Succulent Shrubs

Kalanchoe sexangularis, Kleinia longiflora, Aloe arborescens, Cotyledon barbeyi, C. orbiculata var*. orbiculata, Kalanchoe paniculata, K. rotundifolia, Senecio barbertonicus* and *Tetradenia riparia.*

Woody Climbers

Asparagus buchananii, *Jasminum multipartitum*, *Acacia ataxacantha* and *Cryptolepis cryptolepidioides.*

Herbaceous Climber

Pentarrhinum insipidum

Graminoids

Cymbopogon caesius, *Digitaria eriantha* subsp*. eriantha, Heteropogon contortus*, *Aristida congesta, A. diffusa*, *Enneapogon scoparius*, *Eragrostis rigidior*, *Tricholaena monachne* and *Triraphis andropogonoides.*

Herb

Vahlia capensis subsp. vulgaris

Geophytic Herbs

Boophane disticha, *Drimia altissima*, *D. robusta* and *Eulophia petersii.*

Succulent Herbs

Aloe greatheadii var*. greatheadii*, *Aeollanthus rehmannii*, *Avonia rhodesica*, *Crassula swaziensis*, *Plectranthus grandidentatus* and *P hadiensis.*

The Endemic shrubs *Euphorbia clivicola* and *Khadia media* occur in this vegetation type. The conservation is regarded Least Threatened. Almost 8% statutorily conserved mainly in the Witvinger and Bewaarkloof Nature Reserves. About 6% transformed, including about 2% each of urban and built-up areas, plantations and cultivated land. Land uses include grazing, wood harvesting and medicinal plant collecting. Alien plants include *Nicotiana glauca, Opuntia* species and *Zinnia peruviana*.

8.8.5 Polokwane Plateau Bushveld

Occurs on the higher-lying plains around Polokwane, north of the Strydpoort Mountains and south of the Makhado Sweet Bushveld. Vegetation and landscape features include moderately undulating plains with short open tree layer with a well-developed grass layer to grass plains with occasional trees at higher altitudes. Hills and low mountains of the Mamabolo Mountain Bushveld are embedded within this unit.

Important taxa include the following.

Small Trees
Acacia caffra, A. permixta, A. rehmanniana, A. karroo, A. tortilis subsp*. heteracantha, Combretum molle*, *Ormocarpum kirkii* and *Ziziphus mucronata.*

Succulent Tree
Aloe marlothii subsp*. marlothii*

Tall Shrubs
Acacia hebeclada subsp*. hebeclada, Gymnosporia senegalensis, Combretum hereroense, Diospyros lycioides* subsp*. sericea, Euclea crispa* subsp*. crispa, Heteromorpha arborescens* var*. abyssinica, Lippia javanica, Searsia pyroides* var*. pyroides, Tephrosia rhodesica* and *Triumfetta pilosa* var*. tomentosa.*

Low Shrubs
Anthospermum rigidum subsp*. rigidum, Gymnosporia glaucophylla, Hirpicium bechuanense, Lantana rugosa, Senecio burchellii, Sida rhombifolia* and *Solanum panduriforme.*

Succulent Shrub
Aloe cryptopoda

Woody Climber
Asparagus africanus

Herbaceous Climbers
Momordica balsamina and *Rubia petiolaris.*

Graminoids
Aristida diffusa, Brachiaria nigropedata, Digitaria eriantha subsp*. eriantha, Eragrostis curvula, Themeda triandra, Aristida congesta, Cymbopogon caesius, Cynodon dactylon, Digitaria diagonalis, Diheteropogon amplectens, Elionurus muticus, Eragrostis gummiflua, E. racemosa, E. superba, Eustachys paspaloides, Panicum maximum, Pogonarthria squarrosa* and *Sporobolus africanus.*

Herbs
Felicia mossamedensis, Hermbstaedtia odorata and *Pollichia campestris.*

Geophytic Herbs
Eulophia petersii and *Hypoxis hemerocallidea.*

Succulent Herb
Aloe greatheadii var*. greatheadii*

Biogeographically important taxa (Central Bushveld endemics) occurring in this unit include the graminoid *Mosdenia leptostachys*, the herb *Oxygonum dregeanum* subsp. *canescens* var. *dissectum* and the geophytic herb *Ledebouria crispa*. The conservation status is regarded Least Threatened according to remote sensing sources, but with over one third of the remaining vegetation regarded as degraded, would probably be regarded as Susceptible. Less than 2% is statutorily conserved, mainly in the Percy Fyfe and Kuschke Nature Reserves. An additional 0.7% is conserved in other reserves, for example the Polokwane Game Reserve.

Some 17% is transformed, including about 10% cultivated and 6% urban and built-up. Dense concentration of human settlements is fount particularly in the eastern and north-western parts of the unit. In some regions, scattered populations of alien *Agave*, *Jacaranda mimosifolia*, *Melia azedarach, Opuntia ficus-indica* and *Ricinus communis* are of concern. It is found that woody plants have increased in parts of this unit in the past few decades.

8.8.6 Roodeberg Bushveld

This vegetation unit is distributed in the Limpopo Province, straddling the Tropic of Capricorn, from Marken and Villa Nora in the south through Baltimore to near Swartwater in the north and to the plains around the base of the Blouberg and Lerataupje Mountains in the northeast. Altitude ranges between 850 and 1,100m. Vegetation features include plains and slightly undulating plains, including some low hills, with short closed woodland to tall open woodland and poorly developed grass layer. *Kirkia acuminata* trees occurring in this unit are not limited to hills. Important taxa include the following.

Tall Trees
Acacia burkei, *A. nigrescens, A. robusta, A. erioloba* and *Sclerocarya birrea subsp. caffra.*

Small Trees
Acacia erubescens, A. mellifera subsp*. detinens, A. nilotica, A. tortilis* subsp*. heteracantha, Combretum apiculatum, Kirkia acuminata, Acacia grandicornuta, A. luederitzii* var*. retinens, A. senegal* var*. leiorhachis, Albizia harveyi, Combretum imberbe, Commiphora mollis, Searsia lancea, Terminalia sericea* and *Ziziphus mucronata.*

Tall Shrubs

Dichrostachys cinerea, Grewia flava, Euclea crispa subsp*. crispa, E. undulata, Grewia monticola* and *Hibiscus micranthus.*

Low Shrubs

Commiphora africana, Melhania acuminata, Sida cordifolia and *Solanum delagoense.*

Graminoids

Aristida canescens, Chloris virgata, Digitaria eriantha subsp*. eriantha, Enneapogon cenchroides, Eragrostis rigidior, Panicum maximum, Urochloa mosambicensis, Aristida congesta, Brachiaria deflexa, Cymbopogon pospischilii, Cynodon dactylon* and *Eragrostis rotifer.*

Herbs

Achyranthes aspera, Corbichonia decumbens, Hemizygia elliottii, Kyphocarpa angustifolia, Seddera capensis, Tephrosia purpurea subsp*. leptostachya* and *Waltheria indica.*

The conservation status is regarded Least Threatened. Almost 6% is statutorily conserved, mainly in the Wonderkop and Blouberg (Malebocho) Nature Reserves. An additional 3% is conserved in other reserves, mainly in areas adjacent to the Wonderkop Nature Reserve. About 18% is transformed, mainly by cultivation, with very little urban and built-up areas. The area is mainly used for game ranching.

8.8.7 Strydpoort Summit Sourveld

This vegetation unit is confined to a series of isolated patches in high-lying areas of the Strydpoortberge, from Bewaarkloof in the east as far as the mountain just above Mokopane I the west. The vegetation conforms to tall grasslands along rocky summits and mountain slopes. The landscape has a very broken topography with deeply incised valleys. The slopes are steep and rocky and sparsely wooded. Important taxa include the following.

Small Trees

Acacia caffra, Combretum molle, Cussonia paniculata, Englerophytum magalismontanum, Protea caffra subsp*. caffra, Cussonia transvaalensis, Faurea saligna, Mundulea sericea, Protea roupelliae* subsp*. roupelliae, P. rubropilosa* and *Vangueria infausta.*

Tall Shrub

Searsia dentata

Woody Climbers

Ancylobotrys capensis and *Rhoicissus tridentata.*

Low Shrubs
Searsia magalismontana, Aeschynomene rehmannii, Anthospermum hispidulum, Chrysanthemoides monilifera subsp*. septentrionalis, Justicia betonica, Leonotis ocymifolia* and *Polygala hottentotta.*

Graminoids
Aristida transvaalensis, Loudetia simplex, Monocymbium ceresiiforme, Schizachyrium sanguineum, *Themeda triandra, Trachypogon spicatus*, *Tristachya leucothrix*, *Alloteropsis semialata* subsp*. eckloniana, Andropogon chinensis, Bulbostylis burchellii, Diheteropogon amplectens, D. filifolius, Elionurus muticus, Eragrostis racemosa* and *Sporobolus pectinatus.*

Herbs
Acalypha angustata, Helichrysum nudifolium var*. nudifolium*, *Monsonia attenuata, Pearsonia sessilifolia* subsp*. sessilifolia, Rhynchosia monophylla, Selaginella dregei, Vernonia galpinii, V natalensis* and *Xerophyta retinervis.*

Herbaceous Climber
Rhynchosia totta

Succulent Herbs
Aloe fosteri, *Crassula swaziensis* and *Kleinia stapeliiformis.*

Biogeographically important taxa occurring in this unit (Northern Sourveld Endemics, Wolkberg Endemics) include the small trees *Encephalartos eugene-maraisii*, *Protea rubropilosa*, the tall shrub *Vitex obovata* subsp. *wilmsii*, the low shrubs *Berkheya carlinopsis* subsp. *magalismontana, Helichrysum uninervium* and the succulent herbs *Aloe affinis* and *A. thompsoniae*. Endemic taxa present in this unit include the succulent shrub *Thorncroftia media*, the semiparasitic shrub *Thesium gracilentum* and the herb *Aster nubimontis.*

Conservation Least threatened. About 17% of the area enjoys statutory protection in the Bewaarkloof Nature Reserve. A further small portion is protected in the Wolkberg Wilderness Area. Transformation levels are very low. This unit shares several elements with the Gm 29 Waterberg-Magaliesberg Summit Sourveld, such as *Encephalartos eugene-maraisii* and *Vitex obovata* subsp. *wilmsii*.

8.8.8 Subtropical Alluvial Vegetation

This vegetation type comprises flat alluvial riverine terraces supporting an intricate complex of macrophytic vegetation (channel of flowing rivers and river-fed pans), marginal reed belts (in sheltered oxbows and along very slow-flowing water courses) as well as extensive flooded grasslands, ephemeral herblands and riverine thickets.

Large parts of this vegetation type are statutorily conserved in the Kruger and Mapungubwe National Parks, Vemre and D'Njala Nature Reserves, Ndumo Game Reserve and Greater St Lucia Wetland Park as well as in a number of private reserves fringing the western borders of the Kruger National Park and the Limpopo River. The Ndumo Game Reserve and Greater St Lucia Wetland Park are Ramsar Sites. Much of the area has been transformed for cultivation, urban development and road building. Alien woody species commonly occurring in this vegetation types include *Melia azedarach*, *Chromolaena discolor* and the like.

A poor level of knowledge is estimated for this vegetation type, particularly in the Central Bushveld and Lowveld regions. Important taxa include the following.

- **Riparian thickets**

Small Trees
Acacia natalitia, A. robusta, Boscia foetida subsp. rehmanniana, Combretum erythrophyllum, Phoenix reclinata, Salix mucronata subsp. woodii, Ziziphus mucronata, Acacia luederitzii, A. nebrownii, A. nigrescens, A. tortilis, A. xanthophloea, Colophospermum mopane, Combretum hereroense, Philenoptera violaceae and *Pseudoscolopia polyantha.*

Tall Shrubs
Salvadora angustifolia, Commiphora glandulosa, C. pyracanthoides, Euclea divinorum, Grewia bicolor and *Gymnosporia senegalensis.*

Low Shrubs
Justicia flava and *Ocimum canum.*

Graminoids
Eragrostis trichophora, Panicum maximum, Setaria incrassata, Sporobolus ioclados, Chloris virgata, Dactyloctenium aegyptium, Enneapogon cenchroides and *Urochloa mosambicensis.*

Herbs
Commelina benghalensis, Abutilon austro-africanum, Acalypha indica, Achyranthes aspera, Boerhavia erecta, Commicarpus fallacissimus, Cucumis zeyheri, Heliotropium ovalifolium, Lobelia angolensis, Oxygonum sinuatum, Pupalia lappacea and *Ruellia patula.*

Geophytic Herb
Crinum moorei

Succulent Herb
Portulaca quadrifida

- **Reed beds**

Megagraminoids
Phragmites australis and *P mauritianus.*

- **Flooded grasslands & herblands**

Megagraminoids
Cyperus immensus

Graminoids
Cynodon dactylon, Cyperus articulatus, Echinochloa pyramidalis, Urochloa mosambicensis, Bolboschoenus glaucus, Chloris mossambicensis, C. virgata, Cyperus corymbosus, C. difformis, C. distans, C. fastigiatus, C. sexangularis, Dactyloctenium aegyptium, Hemarthria altissima, Ischaemum afrum, Paspalidium obtusifolium, Setaria sphacelata, Sporobolus consimilis and *S. fimbriatus.*

Herbs
Alternanthera sessilis, Amaranthus praetermissus, Grammatotheca bergiana (Pondoland), *Marsilea ephippiocarpa* and *Scutellaria racemosa.*

Geophytic Herb
Trachyandra saltii

Aquatic Herbs
Ceratophyllum muricatum and *Ottelia exserta.*

The endemic taxon *Crotalaria mollii* occur in flooded grasslands & herblands. The vegetation of the Lowveld alluvia is found in a complex of Subtropical Riverine Forests (gallery forests), and both are usually embedded within various bushveld types of the Savanna Biome. The major distinction between this type of alluvial vegetation and other alluvia is the presence and importance of subtropical and tropical floristic elements and the pronouncedly subtropical climate. The current mapping coverage of Subtropical Alluvial Vegetation reflects our current poor knowledge and the lack of data from all around the Central Bushveld as well as Lowveld regions.

8.8.9 Waterberg Mountain Bushveld

This landscape exhibits rugged mountains with vegetation grading from *Faurea saligna – Protea caffra* bushveld on higher slopes through broad-leaved deciduous bushveld (dominated by *Diplorhynchus condylocarpon*) on rocky mid- and footslopes to *Burkea africana – Terminalia sericea* savanna in the lower lying valleys as well as on deeper sands of the plateaus. The grass layer is moderately developed or well developed. The carrying capacity of the vegetation for livestock animals is low, especially in the dry season.

It is regarded as Least Threatened with about 9% statutorily conserved in the Marakele National Park and Moepel Nature Reserve. Human population density is low. More than 3% is transformed, mainly by cultivation. Carrying capacity for livestock is low, especially during the dry season. Important taxa include the following.

Tall Tree
Acacia robusta

Small Trees
Acacia caffra, Burkea africana, Combretum apiculatum, Croton gratissimus, Cussonia transvaalensis, Faurea saligna, Heteropyxis natalensis, Ochna pulchra, Protea caffra, Albizia tanganyicensis, Combretum molle, Englerophytum magalismontanum, Ficus burkei, F. glumosa, Ochna pretoriensis, Pseudolachnostylis maprouneifolia, Searsia lancea, Terminalia sericea, Vangueria infausta and *V. parvifolia.*

Tall Shrubs
Diplorhynchus condylocarpon, Elephantorrhiza burkei, Combretum moggii, C. nelsonii, Dichrostachys cinerea, Euclea crispa subsp*. crispa, Gnidia kraussiana, Olea capensis* subsp*. enervis, O. europaea* subsp*. africana, Searsia pyroides* var*. pyroides, Strychnos pungens* and *Vitex rehmannii.*

Low Shrubs
Anthospermum rigidum subsp*. rigidum, Barleria affinis, Felicia muricata, Helichrysum kraussii, Protea welwitschii* subsp*. welwitschii* and *Searsia rigida* var*. dentata.*

Geoxylic Suffrutices
Dichapetalum cymosum and *Parinari capensis* subsp*. capensis.*

Succulent Shrubs
Aloe chabaudii and *Lopholaena coriifolia.*

Woody Climbers
Ancylobotrys capensis and *Rhoicissus revoilii.*

Graminoids
Loudetia simplex, Schizachyrium sanguineum, Trachypogon spicatus, Brachiaria serrata, Digitaria eriantha subsp*. eriantha, Elionurus muticus, Enneapogon scoparius, Setaria sphacelata, Themeda triandra* and *Tristachya leucothrix.*

Herbs
Berkheya insignis, Chamaecrista mimosoides, Geigeria elongata, Hibiscus meyeri subsp*. transvaalensis* and *Xerophyta retinervis.*

Geophytic Herbs
Haemanthus humilis subsp*. humilis* and *Hypoxis rigidula.*

Biogeographically important taxa (Central Bushveld Endemic, Northern Sourveld Endemic) occurring in this unit include the small tree *Encephalartos eugene-maraisii*, the tall shrub *Erythrophysa transvaalensis*, the soft shrub *Chorisochora transvaalensis* and the graminoid *Mosdenia leptostachys*. Endemic species of this unit include the tall shrubs *Grewia rogersii, Pachystigma triflorum* and the herb *Oxygonum dregeanum* subsp. *canescens* var. *pilosum*.

8.8.10 Western Sandy Bushveld

This vegetation occurs on flats and undulating plains from Assen northwards past Thabazimbi and remaining west of the Waterberg Mountains towards Steenbokpan in the north. Some patches occur between the Crocodile and Marico Rivers to the west. The vegetation varies from tall open woodland to low woodland, broad-leaved as well as microphyllous tree species prominent. Dominant species include *Acacia erubescens* on flat areas, *Combretum apiculatum* on shallow soils of gravely upland sites and *Terminalia sericea* on deep sands. Occurs on slightly undulating plains. Important taxa include the following.

Tall Trees
Acacia erioloba, A. nigrescens and *Sclerocarya birrea* subsp*. caffra.*

Small Trees
Acacia erubescens, A. mellifera subsp*. detinens, A. nilotica, A. tortilis* subsp*. heteracantha, Combretum apiculatum, C. imberbe, Terminalia sericea, Combretum zeyheri, Lannea discolor, Ochna pulchra* and *Peltophorum africanum.*

Tall Shrubs
Combretum hereroense, Euclea undulata, Coptosperma supra-axillare, Dichrostachys cinerea, Grewia bicolor, G. flava and *G. monticola.*

Low Shrubs

Clerodendrum ternatum, Indigofera filipes and *Justicia flava.*

Graminoids

Anthephora pubescens, Digitaria eriantha subsp *eriantha, Eragrostis pallens, E. rigidior, Schmidtia pappophoroides, Aristida congesta, A. diffusa, A. stipitata* subsp*. graciliflora, Eragrostis superba, Panicum maximum* and *Perotis patens.*

Herbs

Blepharis integrifolia, Chamaecrista absus, Evolvulus alsinoides, Geigeria burkei, Kyphocarpa angustifolia, Limeum fenestratum, L. viscosum, Lophiocarpus tenuissimus and *Monsonia angustifolia.*

The conservation status of this unit is regarded Least Threatened with about 6% statutorily conserved, just over half of which in the Marakele National Park. About 4% transformed, mainly by cultivation. This unit is drier than the Central Sandy Bushveld vegetation unit and is distinguished from it by the presence of such species as *Acacia erubescens, A. nigrescens* and *Combretum imberbe* and general absence of species such as *Burkea africana* and *Ochna pulchra*.

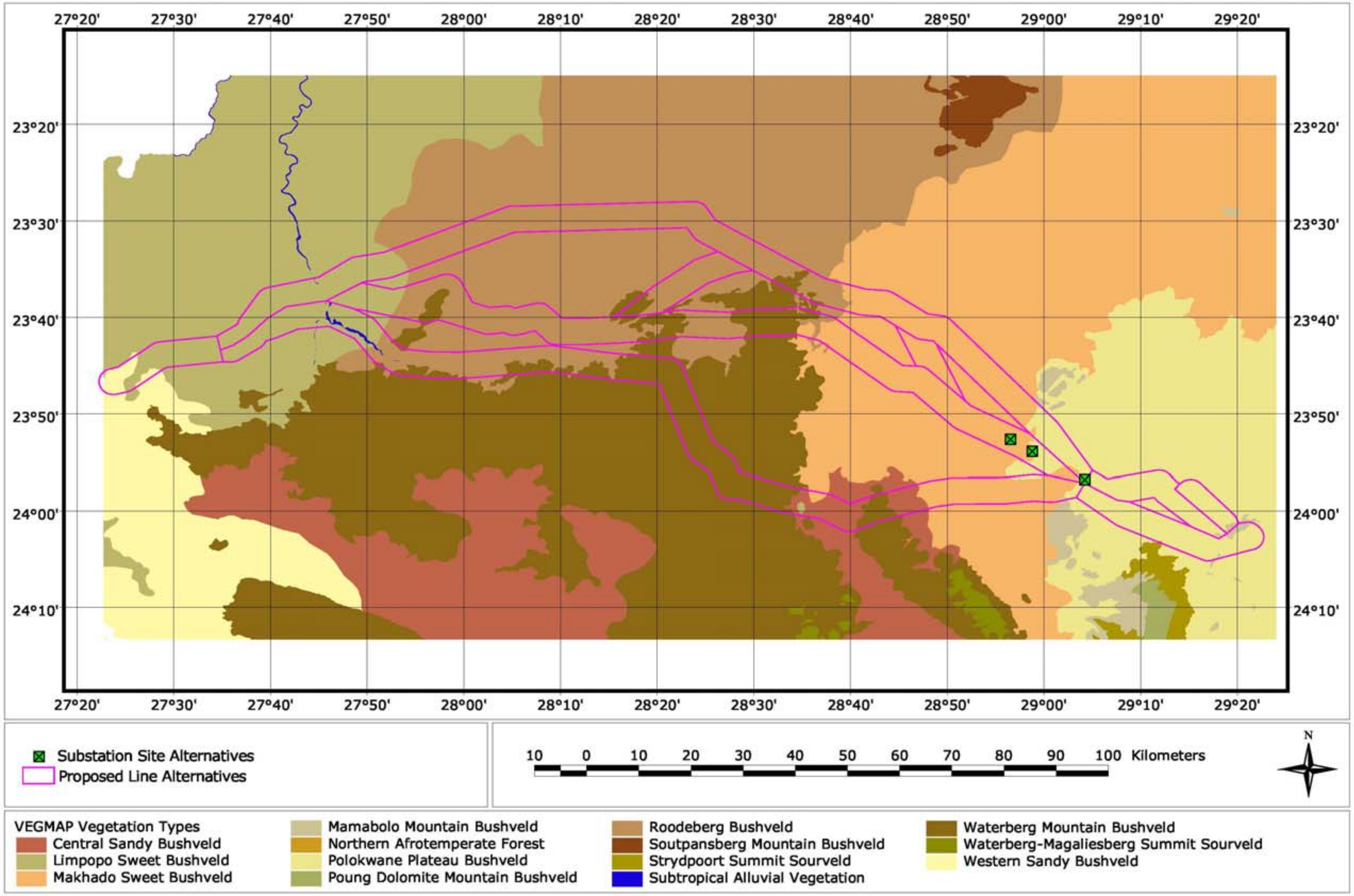

Figure 9: VEGMAP Vegetation types of the study area

9 BIOPHYSICAL SENSITIVITIES OF THE STUDY AREA

This section will provide an explanation of biophysical habitat sensitivities ascribed to areas within the study area based biophysical attributes and how these attributes relate to biodiversity of the area. Ascribed sensitivities are based on a combination of the likelihood of a specific biophysical attribute being important in terms of biodiversity attributes and the expected reaction of the particular attribute to impacts associated with the proposed project. Sensitivities are ultimately collated and a biodiversity sensitivity map is produced that presents an overview of the biodiversity sensitivity of the study area on a regional scale.

One of the shortcomings of this approach are that localised and small areas of importance are not always captured in existing databases and which are not observed during the extensive field surveys, will not be reflected on the sensitivity map. It should be noted that, should a positive authorisation be obtained frm DEA, sensitive areas of a small extent will be identified during the final walk-through of the project. Appropriate avoidance and mitigation recommendations will be included in the EMP.

9.1 Topography and Slopes

Ascribing biodiversity sensitivities to areas of different topographical classes provides an indication of the likelihood of certain topographical classes to contain biodiversity attributes of importance. Although the likelihood of species of conservation importance occurring in other areas is not excluded, this particular sensitivity is based on the association of Red Data species with areas of spatial heterogeneity, the importance of these areas in providing in atypical habitat types and high biodiversity levels that are frequently associated with these areas.

Areas of high topographical heterogeneity constitute relative large portions of the study area and the association of plant and animal species of conservation importance and areas of spatial heterogeneity is a well-known attribute of these habitat types. Conservation of these areas is therefore a priority. Areas of significant slopes are also frequently in a more pristine condition than the lower lying flatter parts, mainly as a result of low accessibility and being unsuitable for land use activities such as agriculture, mining, infrastructure, etc. Also, a result of the technical difficulties of construction in areas of high slopes, impacts of a significant nature is expected, rendering these areas more sensitive to the proposed development than areas with a lower incidence of topographical variation. All areas where slopes exceed 9% and morphological classes of heterogeneity are therefore regarded highly sensitive.

Areas of low slopes or a low incidence of morphological variation, such as plains, undulating plains, lowlands, etc, comprises the largest extent of the study area and the total effect of potential habitat loss is lower in these classes. Expected impacts resulting from the construction and operation of power lines in these areas are significantly lower than in habitat types of a similar disposition located in areas of high slopes. Lower sensitivity ascribed to these classes also highlights the fact that these areas are more likely to exhibit some form of degradation resulting from human activities and are therefore less likely to contain pristine habitat or biological attributes of conservation importance; threatened species are less likely to occupy areas where some form of habitat degradation has occurred. Land transformation activities are, to a large extent, restricted to areas that are accessible or suitable for certain practices, such as agriculture or urban development.

The following biodiversity sensitivities are attributed to topographical classes within the study area:

- Slopes exceeding 9% — High Sensitivity
- Escarpments — High Sensitivity
- Hills — Medium Sensitivity
- Low Mountains — Medium Sensitivity
- Lowlands with Hills — Medium-Low Sensitivity
- Lowlands with Mountains — Medium Sensitivity
- Moderately Undulating Plains — Medium-Low Sensitivity
- Plains — Low Sensitivity
- Slightly Undulating Plains — Low Sensitivity
- Strongly Undulating Plains — Low Sensitivity
- Table Lands — Medium-High Sensitivity

9.2 Areas of Conservation

All formal conservation areas are ascribed a high sensitivity, mainly as a result of the importance that these areas have in terms of achieving national targets of biodiversity conservation. High biodiversity sensitivity ascribed to declared areas of conservation is also based on the high likelihood of these areas being occupied by flora and fauna species of conservation importance which is a result of a combination of the following factors:

- being extensive in size;
- low fragmentation and isolation factors;
- pristine habitat (low degradation factors);
- low species selection/ genetic pool alterations; and
- scientific approach to management with conservation based strategies, which include frequent/ periodic fire, biological monitoring, moderate grazing levels, high existing biodiversity, low hunting/ species selection, etc. that simulates natural conditions to a large extent.

9.3 Surface Water

All areas of surface water are ascribed a high sensitivity, based on the high biodiversity that is associated with these habitat types and the severity of impacts associated with habitat transformation within these areas.

9.4 Land Cover & Land Use

Land cover classes are divided into two main categories, namely areas where habitat transformation has taken place (agriculture, built-up land, mining, cultivated, degraded, plantations), which is attributed a low sensitivity and areas of remaining natural habitat, which is attributed a similar sensitivity than the regional vegetation types. The transformed land cover classes were implemented in the assessment of regional isolation and fragmentation.

9.5 Regional Vegetation - VEGMAP

Effects of a nodal type of development associated with the substations are well known, but in order to assess the sensitivity of natural vegetation types towards this linear development it is necessary to understand the effect of power lines in the natural environment. Impacts that affect the status of natural vegetation are, to a large extent, limited to physical habitat disturbance associated with the footprint areas and, more particularly, the clearing of servitudes. The sensitivity of regional vegetation types is therefore ascribed on the basis of two main criteria, namely the biome (grassland and savanna ecoregions) and secondly the conservation status of the particular vegetation type.

The removal of the dominant woody layer during servitude clearance results in severe effects in woodland areas, causing severe, but localised, impacts on the structure and, ultimately, the species composition of the affected area. Effects include the decimation of the woody layer (particularly large trees), establishment of a more dominant grass layer, infestation of invasive shrub species, etc. In most cases these impacts are only of significance on the vegetation layer as animals will not particularly be affected as a result of their mobility.

In contrast to the significant physiognomic impacts in the woodland areas, extremely low levels of impact are noted in grassland areas. Servitudes appear to be of similar physiognomy and species composition than surrounding areas. The effect on animal species within the grassland region is even less than on the floristic component and these structures does not represent any particular barrier or obstacle for fauna species. Sensitivity of regional vegetation types is presented in Table 2.

9.6 Compilation of Biophysical Sensitivities

The biophysical sensitivity map was compiled by means of a GIS analysis of overlaying databases of biodiversity attributes and sensitivities. The concept of mutual exclusivity was applied, meaning that for each area the attribute of highest sensitivity was selected as being representative of the biodiversity sensitivity of that specific area. For example, in instances where an area is characterised by attributes of medium-low sensitivity as well as high sensitivity (wetland/ river), only the high sensitivity will register as being representative of the biodiversity sensitivity of that particular site. This method was used in preference to a totalling (averaging) method where the high environmental sensitivities are effectively reduced based on lower biophysical sensitivities that characterise an area. For example, the same area as above will only be registered as medium sensitivity if the same values are averaged.

Mutual exclusivity was preferred to the totalling method as the latter was found to 'disguise' areas of high sensitivity in lower classes and areas of low sensitivity in higher classes. Mutual exclusivity was also applied in the case of transformed areas, implying that if a database indicate an area as being transformed (containing no natural habitat), all other sensitivity classes are ignored. For example, an industrial area located on a ridge within a highly endangered vegetation type will still register as being of no importance in terms of biodiversity sensitivity. Biodiversity sensitivities of the study area are illustrated in Figure 10. The accuracy of existing databases was found to be acceptable during the survey period.

It is evident that, in terms of general regional sensitivities, the southern and central areas are regarded more sensitive, mainly as a result of the presence of important biophysical and conservation areas in these parts. The general lower sensitivities of other areas in the study area is mainly a result of the high fragmentation and isolation factors caused by the presence of agricultural areas, urban developments and other forms of land transformation practices.

Ultimately the biophysical sensitivity of any particular area is classed in one of five categories, namely 1 to 5. Categories 1/2 indicate areas where the biodiversity sensitivity is low and is generally the result of the area being transformed with no propensity for any significant biodiversity attributes. These areas are regarded suitable for the proposed development because the construction and operation of power lines in these parts of the study area is not expected to result in an impact on biodiversity attributes. Every effort will be made to guide the selection process in order to utilise as much of these areas as possible.

Category 5 indicates that the biodiversity sensitivity of the particular area is high because of the presence of a sensitive biophysical attribute. Examples include rivers, ridges, conservation areas, etc. These areas are likely to be occupied by a high diversity of flora and fauna species of importance, exhibiting significant and sensitive biodiversity attributes. Impacts associated with the construction and operation of power lines in this type of environment is expected to result in severe/ unacceptable impacts on the biodiversity component. The selection process will be guided in order to utilise as little of these areas as possible. Proposed line variants with the lowest extent of high sensitivity areas will be recommended as suitable for the proposed project.

Categories 3 to 4 exhibit biodiversity sensitivity attributes of moderate levels. It is emphasised that the biophysical attributes of the highest level of sensitivity is regarded representative of the biodiversity sensitivity of that particular area, except in the case of transformed areas where all biodiversity components are regarded entirely compromised in terms of sensitivity.

A dissemination of the extent of sensitivity classes within the respective line variants are presented in Table 3. For the purpose of this assessment, the power line corridors are grouped together in the following sections:

- Delta Medupi (1 Line/ No alternatives)
- Mokopane – Witkop (3 Line Alternatives)
- Medupi – Mokopane (5 Line Alternatives)

Table 3: Extent of sensitivity classes within respective line variants									
Description	**Hectares**					**Percentage**			
Corridor	**Sens 1/2**	**Sens 3**	**Sens 4**	**Sens 5**	**Total**	**Sens 1/2**	**Sens 3**	**Sens 4**	**Sens 5**
Corridor 7	107.08ha	11,787.71ha	0.00ha	0.00ha	11,894.79ha	0.90%	99.10%	0.00%	0.00%
Corridor 4	2,771.53ha	12,113.53ha	570.37ha	2,596.42ha	18,051.84ha	15.35%	67.10%	3.16%	14.38%
Corridor 5	4,243.48ha	13,110.47ha	573.31ha	572.76ha	18,500.02ha	22.94%	70.87%	3.10%	3.10%
Corridor 6	4,356.13ha	13,663.99ha	573.31ha	713.09ha	19,306.52ha	22.56%	70.77%	2.97%	3.69%
Corridor 1	13,484.07ha	12,696.95ha	23,777.63ha	37,459.56ha	87,418.20ha	15.42%	14.52%	27.20%	42.85%
Corridor 2	17,493.09ha	47,927.11ha	12,229.83ha	12,082.03ha	89,732.06ha	19.49%	53.41%	13.63%	13.46%
Corridor 8A	9,791.84ha	25,256.52ha	18,093.4ha	31,313.89ha	84,455.65ha	11.59%	29.91%	21.42%	37.08%
Corridor 8B	9,863.89ha	25,458.90ha	17,851.88ha	32,593.38ha	85,768.05ha	11.50%	29.68%	20.81%	38.00%
Corr 8 Dev	15403.75ha	30600.82ha	20414.92ha	25993.78ha	92413.27ha	16.67%	33.11%	22.09%	28.13%

Biophysical sensitivities of the respective corridors are calculated by means of a simple mathematical method. Results are numerically categorised, indicating the suitability of each line in relation to the others (1 – high suitability, 3/4 – low suitability), based on the extent of the following (Table 4):

- extent of HIGH sensitivity areas (class 5 in order highlight servitudes with extensive areas of highly sensitive sites that are not regarded suitable for the proposed development;
- extent of the sum of HIGH and MEDIUM-HIGH (classes 4 & 5) sensitivity areas within the corridors in order to highlight servitudes with extensive areas of high and medium-high sensitivity that are not regarded suitable for the proposed development;
- extent of LOW sensitivity areas (class 1/2) within the corridors in order to highlight servitudes with extensive areas of low sensitivity that are regarded suitable for the proposed development; and
- extent of the sum of LOW and MEDIUM-LOW sensitivity areas (classes 1/2 & 3) within the corridors in order to highlight servitudes with extensive areas of low and medium-low sensitivity that are regarded suitable for the proposed development.

Suitability values ascribed to each of the corridors were added and subsequently averaged with low values indicating corridors that are regarded more suitable for the proposed development and high values indicating the presence of extensive areas of highly sensitive biological environment. By using this method an attempt was made to ascribe an average value of suitability to each of the identified corridors based on a combination of several biodiversity sensitivity attributes and not only on a single sensitivity class viewed in isolation. The extent of high, intermediate as well as low sensitivity classes within the respective corridors thus plays an equally important role in determining the suitability of these identifiied corridors for the proposed development. No weighting was added to any of the classes.

Sections of the project were compared to other alternatives within the particular section, namely the three corridors within the eastern section were compared to each other, as were the four alternatives within the middle section. Comparisons of the proposed substation sites were based on a subjective assessment of available data and visual observations made during the survey period. Results are presented in Table 4.

Colour precedence is as follows for the respective sections of the project:
Suitable Options - Limited mitigation is expected to prevent/ control most adverse impacts. Limited unavoidable impacts in sensitive areas are still expected;
Moderately Suitable - Significant mitigation measures should control/ prevent most of the expected adverse impacts, but unavoidable impacts will still occur in parts of the servitudes; and
Not Suitable - Even with the application of significant mitigation measures extensive impacts are still expected to occur within sensitive parts of these corridors.

Table 4: Biophysical Sensitivities of the lines					
Corridor	**Sens 5**	**Sens 4+5**	**Sens 1**	**Sens 1+3**	**Average**
Western Section					
Corridor 7	1	1	1	1	**1**
Middle Section					
Corridor 1	5	5	3	5	**4.50**
Corridor 2	1	1	1	1	**1.00**
Corridor 8 A	3	3	5	4	**3.75**
Corridor 8 B	4	4	4	3	**3.75**
Corridor 8 Dev	2	2	2	2	**2.00**
Eastern Section					
Corridor 4	3	3	1	1	**2.00**
Corridor 5	1	1	2	2	**1.50**
Corridor 6	2	2	3	3	**2.50**

It is evident that Corridor 1 of the middle section comprises exensive areas of high biophysical sensitivity. The difference between the biophysical sensitivity of this and onther corridors in this section is significant, which will ultimately compromise the use of this corridor. Both Corridors 8A and 8B comprises habitat of high biophysical sensitivity in the central part of the corridors, placing a moderate to low suitability on the use of these corridors. Corridor 2, comprising extensitive low biophysical sensitivity habitat is regarded the preferred option for the middle section of the development. Corridor 8 Deviation, following much of the existing alignment, avoids much of the sensitive habitat, which is reflected in the significantly lower biophysical sensitivity, rendering this option suitable in terms of biophysical habitat sensitivity. An additional aspect that will be taken into consideration is the presence of an existing servitude; use of existing lines of transformation and degradation is preferred to new lines.

In terms of biophysical sensitivities, combination of Corridor 7 with either Corridor 2 or Corridor 8 Deviation and Corridor 5, are regarded the least sensitive in terms of biophysical sensitivity attributes that relate to the ecology of the region.

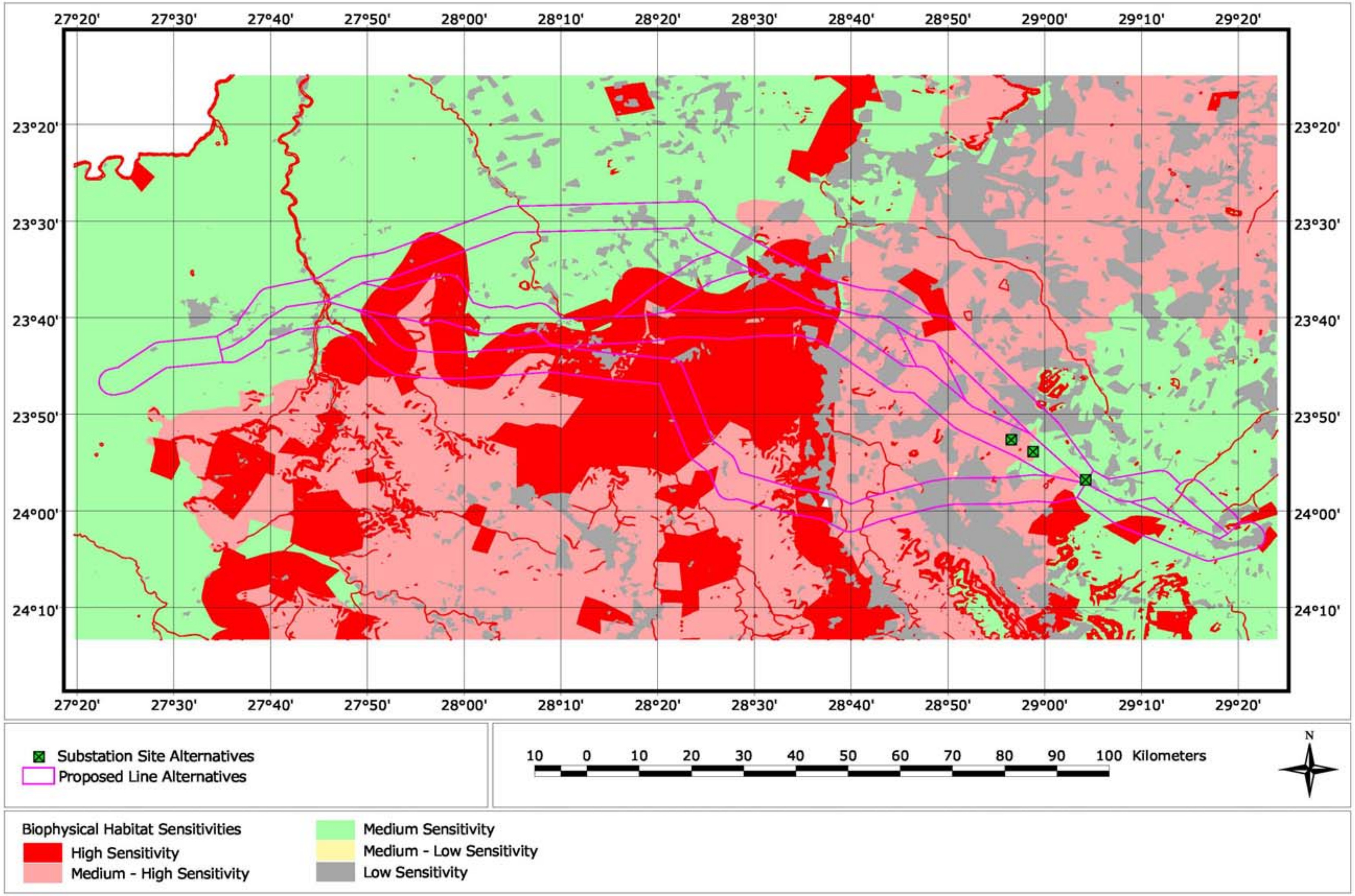

Figure 10: Biophysical sensitivities for the study area

10 FLORA OF THE STUDY AREA

10.1 Regional Floristic Diversity

The compilation of detailed species lists for specific regions was not perceived as part of the scope of this environmental impact assessment. A study of this nature would imply a dedicated sampling process of several years, probably in excess of two years. The study area encapsulates 22 ¼ degree grids. Available information indicates a range of between 22 and 961 plant species within these particular grids, with an average of 184 species per grid. Only in 5 grids are present in the database where the total of species exceeds 300. As a general rule it is estimated that any grid where less than 300 species are known to occur is regarded a result of undersampling and does not reflect the floristic diversity of the particular area. The existing database is therefore not regarded an accurate reflection of the true floristic diversity of the region.

The poor knowledge of floristic diversity of the region however does not reflect the true floristic richness of the study area. A total of 1,656 specis are known to occur in these particular grids and reflects the diversity of habitat types encountered in the study area. The Savanna Biome is known to support more than 5,700 plant species, exceed only by the Fynbos Ecoregion in species richness. While available information about the species richness of the study area might not be accurately reflected, the vegetation of the study area is still regarded diverse on a local and regional scale. A basic dissemination of the growth forms occurring in the study area revealed that the physiognomy is reflected by the prominent shrub (309 species, 18.7%) and tree (242 species, 14.6%) component. A normal high diversity of herbs (540 species, 32.6%) and grasses (188 species, 11.4%) is also encountered (Table 5).

Table 5: Growth forms of the study area		
Growth Form	**Number**	**Percentage**
Bryophytes	26	1.6%
Carnivores	10	0.6%
Climbers	111	6.7%
Cyperoids	67	4.0%
Geophytes	124	7.5%
Graminoids	188	11.4%
Herbs	540	32.6%
Hydrophytes	2	0.1%
Lichens	5	0.3%
Parasites	12	0.7%
Shrubs	309	18.7%
Succulents	13	0.8%
Suffrutex	7	0.4%
Trees	242	14.6%
Total	**1,656**	

10.2 Flora Species of Conservation Importance

10.2.1 Conservation Categories

PRECIS data received from the South African National Biodiversity Institute (SANBI) has been classified according to the old IUCN Red Data categories (Version 3.1, 2001). Categories used in the classification of Red Data flora species are as follows:

- **CR (Critically Endangered)**

A taxon is placed in this category when the available evidence indicates that it meets any of the five IUCN criteria for Critically Endangered, and is therefore facing an extremely high risk of extinction in the wild. When it is known to only occur at a single site, but is not exposed to any direct or plausible potential threat and do not qualify for a category of threat according to the five IUCN criteria.

- **EN (Endangered)**

A taxon is placed in this category when best available evidence indicates that it meets any of the five IUCN criteria for Endangered, and is therefore facing a very high risk of extinction in the wild.

- **VU (Vulnerable)**

A taxon is placed in this category when the best available evidence indicates that it meets any of the five IUCN criteria for Vulnerable, and is therefore facing a high risk of extinction in the wild.

- **NT (Near Threatened)**

A taxon is placed in this category when available evidence indicates that it nearly meets any of the five IUCN criteria for Vulnerable, and is therefore likely to qualify for a threatened category in the near future.

- **Rare**

A taxon is placed in this category when it meets any of the four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and do not qualify for a category of threat according to the five IUCN criteria.

- **Declining**

A taxon is placed in this category when it does not meet any of the five IUCN criteria and does not qualify for the categories Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline in the population.

- **Data Deficient**

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

- **LC (Least Concern)**

A taxon is placed in this category when it has been evaluated against the five IUCN criteria and does not qualify for the categories Critically Endangered, Endangered, Vulnerable and Near Threatened, or the South African categories Critically Rare, Rare or Declining. Widespread and abundant taxa are typically listed in this category.

10.2.2 Red Data Flora Species

Due to the extensive area that is under investigation, no specific comments are made with reference to Red Data flora in terms of distribution patterns and abundance. However, all areas of natural vegetation that are in a pristine condition are considered as fairly suitable for the presence of these species. It is regarded highly likely that numerous Red Data flora species are present within areas of natural/ pristine habitat contained within the proposed servitudes. The location and identification of Red Data flora species is a specialist field, mainly as a result of the following:

- Complex morphological and anatomical characteristics;
- Lack of suitable reference material;
- Low abundance, small populations; and
- Poor public knowledge.

Available data indicates the presence of 319 Red Data plant species within the Limpopo Province. A total of approximately 35 flora species with conservation importance are known to occur in the study area (excluding Least Concern taxa), summarised in Appendix 1.

Areas of pristine habitat, particularly ridge habitat are regarded suitable habitat for these species. Habitat types where Red Data species typically occur include the following:

- Pristine/ well managed grassland and woodland habitat;
- Riparian/ wetland habitat, particularly ecotonal zones;
- Ridges, mountains and outcrops; and
- Conservation areas.

10.2.3 Protected Tree Species

A national list of protected tree species has been declared to contribute towards the protection of the country's biodiversity and ecosystems as part of South Africa's ratification of the Convention on the Protection of Biological Diversity. In terms of the declaration, these particular tree species listed as protected may not be cut, disturbed or damaged and their products transported or sold without a license, which is granted by the Department of Water Affairs and Forestry (or a delegated authority). The proponent must therefore apply for a license prior to the start of construction activities.

Listing certain species as protected is not primarily aimed at preventing the use of a tree species, but to ensure sustainable use through licensing control measures. South Africa is home to more than 1,700 indigenous species of trees and shrubs, some of which are currently threatened on account of their rarity as well as the pressure of commercial and subsistence use. Criteria in listing trees as protected include the following:

- rarity of the species;
- importance of species in the maintenance of an ecosystem (keystone species);
- utilisation pressure on a species (timber, fuelwood or other uses);
- cultural or spiritual value of species (including landscape value); and
- consideration of the degree to which species already enjoyed protection under provincial ordinances and other legislation.

A Protected Tree Task Team has been set up in the department to develop national policy and guidelines for the management of protected tree species. For example, detailed guidelines had already been developed for the handling of license applications to cut Camel thorn trees (*Acacia erioloba*) following extensive research and consultation with a variety of stakeholders. The large-scale felling of Camel thorn for commercial braai wood had made proper control, based on scientific criteria, a matter of urgency.

Other protected species under threat include the Marula tree (*Sclerocarya birrea*), which is one of the most highly valued trees in the country. A large industry is based on products derived from Marula fruit, including beauty products and a famous brand of Marula liqueur. It is also a vital source of income and subsistence for many rural people. The Tsonga-speaking people also celebrate the Feast of the First Fruits by pouring an offering of fresh Marula juice over the graves of deceased chiefs.

Trees are mainly threatened by commercial harvesters, while some ecologically important forest trees are also under pressure from coastal development. An observation that is mentioned specifically is a relative dense population of Baobab (*Adansonia digitata*) in the central southern parts of the study area, in the vicinity of the farm Groot Denteren.

Fourteen tree species included in the national list of declared protected tree species are known to occur in the study area (Table 6). While this list may not be comprehensive, it provides a good indication of the presence of protected tree species within the study area.

Table 6: Protected trees of the study area		
Species name	**Family**	**Common Name**
Acacia erioloba	Mimosaceae	Camel Thorn
Adansonia digitata	Bombacaceae	Baobab
Boscia albitrunca	Capparaceae	Shepherd's Tree
Catha edulis	Celastraceae	Bushman's Tea
Combretum imberbe	Combretaceae	Leadwood
Curtisia dentata	Cornaceae	Assegai
Elaeodendrum transvaalense	Celastraceae	Bushveld Saffron
Erythrophysa transvaalensis	Sapindaceae	Bushveld Red Balloon
Mimusops zeyheri	Sapotaceae	Coastal Red Milkwood
Philenoptera violaceae	Fabaceae	Apple-leaf
Pittosporum viridiflorum	Pittosporaceae	Cheesewood
Prunus africana	Rosaceae	Red Stinkwood
Sclerocarya birrea subsp. *caffra*	Anacardiaceae	Marula
Securidaca longipedunculatum	Polygalaceae	Violet Tree

10.3 Remaining Natural Vegetation

The extent of remaining natural vegetation was calculated by GIS analysis with overlays of transformed areas and presented in Table 7. Table 8 presents these results expressed as percentages of the area of the respective line corridors.

Table 7: Extent of remaining natural vegetation within line variants, expressed in hectares

Vegetation Types	Corridors								
	Delta Medupi	Corridor 8A	Corridor 8B	Corridor 8 Dev	Corridor 1	Corridor 2	Corridor 4	Corridor 5	Corridor 6
Central Sandy Bushveld	0.0ha	0.0ha	0.0ha	0.0ha	5,362.7ha	0.0ha	0.0ha	0.0ha	0.0ha
Limpopo Sweet Bushveld	8,485.2ha	16,778.9ha	16,890.1ha	17,665.3ha	12,662.3ha	17,600.8ha	0.0ha	0.0ha	0.0ha
Makhado Sweet Bushveld	0.0ha	10,907.0ha	10,877.8ha	18,477.0ha	4,999.5ha	7,249.2ha	560.2ha	563.1ha	563.1ha
Mamabolo Mountain Bushveld	0.0ha	0.0ha	0.0ha	0.0ha	88.5ha	30.9ha	761.0ha	982.2ha	984.6ha
Polokwane Plateau Bushveld	0.0ha	2,951.6ha	2,924.3ha	4,610.2ha	1,299.3ha	1,958.5ha	11,643.2ha	7,941.4ha	8,356.4ha
Roodeberg Bushveld	0.0ha	23,306.6ha	25,109.8ha	30,674.6ha	14,809.2ha	28,572.0ha	0.0ha	0.0ha	0.0ha
Strydpoort Summit Sourveld	0.0ha	0.0ha	0.0ha	0.0ha	0.0ha	0.0ha	15.5ha	0.0ha	0.0ha
Subtropical Alluvial Vegetation	0.0ha	55.5ha	53.3ha	58.3ha	854.2ha	0.0ha	0.0ha	0.0ha	0.0ha
Transformed Habitat	778.0ha	19,651.7ha	19,923.9ha	15,403.8ha	18,277.6ha	33,025.3ha	5,025.9ha	9,013.6ha	9,387.3ha
Waterberg Mountain Bushveld	0.0ha	10,758.1ha	9,942.6ha	5,524.2ha	27,763.8ha	1,095.2ha	0.0ha	0.0ha	0.0ha
Western Sandy Bushveld	2,631.1ha	0.0ha	0.0ha	0.0ha	0.0ha	0.0ha	0.0ha	0.0ha	0.0ha
Total	**11,894.3ha**	**84,409.4ha**	**85,721.8ha**	**92,413.3ha**	**86,117.0ha**	**89,532.0ha**	**18,005.8ha**	**18,500.3ha**	**19,291.4ha**

Table 8: Extent of remaining natural vegetation within line variants, expressed as percentage									
Vegetation Types	**Corridors**								
	Delta Medupi	**Corridor 8A**	**Corridor 8B**	**Corridor 8 Dev**	**Corridor 1**	**Corridor 2**	**Corridor 4**	**Corridor 5**	**Corridor 6**
Central Sandy Bushveld	0.0%	0.0%	0.0%	0.0%	6.2%	0.0%	0.0%	0.0%	0.0%
Limpopo Sweet Bushveld	71.3%	19.9%	19.7%	22.9%	14.7%	19.7%	0.0%	0.0%	0.0%
Makhado Sweet Bushveld	0.0%	12.9%	12.7%	24.0%	5.8%	8.1%	3.1%	3.0%	2.9%
Mamabolo Mountain Bushveld	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	4.2%	5.3%	5.1%
Polokwane Plateau Bushveld	0.0%	3.5%	3.4%	6.0%	1.5%	2.2%	64.7%	42.9%	43.3%
Roodeberg Bushveld	0.0%	27.6%	29.3%	39.8%	17.2%	31.9%	0.0%	0.0%	0.0%
Strydpoort Summit Sourveld	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Subtropical Alluvial Vegetation	0.0%	0.1%	0.1%	0.1%	1.0%	0.0%	0.0%	0.0%	0.0%
Transformed Habitat	6.5%	23.3%	23.2%	0.0%	21.2%	36.9%	27.9%	48.7%	48.7%
Waterberg Mountain Bushveld	0.0%	12.7%	11.6%	7.2%	32.2%	1.2%	0.0%	0.0%	0.0%
Western Sandy Bushveld	22.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Substation Site 1 is situated within Polokwane Plateau Bushveld, with moderate transformation in surrounds;
Substation Site 3 is situated within Makhado Sweet Bushveld, with moderate transformation in surrounds; and
Substation Site 4 is situated within Polokwane Plateau Bushveld, with little transformation in surrounds.

10.4 Floristic Sensitivity of Vegetation Types

Due to the size of the study area, floristic sensitivities could not be ascribed to local communities or variations as the delineation of such areas and the investigation into the status of each community/ variations will take several years to complete. Floristic sensitivity was therefore calculated for the regional vegetation types on the basis of a subjective assessment of the following aspects (Table 9):

- regional importance of a particular vegetation type;
- type of vegetation;
- potential impact of the proposed development;
- observations made to the status and quality of areas during field surveys; and
- potential/ likelihood of RD and protected species.

The following floristic sensitivities were ascribed to the regional vegetation types.

- Central Sandy Bushveld — Medium-High Floristic Sensitivity
- Limpopo Sweet Bushveld — Medium Floristic Sensitivity
- Makhado Sweet Bushveld — Medium-High Floristic Sensitivity
- Mamabolo Mountain Bushveld — Medium Floristic Sensitivity
- Polokwane Plateau Bushveld — Medium Floristic Sensitivity
- Roodeberg Bushveld — Medium-High Floristic Sensitivity
- Strydpoort Summit Sourveld — Low Floristic Sensitivity
- Subtropical Alluvial Vegetation — High Floristic Sensitivity
- Transformed Habitat — No/ Zero Floristic Sensitivity
- Waterberg Mountain Bushveld — High Floristic Sensitivity
- Western Sandy Bushveld — Low Floristic Sensitivity

Flora within the central parts of Corridor 1 and the existing Corridor 8 lines, particularly in the mountainous areas, are regarded primary and of high sensitivity. The severity of habitat clearance along the existing Matimba-Witkop line in the central parts bears evidence to significant impacts associated with the construction and operation of power lines in these habitat types.

Results indicate the presence of extensive Medium-High vegetation types within Corridors 1 and 8 Deviation, resulting in high floristic sensitivity values of both these corridors. It is evident that the extent of High sensitivity habitat (Waterberg Mountain Bushveld) within Corridor 1 is a main reason for the High floristic sensitivity of this particular corridor. In comparison, the presence of extensive Medium-High habitat within Corridor 8 Deviation is a reflection of the length of this corridor, resulting in the presence of extensive Medium-High sensitivity habitat, Roodeberg Bushveld and Makhado Sweet Bushveld in particular. The extent of High sensitivity habitat within this particular corridor is relative low, comprising the second lowest total. However, Corridors 1 and 8 Deviation are regarded the least preferred options in terms of floristic sensitivity.

Table 9: Floristic Habitat Sensitivity Calculations

Corridors	Remaining Natural Vegetation										Total
	Central Sandy Bushveld	Limpopo Sweet Bushveld	Makhado Sweet Bushveld	Mamabolo Mountain Bushveld	Polokwane Plateau Bushveld	Roodeberg Bushveld	Strydpoort Summit Sourveld	Subtropical Alluvial Vegetation	Waterberg Mountain Bushveld	Western Sandy Bushveld	
Corridor 7	0.00	25.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63	**28.09**
Corridor 8A	0.00	50.34	43.63	0.00	8.85	93.23	0.00	0.28	53.79	0.00	**250.11**
Corridor 8B	0.00	50.67	43.51	0.00	8.77	100.44	0.00	0.27	49.71	0.00	**253.37**
Corridor 1	21.45	37.99	20.00	0.27	3.90	59.24	0.00	4.27	138.82	0.00	**285.93**
Corridor 2	0.00	52.80	29.00	0.09	5.88	114.29	0.00	0.00	5.48	0.00	**207.53**
Corridor 8 Dev	0.00	53.00	73.91	0.00	13.83	122.70	0.00	0.29	27.62	0.00	**291.34**
Corridor 4	0.00	0.00	2.24	2.28	34.93	0.00	0.02	0.00	0.00	0.00	**39.47**
Corridor 5	0.00	0.00	2.25	2.95	23.82	0.00	0.00	0.00	0.00	0.00	**29.02**
Corridor 6	0.00	0.00	2.25	2.95	25.07	0.00	0.00	0.00	0.00	0.00	**30.28**

Colour precedence is as follows for the respective sections of the project:

Suitable Options - Limited mitigation is expected to prevent/ control most adverse impacts. Limited unavoidable impacts in sensitive areas are still expected;

Moderately Suitable - Significant mitigation measures should control/ prevent most of the expected adverse impacts, but unavoidable impacts will still occur in parts of the servitudes; and

Not Suitable - Even with the application of significant mitigation measures extensive impacts are still expected to occur within sensitive parts of these corridors.

Floristic sensitivity calculations indicate that the combination of Corridor 7 with Corridor 2 and Corridor 5 or 3 are regarded the least sensitive in terms of floristic attributes.

11 FAUNAL ATTRIBUTES

11.1 General Faunal Diversity of the Study Area

The faunal diversity of an area is influenced by a large number of environmental variables, the effects of which are experienced on different scales by different animal taxa; invertebrate assemblages are influenced by microclimatic changes where-as large carnivores experience large-scale flooding and drought periods as more relevant.

It is important to remember that, although more visible and therefore more prevalent in conservation actions, vertebrates (mammals, birds, reptiles and amphibians) constitute an insignificant portion of the faunal diversity of any given habitat or natural area. By far the most significant source of '*variability among living organisms*' in any ecosystem (terrestrial or aquatic) is found within the invertebrate discipline. For example, the largest mammal ORDER, Rodentia (rodents), includes eight families for the southern African subregion and the largest FAMILY within the Rodentia, Muridae (rats and mice) has a known 59 species. In comparison, the largest insect ORDER, Coleoptera (beetles), includes a known 102 beetle families and the largest beetle FAMILY are at least 3,000 species within the families of the Curculionidae (weevils) and Scarabaeidae (dung beetles and relatives). This number is also increasing on an annual basis as new species are constantly being described.

It is therefore a fact that the species richness numbers are heavily favouring the smaller constituents of functioning ecosystems. They are also responsible for the majority of ecosystem functions – it is estimated that harvester termites found in the Kruger National Park consume more grass (in terms of biomass) annually than do all the larger vertebrate herbivores combined. Unfortunately extremely little information is available for the invertebrates of South Africa. The taxonomic status of many groups is still unresolved as much of the ecological contributions and ecosystem function roles of most groups are wholly unknown.

It is for this reason that the ecosystem or landscape approach to biodiversity conservation is important. Based on the information available for some well-studied groups such as dung beetles and butterflies as well as the combined vertebrate ecology information available, it can be extrapolated that the conservation of diverse, pristine ecological systems or habitats will imply significant biological diversity conservation.

The high levels of species and system diversity that is likely to be present in the study area is a result of the high variability of environmental factors such as temperature, humidity, rainfall, slope, elevation, geological variation, soil characteristics, surface water, and terrestrial habitat types. These variations are even more significant on the micro-habitat scale where invertebrates are influenced.

A loss of biodiversity leads to loss of ecosystem integrity and results in the loss of stability as the ecosystem becomes vulnerable to any additional disturbance or perturbation such as climate change (Mampye *et al*, 2008). The status quo of biodiversity on broad scales has been investigated on numerous occasions on a national scale, including the following:

- National Spatial Biodiversity Assessment (Driver *et al*, 2004);
- National Protected Area Expansion Strategy (Jackelman *et al*, 2008);

Due to the size of the study area, high level of habitat variation and information biases in the available databases, the focus of the faunal assessment (within the larger biodiversity assessment) is on landscape – or habitat diversity conservation. As a result, no lists of observed species or species likely to occur (other than Red Data fauna species) in the study are presented. The compilation of such species list will form the subject of several years of intensive studies conducted across the study area. In addition, such lists would have no real purpose or add significant value to the comparative sensitivity analyses or impact assessments.

The area investigated is characterised by a significant number of game farms. The presence of certain game species on a property is not always identical to fauna habitat conservation. Because game farming focuses on economic principles, the number of animals, combination of species and specific species introduced into these farms are often detrimental to the general health of the ecosystems found on these farms. Often these farms are over-grazed, and bush encroachment (of species such as *Dichrostachys cinerea* and *Acacia mellifera*) has led to the degradation of the general faunal habitat. The focus being on catering for a couple of species rather than species richness (the greatest number of species originally found in these areas) and species diversity (the most natural combination of animal species found in the area before human interference), these game farms cannot automatically be equated with nature conservation areas.

It is simply logical that many game farms are managed according to accepted and principally effective ecological principles (good fire regime, low game numbers etc.) and these farms are, on a local scale, will be considered more sensitive than those managed solely on short term economic principles. It is however not within the scope of this study to assess each game farm in terms of management and consequent habitat condition and – diversity and faunal habitat types and sensitivities are estimated on visual characteristics and biophysical attributes. Therefore the focus of the assessment was purely to assess the state of areas, taking cognisance of aspects such as over-grazing and bush encroachment (indicators of poor ecological management), erosion, etc.

Conservation areas (such as Touchstone, Percy Fyve, Lapalala and Moepel farms) were however assigned a higher ecological and sensitivity status than other areas; this is based on an assumption that these areas are managed to preserve and conserve nature as a whole; including all species of animal whether they can be hunted or not. Ground truthing of this assumption in areas such as Percy Fyve, Touchstone and Lapalala Wilderness area proved it to conform to the general pre-conceived notion that these areas are ecologically in a better state than areas outside of formal nature conservation areas.

11.2 Red Data Fauna Probabilities for the Study Area

Use was also made of night time photography that was conducted on the farm Lilliefontein (Corridor 8).

The following numbers of Red Data species are listed for the Limpopo Province:

- 7 butterfly species;
- 2 frog species;
- 8 reptile species; and
- 72 mammal species.

The following statuses are ascribed to these species:

- 26 species are listed as Data Deficient (DD);
- 29 species are listed as Near Threatened (NT);
- 22 species are listed as Vulnerable (VU);
- 8 species are listed as Endangered (EN);
- 3 species are listed as Critically Endangered (CR); and
- 1 species is listed as Extinct (EX).

Probabilities of occurrence in the study area for the 89 Red Data fauna species are as follows (results presented in Table 10):
50 species are estimated to have a low likelihood of occurring in the study area;
11 species are estimated to have a moderate likelihood of occurring in the study area; and
28 species are estimated to have a high likelihood of occurring in the study area.

Although the categories of Data Deficient and Near Threatened are not considered as "threatened" species the importance of these groups cannot be over-estimated. Most of the Data Deficient species are more than not likely to be "threatened", but insufficient data exists to verify their true status. When considering nature conservation, prevention is surely better than cure. Although nature conservationists have to focus on "crisis management" – i.e. scrambling to conserve threatened taxa, it is just as important to considered taxa on the brink of being under threat – i.e. Near Threatened species. As a result of these principles, the above-mentioned IUCN Red Data categories are used in the sensitivity analyses and impact assessments.

Table 10: Red Data fauna probabilities for the study area			
Species Details		**Status**	**Result**
Invertebrates			
Alaena margaritacea	Wolkberg Zulu	Critically Endangered	low
Aloeides stevensoni	Stevenson's Copper	Vulnerable	low
Dingana dingana clara	Wolkberg Widow	Vulnerable	low
Erikssonia acraeina	Eriksson's Copper	Endangered	low
Hyalites induna	Induna Acraea	Vulnerable	low
Lepidochrysops lotana	Lotana Blue	Critically Endangered	high
Pseudonympha swanepoeli	Swanepoel's Brown	Vulnerable	low
Amphibians			
Breviceps sylvestris	Northern Forest Rain Frog	Vulnerable	low
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	high
Reptiles			
Acontophiops lineatus	Woodbush Legless Skink	Vulnerable	low
Australolacerta rupicola	Soutpansberg Rock Lizard	Near Threatened	low
Homopholis mulleri	Muller's Velvet Gecko	Near Threatened	moderate
Lamprophis swazicus	Swazi Rock Snake	Near Threatened	low
Lygodactylus methueni	Methuen's Dwarf Gecko	Vulnerable	low
Platysaurus relictus	Soutpansberg Flat Lizard	Near Threatened	low
Tetradactylus eastwoodae	Eastwood's Long-tailed Seps	Extinct	low
Xenocalamus transvaalensis	Transvaal Quillsnout Snake	Data Deficient	low
Mammals			
Acinonyx jubatus	Cheetah	Vulnerable	high
Amblysomus hottentotus	Hottentot's Golden Mole	Data Deficient	low
Atelerix frontalis	South African Hedgehog	Near Threatened	high
Calcochloris obtusirostris	Yellow Golden Mole	Vulnerable	low
Canis adustus	Side-striped Jackal	Near Threatened	low
Cercopithecus mitis	Samango Monkey	Vulnerable	low
Cercopithecus mitis erythrarchus	Samango Monkey	Vulnerable	low
Cercopithecus mitis labiatus	Samango Monkey	Endangered	low
Cloeotis percivali	Short-eared Trident Bat	Critically Endangered	moderate
Cricetomys gambianus	Giant Rat	Vulnerable	low
Crocidura cyanea	Reddish-grey Musk Shrew	Data Deficient	high
Crocidura fuscomurina	Tiny Musk Shrew	Data Deficient	low
Crocidura hirta	Lesser Red Musk Shrew	Data Deficient	high
Crocidura maquassiensis	Maquassie Musk Shrew	Vulnerable	low
Crocidura mariquensis	Swamp Musk Shrew	Data Deficient	high
Crocidura silacea	Lesser Grey-brown Musk Shrew	Data Deficient	low
Crocuta crocuta	Spotted Hyaena	Near Threatened	high
Damaliscus lunatus lunatus	Tsessebe	Endangered	moderate
Dasymys incomtus	Water Rat	Near Threatened	high
Dendromus nyikae	Nyika Climbing Mouse	Near Threatened	low
Diceros bicornis minor	Black Rhinoceros	Vulnerable	high
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	Data Deficient	high
Elephantulus intufi	Bushveld Elephant-shrew	Data Deficient	moderate
Epomophorus gambianus crypturus	Gambian Epauletted Fruit Bat	Data Deficient	moderate

Table 10: Red Data fauna probabilities for the study area			
Species Details		**Status**	**Result**
Glauconycteris variegatus	Butterfly Bat	Near Threatened	low
Grammomys cometes	Mozambique Woodland Mouse	Data Deficient	low
Grammomys dolichurus	Woodland Mouse	Data Deficient	low
Graphiurus platyops	Rock Dormouse	Data Deficient	high
Hipposideros caffer	Sundevall's Leaf-nosed Bat	Data Deficient	low
Hippotragus equinus	Roan Antelope	Vulnerable	high
Hippotragus niger niger	Sable Antelope	Vulnerable	high
Hyaena brunnea	Brown Hyaena	Near Threatened	high
Kerivoula argentata	Damara Woolly Bat	Endangered	low
Kerivoula lanosa	Lesser Woolly Bat	Near Threatened	low
Laephotis botswanae	Botswana Long-eared Bat	Vulnerable	moderate
Lemniscomys rosalia	Single-striped Mouse	Data Deficient	high
Leptailurus serval	Serval	Near Threatened	high
Lutra maculicollis	Spotted-necked Otter	Near Threatened	low
Lycaon pictus	African Wild Dog	Endangered	high
Manis temminckii	Pangolin	Vulnerable	high
Mellivora capensis	Honey Badger	Near Threatened	high
Miniopterus fraterculus	Lesser Long-fingered Bat	Near Threatened	low
Miniopterus schreibersii	Schreiber's Long-fingered Bat	Near Threatened	high
Mus neavei	Thomas' Pygmy Mouse	Data Deficient	low
Myosorex cafer	Dark-footed Forest Shrew	Data Deficient	low
Myosorex varius	Forest Shrew	Data Deficient	low
Myotis bocagei	Rufous Hairy Bat	Data Deficient	low
Myotis tricolor	Temminck's Hairy Bat	Near Threatened	moderate
Myotis welwitschii	Welwitsch's Hairy Bat	Near Threatened	moderate
Neamblysomus gunningi	Gunning's Golden Mole	Endangered	low
Neamblysomus juliane	Juliana's Golden Mole	Vulnerable	low
Neotragus moschatus zuluensis	Suni	Vulnerable	low
Nycteris woodi	Wood's Slit-faced Bat	Near Threatened	low
Panthera leo	Lion	Vulnerable	high
Paracynictis selousi	Selous' Mongoose	Data Deficient	low
Petrodromus tetradactylus	Four-toed Elephant-shrew	Endangered	low
Pipistrellus anchietae	Anchieta's Pipistrelle	Near Threatened	moderate
Pipistrellus rusticus	Rusty Bat	Near Threatened	high
Poecilogale albinucha	African Weasel	Data Deficient	high
Raphicerus sharpei	Sharp's Grysbok	Near Threatened	high
Rhinolophus blasii	Peak-saddle Horseshoe Bat	Vulnerable	moderate
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Near Threatened	high
Rhinolophus darlingi	Darling's Horseshoe Bat	Near Threatened	high
Rhinolophus fumigatus	Ruppel's Horseshoe Bat	Near Threatened	low
Rhinolophus hildebrantii	Hildebrant's Horseshoe Bat	Near Threatened	moderate
Rhinolophus landeri	Lander's Horseshoe Bat	Near Threatened	low
Rhinolophus swinnyi	Swinny's Horseshoe Bat	Endangered	low
Rhynchogale melleri	Meller's Mongoose	Data Deficient	low
Suncus infinitesimus	Least Dwarf Shrew	Data Deficient	low
Suncus lixus	Greater Dwarf Shrew	Data Deficient	low

Table 10: Red Data fauna probabilities for the study area			
Species Details		**Status**	**Result**
Suncus varilla	Lesser Dwarf Shrew	Data Deficient	low
Tatera leucogaster	Bushveld Gerbil	Data Deficient	high

It should be mentioned that the previously listed SA Python (*Python natalensis*) is not included in the Red Data list for the study area as a result of the de-listing of the species by the IUCN (IUCN Red List 2009). At the completion of the SARCA (South African Reptile Conservation Assessment) the issue of this species' status should be finalised. However, for the moment it is not considered to have an official Red Data status and is therefore excluded from the assessment.

Please note that only free-roaming mammals are included in the assessments, discussions and tables. Free-roaming animals listed above are considered important elements of the habitat variation and status found in the untransformed regions of the study area – they are often important indicators of sensitive faunal habitat due to their inherent sensitive nature to habitat degradation and fragmentation.

A final consideration with relevance to the Red Data fauna species of the study area involves the game farming industry and breeding programmes for Red Data mammals, particularly the following species:

- African Wild Dog (*Lycaon pictus* – EN);
- Black Rhino (*Diceros bicornis* – VU);
- Cheetah (*Acinonyx jubatus* – VU);
- Lion (*Panthera leo* – VU);
- Roan (*Hippotragus equinus* – VU);
- Sable (*Hippotragus niger* – VU);
- Spotted Hyaena (*Crocuta crocuta* – NT); and
- Tsessebe (*Damaliscus lunatus* – EN).

Although these species carry official Red Data status, their presence within the study area is not considered 'natural'; with few exceptions it is a fact that these species have been re-introduced into the study area for game farming and eco-tourism purposes, being managed for purposes other than ecosystem conservation. This aspect alone renders the presence of these species on a farm an economical consideration, more than a biodiversity attribute. Also, as a result of the highly isolated nature of game farms (fencing), these species are not able to roam freely throughout their natural habitat, resulting in significant effects on genepools, population dynamics, interactions, cross breeding, etc.

The introduction of these animals in an area by means of relocation represents *ex situ* conservation. *Ex-situ* conservation means literally, "off-site conservation". It is the process of protecting species by relocating part of the population from a threatened habitat to a new location, which may be a wild area or within the care of humans.

As a result, these species are not considered in the sensitivity analyses and impact assessments as their inclusion into comparative sensitivity analyses would create a false picture of the faunal sensitivity of game farms that support these species when compared to areas without these species but with similarly sensitive faunal habitat such as wetlands and rocky areas.

Of the 89 Red Data fauna species listed for the Limpopo Province, it is estimated that 39 (44%) of these species are either moderately or highly likely to be found within the region of the study area (within the corridors). Few of these species are likely to be restricted to one or two of the proposed alternative lines (as used in the data analyses. Most are widely distributed in the region of the study area. The 50 species that are estimated to be unlikely (low likelihood) inhabitants of the area investigated are known from other parts of the Limpopo Province and are not excluded as a result of poor habitat conditions or lack of suitable habitat.

11.3 Fauna Habitat Sensitivity

Faunal habitat sensitivities for the respective lines are presented in Table 11.

Table 11: Faunal Habitat Sensitivity Calculations

Corridor	Fauna Habitat Sensitivity Criteria						
	Transformation	Terrain Morphology	Conservation	Rivers	Special Fauna Habitat	Ridges	Total
Corridor 7	**11**	**0**	**0**	**0**	**36**	**0**	**47**
Middle Section							
Corridor 8A	**67**	**89**	**77**	**5**	**172**	**13**	**422**
Corridor 8B	**68**	**91**	**76**	**5**	**175**	**11**	**427**
Corridor 1	**71**	**125**	**132**	**15**	**192**	**30**	**566**
Corridor 2	**58**	**62**	**47**	**6**	**118**	**4**	**294**
Corridor 8 Dev	**68**	**86**	**63**	**6**	**160**	**7**	**390**
Eastern Section							
Corridor 4	13	21	35	0	0	1	**71**
Corridor 5	10	21	13	1	0	2	**47**
Corridor 6	10	19	14	2	0	2	**48**

Colour precedence is as follows for the respective sections of the project:

Suitable Options - Limited mitigation is expected to prevent/ control most adverse impacts. Limited unavoidable impacts in sensitive areas are still expected;

Moderately Suitable - Significant mitigation measures should control/ prevent most of the expected adverse impacts, but unavoidable impacts will still occur in parts of the servitudes; and

Not Suitable - Even with the application of significant mitigation measures extensive impacts are still expected to occur within sensitive parts of these corridors.

11.4 Discussion

Based on the assessment, the following sensitivities and preferences in terms of the proposed project are assigned to the power line corridors and three substation sites:

Corridor 7:	Low faunal sensitivity (preference not relevant)
Corridor 8A:	Moderate faunal sensitivity (second least preferred)
Corridor 8B	Moderate faunal sensitivity (second least preferred)
Corridor 8 Deviation	Moderate/ Low faunal sensitivity (moderate suitability)
Corridor 1:	High faunal sensitivity (least preferred)
Corridor 2:	Low faunal sensitivity (most preferred)
Corridor 4:	High faunal sensitivity (least preferred)
Corridor 5:	Moderate faunal sensitivity (most preferred)
Corridor 6:	Moderate faunal sensitivity (second least preferred)

11.4.1 Corridor 7

Situated at the western end of the proposed lines, it comprises approximately 23.0 km in length and is characterised by the plains of Western Sandy Bushveld and Limpopo Sweet Bushveld. Small portions are transformed (cultivated lands) and degraded and the area is characterised by special fauna habitat. No alternative was presented for this line and a comparative analysis is therefore not possible. No significantly sensitive faunal habitat or outstanding landscape features were observed within this corridor.

11.4.2 Corridor 8A & B

The existing Matimba Witkop corridors are situated in the central section of the study area and are approximately 142km in length. It is characterised by escarpments, plains, table-lands and lowlands with mountains topographical variations. Vegetation types that occur include Limpopo Sweet Bushveld, Roodeberg Bushveld, Waterberg Mountain Bushveld, Makhado Sweet Bushveld and Polokwane Plateau Bushveld. A matrix of untransformed, degraded and transformed faunal habitats is found in this corridor; it includes the nature conservation areas of Keta and Moepel. The two Matimba-Witkop corridors are similar in faunal sensitivity in terms of faunal attributes.

Although representing an existing impact, it was indicated by Eskom that unavoidable deviations from the existing line will result due to space constraints caused by topographical variations. The faunal sensitivity of these areas was therefore assessed as untransformed areas.

11.4.3 Corridor 1

The Medupi–Mokopane 1 corridor is situated in the central-southern part of the study and is approximately 173km in length. It is characterised by the escarpments, plains, table-lands, low mountains and lowlands with mountains topographical variations. Vegetation types that occur include Limpopo Sweet Bushveld, Roodeberg Bushveld, Waterberg Mountain Bushveld, Makhado Sweet Bushveld, Central Sandy Bushveld and Polokwane Plateau Bushveld. A matrix of untransformed, degraded and transformed faunal habitats is found in this corridor, including nature conservation areas of Touchstone and Witvinger. This line variant was estimated to be the most sensitive alternative of the middle section of the study area in terms of faunal attributes.

11.4.4 Corridor 2

This corridor is situated in the central-northern part of the study area and comprises approximately 179km. It is characterised by the escarpments, plains (including slightly and strongly undulating plains), and lowlands with mountains topographical variations. Vegetation types that occur include Limpopo Sweet Bushveld, Roodeberg Bushveld, Makhado Sweet Bushveld and Polokwane Plateau Bushveld. A matrix of untransformed, degraded and transformed faunal habitats is found in this corridor, including nature conservation areas of Bellevue and Masebe. This line variant was estimated to be the least sensitive alternative of the middle section of the study area in terms of faunal attributes.

11.4.5 Corridor 8 Deviation

This corridor is utilises an extensive part of the existing Matimba Witkop line, deviating to the north beforethe high sensitivity habitat and following part of Corridor 2 until a deviation to the south to reconnect with the existing line. A major reason for the relative high faunal sensitivity of this corridor is the length of the line, in comparison to other corridors; approximately 216km. The central part of the corridor comprises sensitive habitat, but the alignment with the existing line is likely to reduce potential impacts to an acceptable level.

11.4.6 Corridor 4

The Corridor 4 Corridor represents the southern option of the eastern section of the study area, comprising approximately 35km in length. It is characterised by the strongly undulating plains and low mountains topographical variations. Vegetation types that occur include Polokwane Plateau Bushveld and Mamabolo Mountain Bushveld. Small portions are transformed and degraded and the area is characterised the buffer zones and core conservation areas of the Percy Fyve and Kuschke conservation areas. This particular corridor is partly situated within the ¼degree grid 2429AA – the only grid in the study area listed as known habitat for the critically endangered *Lepidochrysops lotana* (Lotana Blue). This corridor is estimated to be the most sensitive alternative of the eastern section of the study area in terms of faunal attributes.

11.4.7 Corridor 5

This corridor represents the middle option of the eastern section of the study area, comprising approximately 28km in length. The habitat is characterised by the strongly undulating plains topographical variations. Vegetation types that occur include the Polokwane Plateau Bushveld. Small portions are transformed and degraded and the area is characterised some buffer zones of the conservation areas of the Percy Fyve and Kuschke conservation areas. This corridor estimated to be the least sensitive alternative of the eastern section of the study area in terms of faunal attributes.

11.4.8 Corridor 6

This corridor represents the northern option of the eastern section of the study area, comprising approximately 28km in length. The habitat is characterised by the strongly undulating plains of Polokwane Plateau Bushveld and Mamabolo Mountain Bushveld. Small portions are transformed (cultivated lands) and degraded. This corridor exhibits faunal sensitivity attributes of a similar nature as the Corridor 5 line, only slightly more sensitive.

11.4.9 Substation Site 1

This site is regarded moderate-low in faunal sensitivity and no attributes were observed on the site and the immediate surrounds that would suggest the potential presence of faunal attributes of high sensitivity.

11.4.10 Substation Site 3

This substation site is exhibits faunal sensitivity attributes of moderate sensitivity. The presence of a drainage line to the south of this site and the strongly undulating landscape represent some aspects of faunal sensitivity. It is therefore regarded to be more sensitive compared to Substation site 1.

11.4.11 Substation Site 4

This substation site is exhibits faunal sensitivity attributes of moderate sensitivity. The presence of a drainage line to the south of this site and the strongly undulating landscape represent some aspects of faunal sensitivity. It is therefore regarded to be more sensitive compared to Substation site 1.

12 INTEGRATION OF ECOLOGICAL RESULTS & RECOMMENDATIONS

Results of the biophysical, floristic and faunal sensitivity assessments are integrated to obtain an integrated biodiversity sensitivity of respective corridors. Ratings are given to respective corridors in terms of suitability of the respective disciplines and totalled to present an overview of the combined disciplines. Results are presented in Table 12.

Table 12: Ecological Habitat Sensitivity

Corridor	Biophysical Habitat Sensitivities	Floristic Habitat Sensitivities	Fauna Habitat Sensitivity	Ecological Sensitivity
Corridor 7	1	1	1	**3**
Corridor 1	5	4	5	**14**
Corridor 2	1	1	1	**3**
Corridor 8A	4	2	3	**9**
Corridor 8B	3	3	4	**10**
Corridor 8 Deviation	2	5	2	**9**
Corridor 4	2	3	3	**8**
Corridor 5	1	1	1	**3**
Corridor 6	3	2	2	**7**

Colour precedence is as follows for the respective sections of the project:

Suitable Options - Limited mitigation is expected to prevent/ control most adverse impacts. Limited unavoidable impacts in sensitive areas are still expected;

Moderately Suitable - Significant mitigation measures should control/ prevent most of the expected adverse impacts, but unavoidable impacts will still occur in parts of the servitudes; and

Not Suitable - Even with the application of significant mitigation measures extensive impacts are still expected to occur within sensitive parts of these corridors.

From the integration of the respective biophysical-, floristic- and faunal habitat sensitivity calculations and ratings it is evident that Corridors 1 (middle section) and (eastern section) are not regarded suitable for the proposed project. Calculations in the respective disciplines mirrored the eventual results. Conversely, the Corridor 2 and Corridor 5 Lines are regarded the least sensitive in terms of ecological attributes and is therefore recommended for the proposed project.

Sensitivity of Corridors 8A and 8B was influenced by the presence of existing lines. However, Eskom has indicated that the new line will not be able to follow existing lines entirely as topographical constraints in certain areas will not allow sufficient space for the required corridor. Deviations in certain areas are therefore unavoidable. Inevitably, areas that represent technical difficulties for the construction of powerlines are mostly associated with high ecological sensitivities. Sensitivities of natural habitat in Corridors 8A and 8B, particularly in highly sensitive areas, were therefore ascribed without the consideration of the existing lines.

The moderate suitability of Corridor 8 Deviation is strongly biased by the Floristic sensitivity. As indicated in the relevant section, this sensitivity reflects the presence of extensive areas of Medium-high floristic sensitivity which is the result of the length of the alignment. The extent of High floristic sensitivity habitat within this alignment is actually lower than in other corridors. The suitability of this line for the proposed project is also strongly influenced by the presence of an existing line for much of the alignment, rendering this option also suitable for the project. It should be mentioned that this statement only holds true where the approved servitude follows the existing servitude. Should the servitude deviate from the existing line outside the deviation, the sensitivity will increase proportionally.

13 IMPACT ASSESSMENT

Rating of impacts is based on the estimated effect that construction and operation of power lines will have on terrestrial biodiversity and ecological attributes of the study area. Impacts identified in this section are partly based on the Guidance Document on Biodiversity, Impact Assessment and Decision Making in Southern Africa (2006).

13.1 Anticipated Impacts

No impacts were identified that could lead to a beneficial impact on the ecological environment of the study area since the proposed development is largely destructive.

Impacts resulting from the construction and operation of power lines on ecological attributes of the study area are largely restricted to the physical impacts on biota or the habitat in which they occur. Direct impacts, such as habitat destruction and modifications, are regarded immediate, long-term and of high significance. These impacts are mostly measurable and fairly easy to assess as the effects thereof is immediately visible and can be determined to an acceptable level of certainty. In contrast, the effect of indirect impacts is not immediately evident and can consequently not be measured immediately. A measure of estimation is therefore necessary in order to evaluate these impacts. Lastly, impacts of a cumulative nature places direct and indirect impacts of this projects into a regional and national context, particularly in view of similar or resultant developments and activities. Eleven impacts were identified and placed in three categories in which they will be assessed, namely:

- Direct impacts:
  - Destruction of threatened flora species;
  - Destruction of protected tree species;
  - Direct impacts on threatened fauna species;
  - Direct impacts on common fauna species;
  - Destruction of sensitive/ pristine regional habitat types;

- Indirect Impacts:
  - Floristic species changes within the servitudes;
  - Faunal interactions with structures, servitudes and personnel;
  - Impacts on surrounding habitat/ species;

- Cumulative Impacts:
  - Impacts on SA's conservation obligations & targets;
  - Increase in local and regional fragmentation/ isolation of habitat; and
  - Increase in environmental degradation.

Other, more subtle impacts on biological components, such as changes in local, regional and global climate, effects of noise pollution on fauna species, increase in acid rain, ground water deterioration, the effect of EMF on fauna species, etc. are impacts that cannot be quantified to an acceptable level of certainty and is mostly subjective in nature as either little literature is available on the topic or contradictory information exist.

13.2 Nature of Impacts

13.2.1 Destruction of Threatened Flora Species

This impact is regarded a direct impact as it results in the physical damage or destruction of Red Data or Threatened species or areas that are suitable for these species, representing a significant impact on the biodiversity of a region. Threatened species, in most cases, do not contribute significantly to the biodiversity of an area in terms of sheer numbers as there are generally few of them, but a high ecological value is placed on the presence of such species in an area as they are frequently an indication of pristine habitat conditions. Conversely, the presence of pristine habitat conditions can frequently be accepted as an indication of the potential presence of species of conservation importance.

Red Data species are particularly sensitive to changes in their environment, having adapted to a narrow range of specific habitat requirements. Habitat changes, mostly a result of human interferences and activities, are one of the greatest reasons for these species having a threatened status. Surface transformation activities within habitat types that are occupied by flora species of conservation importance will definitely result in significant and permanent impacts on these species and their population dynamics. Effects of this impact are usually permanent and recovery or mitigation is generally not perceived as possible.

One of the greatest drawbacks in terms of limiting this particular impact is that extremely little information is available in terms of the presence, distribution patterns, population dynamics and habitat requirements of Red Data flora species in the study area. In order to assess this impact an approach it is therefore necessary to assess the presence/ distribution of habitats frequently associated with these species. Furthermore, by applying ecosystem conservation principles to this impact assessment and subsequent planning and development phases, resultant impacts will be limited to a large extent.

13.2.2 Destruction of Protected Tree Species

Tree species included in the National List of Declared Protected trees (as promulgated by the National Forests Act, 1998 (No 84 of 1998)) are present throughout the study area, particularly the woodland regions and impacts will be unavoidable, stemming from physical habitat disturbance. As a result of the distribution patterns of these species and their abundance in the study area, the level of impact on these species (in terms of conservation status) is not as severe as in the case of Red Data flora species. Cognisance of the presence of these species is taken during this phase of the project, but site specific actions will be recommended during the walk-through phase of the project.

In order to assess this particular direct impact, the association of these species with pristine regional habitat is used as an indication of their presence, i.e. degraded and transformed habitat is assumed to have a lower abundance of these species compared to pristine regional habitat types.

13.2.3 Direct Impacts on Threatened Fauna Species

Direct threats to threatened fauna species is regarded low in probability, mainly as a result of the ability of fauna species to migrate away from areas where impacts occur. Probably the only exception to this statement will be in the event where extremely localised habitat that are occupied by threatened fauna species are impacted by construction and operational activities to the extent that the habitat no longer satisfy the habitat requirements of the particular species, or where an increase in the isolation and fragmentation factors renders the remaining habitat inadequate. It should also be noted that most of the threatened fauna species potentially occurring in the study area have relatively wide habitat preferences and ample suitable habitat is presently available throughout the study area. To place this aspect into context it is estimated that habitat loss and transformation resulting from non-invasive and often overlooked impacts, such as overgrazing, infestation by invasive shrubs and selective hunting probably are likely to contribute more to impacts on most threatened fauna species than powerline developments.

13.2.4 Direct Impacts on Common Fauna Species

The likelihood of this impact occurring is relatively low as a result of the ability of animal species to migrate away from direct impacts. The tolerance levels of common animal species occurring in the study area is of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact. It is also unlikely that the conservation status of common animal species will be affected as a result of direct and indirect impacts of power lines on these species and their habitat.

13.2.5 Destruction of Sensitive / Pristine Regional Habitat Types

The loss of pristine natural regional habitat (primary vegetation) represents loss of habitat and biodiversity on a regional scale. Sensitive habitat types include mountains, ridges, koppies, wetlands, rivers, streams and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is attributed to the floristic communities and faunal assemblages of these areas as they contribute significantly to the biodiversity of a region. Furthermore, these habitat types are generally isolated and are frequently linear in nature, such as rivers and ridges. Any impact that disrupts this continuous linear nature will risk fragmentation and isolation of existing ecological units, affecting the migration potential of some fauna species adversely, pollinator species in particular.

The importance of regional habitat types is based on the conservation status ascribed to vegetation types. Woodland areas are affected significantly and the structure and species composition is altered severely as a result of servitude clearance. Micro-habitat conditions are changed as a result of the removal of the woody layer, affecting shade conditions, habitat competition, germination success of the herbaceous layer, etc. The removal of the dominant shrub canopy is likely to result in the establishment of a species composition that is entirely different than original conditions and the immediate surrounds, in many cases also comprising species of an invasive nature, particularly shrubs.

The effect of increased erosion is included in this impact.

13.2.6 Floristic Species Changes within the Servitudes

This impact is regarded an indirect impact. The transformation of particularly woodland habitat during the construction process will inevitably result in the establishment of habitat types that are not considered representative of the region. As a result of the severity of habitat manipulation, servitudes are frequently invaded by species not normally associated with the region (exotic and invasive species). In addition, many species that are not necessarily abundant in the region will increase in abundance as a result of more favourable habitat conditions being created as a result of habitat manipulation activities (encroacher species). This effect is more pronounced in the floristic component, but changed habitat conditions in the habitat will inevitably imply changes in the faunal component that occupies the habitat.

If left unmitigated, this risk will result in decreased habitat, increased competition and lower numbers of endemic biota, the genetic pool of species might eventually be influenced by the introduction of non-endemic species. Different faunal assemblages and plant communities have developed separate gene structures as a result of habitat selection and geographical separation and the introduction of individuals of the same species that might be genetically dissimilar to the endemic species might lead to different genetic selection structures, eventually affecting the genetic structure of current populations and assemblages.

13.2.7 Faunal Interactions with Structures, Servitudes & Personnel

It should be noted that animals generally avoid contact with human structures, but do grow accustomed to structures after a period. While the structures are usually visible as a result of clearance around tower footprints, injuries and death of animals do occur sporadically as a result of accidental contact. Large mammals are mostly prone to this type of impact. In particular, primate species such as baboons and monkeys are known to climb pole structures.

Alteration of habitat conditions within the servitudes does not necessarily imply a decrease in faunal habitation. These areas are frequently preferred by certain fauna species. The establishment of a dominant grass layer generally results in increased presence of grazer species, which might lead to an unlikely, but similar increase in predation within these areas.

The presence of personnel within the servitude during construction and maintenance periods will inevitably result in contact with animals. While most of the larger animal species are likely to move away from human contact, dangerous encounters with snakes, scorpions and possibly larger predators always remain likely. Similarly, the presence of humans within areas of natural habitat could potentially result in killing of animals by means of snaring, poaching, road kills, poisoning, trapping, etc.

13.2.8 Impacts on Surrounding Habitat/ Species

Surrounding areas and species present in the direct vicinity of the study area could be affected by indirect impacts resulting from construction and operation activities. This indirect impact could potentially include all of the above impacts, depending on the sensitivity and status of surrounding habitat and species as well as the extent of impact activities.

13.2.9 Impacts on SA's Conservation Obligations & Targets

This impact is regarded a cumulative impact since it affects the status of conservation strategies and targets on a local as well as national level and is viewed in conjunction with other types of local and regional impacts that affects conservation areas.

A number of declared conservation areas are present within the study area. These conservation areas contribute to the national conservation strategies and targets. Impacts that could potentially affect the status of these areas are regarded unacceptable and should be avoided at all costs. Also, aligning the servitudes in proximity to conservation areas as a mitigation measure against impacting on the conservation areas is not always a good solution as it places a limitation on the future expansion of conservation areas. This will only be a solution in selected cases where extensive transformed habitat is available for the use of servitudes. Natural habitat in the general surrounds of conservation areas do act as a buffer for these areas, also as a potential source of genetic variability, particularly in the case of relative small conservation areas.

13.2.10 Increase in Local & Regional Fragmentation / Isolation of Habitat

Uninterrupted habitat is a precious commodity for biological attributes in modern times, particularly in areas that are characterised by moderate and high levels of transformation. The loss of natural habitat, even small areas, implies that biological attributes have permanently lost that ability of occupying that space, effectively meaning that a higher premium is placed on available food, water and habitat resources in the immediate surrounds. This, in some instances might mean that the viable population of plants or animals in a region will decrease proportionally with the loss of habitat, eventually decreasing beyond a viable population size.

The danger in this type of cumulative impact is that effects are not known, or is not visible; with immediate effect and normally when these effects become visible they are beyond repair. Lineare types of developments affect the migratory success of animals in particular.

An important mitigation measure in this regard is to utilise existing causal factors of habitat fragmentation. One factor that will be taken into consideration is the presence of existing power lines in the study area. Habitat fragmentation will not be increased significantly when new power lines are placed adjacent to existing lines or other types of linear structures, such as roads. In contrast, constructing new power lines through areas of unfragmented habitat, the adverse effects of habitat fragmentation and isolation will be maximised. Therefore, where potential servitudes are presented with similar sensitivities, a potential corridor with an existing servitude might result in one being more suitable for the proposed development than an option affecting an area of largely untransformed habitat. Unfortunately this is not always a clear-cut case as it is heavily dependent on the local and regional sensitivity of the existing line, which might be located in areas of high sensitivity, while a line going through untransformed habitat might represent impacts of lower significance in terms of other types of impacts.

13.2.11 Increase in Environmental Degradation

Cumulative impacts associated with this type of development will lead to initial, incremental or augmentation of existing types of environmental degradation, including impacts on the air, soil and water present within available habitat. Pollution of these elements might not always be immediately visible or readily quantifiable, but incremental or fractional increases might rise to levels where biological attributes could be affected adversely on a local or regional scale. In most cases are these effects are not bound and is dispersed, or diluted over an area that is much larger than the actual footprint of the causal factor.

Similarly, developments in untransformed and pristine areas are usually not characterised by visibly significant environmental degradation and these impacts are usually most prevalent in areas where continuous and long-term impacts have been experienced.

13.3 Impact Assessment Rating

13.3.1 Line Variation Corridor 1

Nature	**Biodiversity Impacts of power lines along proposed Corridor 1**	
	Without Mitigation	**With Mitigation**
Extent	3 (Regional)	3 (Regional)
Duration	5 (Permanent)	4 (Long term)
Magnitude	4 (High)	4 (High)
Reversibility	5 (Irreversible)	3 (Recoverable, needs input)
Consequence	17	14
Probability	5 (Definite)	5 (Definite)
Significance	**85 (High)**	**70 (High)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Significant increase in fragmentation and isolation of remaining natural habitat, particularly in central part of study area, extensive untransformed areas will be affected. Significant effect on conservation targets/ areas on a regional scale. Significant increase in general environmental degradation.	
Residual Impacts	Cleared servitudes likely to become infested with increaser and invasive plant species. Remains of access into topographically challenging areas likely to remain as visual and environmental impacts.	

13.3.2 Line Variation Corridor 2

Nature	**Biodiversity Impacts of power lines along proposed Corridor 2**	
	Without Mitigation	**With Mitigation**
Extent	2 (Local)	2 (Local)
Duration	4 (Long term)	4 (Long term)
Magnitude	3 (Moderate)	2 (Low)
Reversibility	3 (Recoverable, needs input)	1 (Reversible, naturally)
Consequence	12	9
Probability	3 (Medium probability)	2 (Low probability)
Significance	**36 (Moderate)**	**18 (Low)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat, particularly in western sections. Slight impact on conservation targets/ areas on a regional scale. Slight increase in general environmental degradation.	
Residual Impacts	Cleared servitudes likely to become infested with increaser and invasive plant species. Remains of access into topographically challenging areas likely to remain as visual and environmental impacts.	

13.3.3 Line Variation Corridor 4

Nature	**Biodiversity Impacts of power lines along proposed Corridor 4**	
	Without Mitigation	**With Mitigation**
Extent	4 (National)	4 (National)
Duration	4 (Long term)	3 (Medium, 3-15 yrs)
Magnitude	4 (High)	3 (Moderate)
Reversibility	3 (Recoverable, needs input)	3 (Recoverable, needs input)
Consequence	15	13
Probability	4 (High probability)	4 (High probability)
Significance	**60 (High)**	**52 (Moderate)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat, particularly in central section. Slight impact on conservation targets/ areas on a regional scale. Slight increase in general environmental degradation.	
Residual Impacts	Cleared servitudes likely to become infested with increaser and invasive plant species.	

13.3.4 Line Variation Corridor 5

Nature	**Biodiversity Impacts of power lines along the proposed Corridor 5**	
	Without Mitigation	**With Mitigation**
Extent	3 (Regional)	2 (Local)
Duration	4 (Long term)	3 (Medium, 3-15 yrs)
Magnitude	3 (Moderate)	3 (Moderate)
Reversibility	3 (Recoverable, needs input)	3 (Recoverable, needs input)
Consequence	13	11
Probability	3 (Medium probability)	3 (Medium probability)
Significance	**39 (Moderate)**	**33 (Moderate)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat, particularly in central section. Slight increase in general environmental degradation.	
Residual Impacts	Cleared servitudes likely to become infested with increaser and invasive plant species.	

13.3.5 Line Variation Corridor 6

Nature	**Biodiversity Impacts of power lines along the proposed Corridor 6**	
	Without Mitigation	**With Mitigation**
Extent	3 (Regional)	2 (Local)
Duration	4 (Long term)	3 (Medium, 3-15 yrs)
Magnitude	4 (High)	3 (Moderate)
Reversibility	3 (Recoverable, needs input)	3 (Recoverable, needs input)
Consequence	14	11
Probability	3 (Medium probability)	3 (Medium probability)
Significance	**42 (Moderate)**	**33 (Moderate)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat, particularly in central section. Slight increase in general environmental degradation.	
Residual Impacts	Cleared servitudes likely to become infested with increaser and invasive plant species.	

13.3.6 Line Variation Corridor 7

Nature	**Biodiversity Impacts of power lines along proposed Corridor 7**	
	Without Mitigation	**With Mitigation**
Extent	2 (Local)	1 (Site only)
Duration	4 (Long term)	4 (Long term)
Magnitude	3 (Moderate)	2 (Low)
Reversibility	3 (Recoverable, needs input)	1 (Reversible, naturally)
Consequence	12	8
Probability	3 (Medium probability)	2 (Low probability)
Significance	**36 (Moderate)**	**16 (Low)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat. Slight increase in general environmental degradation.	
Residual Impacts	Cleared servitudes and immediate surrounds might become infested with increaser and invasive plant species during and subsequent to operational phase.	

13.3.7 Line Variation Corridor 8A

Nature	Biodiversity Impacts of power lines along proposed Corridor 8A	
	Without Mitigation	**With Mitigation**
Extent	3 (Regional)	2 (Local)
Duration	4 (Long term)	4 (Long term)
Magnitude	4 (High)	4 (High)
Reversibility	5 (Irreversible)	3 (Recoverable, needs input)
Consequence	16	13
Probability	4 (High probability)	4 (High probability)
Significance	**64 (High)**	**52 (Moderate)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat, particularly in central part of study area, mainly because of existing line, otherwise more severe cumulative impact. Increase in general environmental degradation.	
Residual Impacts	Cleared servitudes and immediate surrounds might become infested with increaser and invasive plant species. Physical habitat disturbance likely to result in permanent scars in sensitive areas, evident from existing line in high sensitivity areas.	

13.3.8 Line Variation Corridor 8B

Nature	**Biodiversity Impacts of power lines along proposed Corridor 8B**	
	Without Mitigation	**With Mitigation**
Extent	3 (Regional)	2 (Local)
Duration	4 (Long term)	4 (Long term)
Magnitude	4 (High)	3 (Moderate)
Reversibility	5 (Irreversible)	3 (Recoverable, needs input)
Consequence	16	12
Probability	4 (High probability)	4 (High probability)
Significance	**64 (High)**	**48 (Moderate)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat, particularly in central part of study area, mainly because of existing line, otherwise more severe cumulative impact. Increase in general environmental degradation.	
Residual Impacts	Cleared servitudes and immediate surrounds might become infested with increaser and invasive plant species. Physical habitat disturbance likely to result in permanent scars in sensitive areas, evident from existing line in high sensitivity areas.	

13.3.9 Line Variation Corridor 8 Deviation

Nature	**Biodiversity Impacts of power lines along proposed Corridor 8 Deviation**	
	Without Mitigation	**With Mitigation**
Extent	2 (Local)	2 (Local)
Duration	4 (Long term)	4 (Long term)
Magnitude	4 (High)	3 (Moderate)
Reversibility	3 (Recoverable, needs input)	1 (Reversible, naturally)
Consequence	13	10
Probability	3 (Medium probability)	2 (Low probability)
Significance	**39 (Moderate)**	**20 (Low)**
Status	Negative	Negative
Irreplaceable loss of resources?	No, possible	
Can impacts be mitigated	Yes	
Mitigation	Section 15.2 & 15.3	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat. Slight increase in general environmental degradation	
Residual Impacts	Cleared servitudes might be infested with increaser and invasive plant species.	

13.3.10 Substation Site 1 & Turn-in Lines

Nature	**Biodiversity Impacts at Substation Site 1 & Turn-in Lines**	
	Without Mitigation	**With Mitigation**
Extent	2 (Local)	2 (Local)
Duration	4 (Long term)	3 (Medium, 3-15 yrs)
Magnitude	3 (Moderate)	2 (Low)
Reversibility	3 (Recoverable, needs input)	3 (Recoverable, needs input)
Consequence	12	10
Probability	3 (Medium probability)	2 (Low probability)
Significance	**36 (Moderate)**	**20 (Low)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat. Slight increase in general environmental degradation.	
Residual Impacts	Cleared servitudes of turn-in lines are likely to become infested with increaser and invasive plant species. Decommissioning of substation will result in transformed habitat.	

13.3.11 Substation Site 3 & Turn-in Lines

Nature	**Biodiversity Impacts at Substation Site 3 & Turn-in Lines**	
	Without Mitigation	**With Mitigation**
Extent	3 (Regional)	2 (Local)
Duration	4 (Long term)	3 (Medium, 3-15 yrs)
Magnitude	4 (High)	3 (Moderate)
Reversibility	3 (Recoverable, needs input)	3 (Recoverable, needs input)
Consequence	14	11
Probability	4 (High probability)	3 (Medium probability)
Significance	**56 (Moderate)**	**33 (Moderate)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Moderate increase in fragmentation and isolation of remaining natural habitat. Slight increase in general environmental degradation. Increased impact on nearby riparian and ridge habitat.	
Residual Impacts	Cleared servitudes of turn-in lines are likely to become infested with increaser and invasive plant species. Decommissioning of substation will result in transformed habitat in otherwise untransformed area.	

13.3.12 Substation Site 4 & Turn-in Lines

Nature	**Biodiversity Impacts at Substation Site 4 & Turn-in Lines**	
	Without Mitigation	**With Mitigation**
Extent	3 (Regional)	2 (Local)
Duration	4 (Long term)	3 (Medium, 3-15 yrs)
Magnitude	4 (High)	3 (Moderate)
Reversibility	3 (Recoverable, needs input)	3 (Recoverable, needs input)
Consequence	14	11
Probability	4 (High probability)	3 (Medium probability)
Significance	**56 (Moderate)**	**33 (Moderate)**
Status	**Negative**	**Negative**
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Section 14	
Cumulative Impacts	Slight increase in fragmentation and isolation of remaining natural habitat, presence of existing lines are noted. Slight increase in general environmental degradation.	
Residual Impacts	Cleared servitudes of turn-in lines are likely to become infested with increaser and invasive plant species. Decommissioning of substation will result in transformed habitat in otherwise untransformed area.	

13.4 Ecological Impact Assessment Summary

Table 13 presents a summary of the significance of expected impacts within the respective power line corridors and substation sites for comparison purposes.

Table 13: Summary of Ecological Impact Assessment

Corridor	Significance pre-mitigation	Status	Significance post-mitigation	Status
Western Section				
Corridor 7	36	Moderate	16	Low
Middle Section				
Corridor 8A	64	High	52	Moderate
Corridor 8B	64	High	48	Moderate
Corridor 1	85	High	70	High
Corridor 2	36	Moderate	18	Low
Corridor 8 Deviation	39	Moderate	20	Low
Eastern Section				
Corridor 4	60	High	52	Moderate
Corridor 5	39	Moderate	33	Moderate
Corridor 6	42	Moderate	33	Moderate
Substation Site				
Substation Site 1	36	Moderate	20	Low
Substation Site 2	56	Moderate	33	Moderate
Substation Site 3	56	Moderate	33	Moderate
Substation Site 4	56	Moderate	33	Moderate

14 RECOMMENDED MITIGATION MEASURES

The single most important mitigation measure in the case of power line corridors, or any area where development will take place that were identified as being unsuitable for the proposed development, in terms of biodiversity and ecological aspects, is the preferred use of an alternative area or corridor that will result in less significant impacts.

Mitigation measures are divided into two groups, namely:

- generic mitigation measures (measures that is required/ recommended for the entire line and during the maintenance/ construction process); and
- site/ action specific mitigation measures (measures that is required/ recommended for specific sites, or in the event of specific activities or impacts).

14.1 Activities Resulting in Impacts

A summation/ elaboration of expected activities are presented, based on generic procedures followed (Section 21). Activities that will result in adverse impacts on the natural environment will include the following, but are not necessarily limited to:

Activity 1 - construction and use of access roads;
Activity 2 - clearing of vegetation for construction and access purposes;
Activity 3 - surface disturbances surrounding footprint areas;
Activity 4 - surface disturbances in areas used for storage space;
Activity 5 - excavation of footprints;
Activity 6 - human movement and use of surrounding areas;
Activity 7 - health and sanitation issues;
Activity 8 - occurrence of open and accidental fires;
Activity 9 - refuelling and vehicle maintenance (spillages and pollution);
Activity 10 - poaching/trapping/ illegal hunting;
Activity 11 - storage and use of chemicals; and
Activity 12 - clearing of vegetation for servitude maintenance (removing, cutting, trimming of trees), including physical clearance and use of chemicals.

14.1.1 Access Roads - Construction & Use

For much of the area, particularly the grassland areas, this activity does not constitute a significant impact and the loss of biodiversity attributes are not expected to affect the status or sensitivity of habitat or species on a local or regional scale. However, sensitive areas, including rivers, streams and mountainous parts in particular, are regarded extremely vulnerable for related impacts and significant impacts is expected to occur as a result of the construction and use of access roads. Adverse effects of this activity include increased erosion, destabilisation of the substrate, prevalence of weeds and invasive species, damage to pristine and sensitive environments.

The rehabilitation and use of existing roads is recommended for the proposed operations. Construction of new access roads in the mountainous areas is regarded a prohibited activity and should be considered only when all other alternatives have been exhausted. The construction process should be undertaken with extreme care and under the implementation of all necessary mitigation measures.

14.1.2 Surface Disturbances Surrounding Footprint Areas

Importing materials, vehicles, personnel, storage of materials, infrastructure, removal of existing structures, excavation, construction activities include actions that will result in the degradation of the immediate surrounds of pole locations. These effects are usually associated with the decimation of herbaceous and scrubby layers, open soils, erosion and infestation by weeds and pioneer species. Clear and proper demarcation of construction areas should be maintained in order to limit the effect of these activities to a minimum. Proper cleanup and rehabilitation should suffice in limiting impacts associated with this activity.

This activity is not expected to result in significant impacts in low sensitivity areas, but high sensitivity areas will be affected adversely.

14.1.3 Surface Disturbances in Areas used for Storage Space

Extensive storage areas lead to surface disturbances that contribute to environmental degradation. Accessibility and future rehabilitation need to be considered in the selection of storage areas. Sensitive areas need to be avoided at all costs. Provisions must be made for waste management, temporary ablution facilities, vehicle maintenance areas, erosion control, proper fencing, etc.

14.1.4 Excavation of Footprints

Areas need to be excavated in order for the substrate anchoring of pole structures. Fortunately these areas are small in size and associated activities and movement of vehicles and personnel is regarded to represent a more severe risk to the environment than the actual footprint excavation. It is cautioned that the loss of topsoil, infestation with weeds and pioneer species, increased erosion and localised impacts on flora are some of the impacts associated with this activity that need to be monitored.

This activity is not expected to result in significant impacts in low sensitivity areas, but high sensitivity areas will be affected adversely.

14.1.5 Human Movement & Use of Surrounding Areas

The presence of personnel and the activities in a natural environment will result in localised surface disturbances in and around the construction sites. All vehicle and human movement must be restricted to the servitude area and access roads. Clear demarcation of construction areas must be provided. This is regarded particularly important in order to avoid any contact with animals within conservation areas and game farms. Speed limits must be sufficiently low in order to prevent accidents while periods of vehicular movement should be restricted to periods of light, i.e. no travelling during the night.

Noise levels should be controlled. It is unavoidable that periods of high noise will be experienced, every attempt should be made to limit these periods as far as possible. It is envisaged that this will form part of the responsibilities of the ECO.

Animals usually have a relative high tolerance for noise and disturbances. Most species, when being disturbed, will temporarily evacuate the area and seek suitable shelter, to return at a later stage. However, some animals might be affected to the state where nests or cover is permanently abandoned. The identification of these sites and location of infrastructure and construction facilities as far away as possible should form part of the responsibilities of the ECO.

Any unnecessary disturbances, particularly from vehicles and helicopters, should be avoided as far as possible.

14.1.6 Health, Sanitation and Litter Issues

Drinking of water from streams should not be allowed, drinking water should be provided for on site workers from a trusted source. Temporary sanitation facilities need to be available to site workers at all times. The use thereof should furthermore be advocated.

Aspects pertaining to snakes, scorpions and similar dangerous impacts need to be taken into consideration during the period of maintenance and construction. All health and safety related issues need to be addressed prior to any personnel going on site.

All litter should be contained in suitable storage areas and immediately removed to a suitable disposal facility. Plastic bags, containers, wrapping and insulation material will pose a threat to animals of the area.

14.1.7 Occurrence of Open & Accidental Fires

The use of fires for cooking purposes or any other purpose may result in accidental spread to adjacent areas. All areas, as a result of high biomass and flammability are regarded prone to the development and spread of accidental fires. Although fire is a natural occurrence, any accidental occurrence should be prevented. Other causes include smoking, discarded cigarettes and matches, overheating vehicles or equipment or faulty electrical equipment or wiring, welding and cutting operations. No firewood may be collected.

14.1.8 Refuelling & Vehicle Maintenance (spillages and pollution)

Refuelling should be restricted to areas dedicated for this activity, preferably at an existing off-site refuelling facility. On-site refuelling should be done with extreme care, taking all preventative measures against spillages.

Similarly, emergency vehicle maintenance/ repairs should be done in a suitably manner to avoid any spillages or pollution of the environment. Spillages of any nature should be cleaned and rehabilitated by means of appropriate measures.

14.1.9 Poaching/ Trapping/ Illegal Hunting

Any interaction with wild animals should be prevented and all wild animals should be treated as dangerous, particularly snakes, scorpions, large mammals and predators. The trapping, poaching or capturing of any animal is regarded an illegal activity. Any contact with wild animals should be avoided as far as possible. Should the presence of wild animals happen to interfere with construction, safety or operational procedures a responsible person should be contacted to deal with the problem or remove the animals. It is strongly advised that a herpetologist/ snake capturer be on permanent stand-by for the specialised capturing, removing and relocating of reptiles. Proper medical procedures/ treatment should also be available on-site in the event of injuries or incidents, particularly for snake-bites.

14.1.10 Clearing of Vegetation for Construction & Access Purposes

Clearance of vegetation will be required in order to facilitate access and construction purposes, particularly in savanna areas. Protected trees are likely to occur in parts of the servitude, care should be taken to ensure that all relevant permits are in order prior to damaging/ cutting, pruning or removal of any protected tree. Clearance of vegetation should be done in accordance to standards as available in Eskom documentation.

14.1.11 Storage & Use of Hazardous Materials & Chemicals

Hazardous materials and chemicals should be stored and use in a manner not to affect the natural environment negatively. Storage should be off site and only be transported to a site when required and then only in an acceptable and safe manner. Mixing of chemicals should be conducted as per manufacturer's label, taking cognisance of all specifications. Appropriate safety measures should implemented by users of all chemicals. By no means should any water be extracted from streams and rivers for the purpose of mixing chemicals. In the event of pollution it must be dealt with in the prescribed manner so that the environment is not damaged.

Chemicals used in the immediate vicinity of rivers, streams and dams should be applied in a manner not to pollute the water. This would probably exclude spraying methods. Pollution of any surface of ground water must be reported to the Department of Water Affairs.

14.1.12 Clearing of Vegetation for Servitude Maintenance

Clearance levels between the conductor and vegetation need to be maintained in the interest of effective line performance and for safety purposes. Riparian zones and the mountains represent the habitat types where trees are most prevalent. Pruning of indigenous trees is preferred to complete removal. Pruning must be according to set standards as available in Eskom documentation.

Alien vegetation is mostly associated with the rivers and old agricultural fields. All alien vegetation should be removed from the servitude area. Accepted removal and treatment methods should be implemented with extreme caution not to contaminate aquatic systems. Herbicide application to be conducted according to manufacturer's label. Clearance of vegetation should be done in accordance to standards as available in Eskom documentation.

Grass buildup around structures should be hoed/ slashed to required levels. The implementation of a fire management strategy is recommended to prevent grass buildup within the servitude areas. This is preferred to large scale mowing.

14.2 Generic Mitigation Measures

Mitigation Measure 1 - Appoint Environmental Control/ Site Officer. Appointment prior to start of construction, responsibilities should include, but not limited to ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;

Mitigation Measure 2 - Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation;

Mitigation Measure 3 - Conduct a final walkthrough prior to commencement of construction activities. This should be the responsibility of ECO/ ecologist. Responsibilities should be ensuring absence of Red Data species from construction sites, marking of Protected tree species, identification of localised areas of significance;

Mitigation Measure 4 - Identify areas of high ecological sensitivity during final walk-through and recommend localised deviations in the corridor;

Mitigation Measure 5 - Identify areas that will be suitable for access roads, ensuring proper upgrade/ construction/ maintenance in order to limit erosion, proliferation of weeds, etc.;

Mitigation Measure 6 - Limit construction, maintenance and inspection activities to dry periods in order to curb occurrence/ augmentation of erosion in areas of existing erosion, destabilizing of substrate in areas of high slopes, riparian zones, etc;

Mitigation Measure 7 - Demarcate construction areas in order to control movement of personnel, vehicles, providing boundaries for construction sites in order to limit dilution or spread of peripheral impacts;

Mitigation Measure 8 - Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area;

Mitigation Measure 9 - Compile an education programme for all contractors and subcontractors/ workers to ensure compliance to all aspects of EMP as well as educating personnel in the safe and proper conduct within areas of natural habitat;

Mitigation Measure 10 - Prevent open fires, provide demarcated fire-safe zones, facilities and fire control measures;

Mitigation Measure 11 - Ensure minimum ground clearance of lines in order to prevent electrocution of large mammals by means of accidental contact with lines, particularly in areas where topographical variation occurs;

Mitigation Measure 12 - Limit damage/ pruning/ cutting of trees to a minimum in accordance to Eskom guidelines;

Mitigation Measure 13 - The pruning of the woody layer is recommended instead of complete removal of all woody plants. Leaving a significant portion of the woody structure intact will prevent the establishment of an atypical habitat, limiting adverse impacts to a large extent;

Mitigation Measure 14 - Ensure off site storage of hazardous materials, chemicals, fuels, oils, etc. in order to prevent accidental spillage, contamination or pollution;

Mitigation Measure 15 - Develop emergency maintenance operational plan to deal with any event of contamination, pollution or spillages, particularly in sensitive areas;

Mitigation Measure 16 - Provide temporary on-site sanitation, litter and waste management and hazardous materials management facilities;

Mitigation Measure 17 - Ensuring surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;

Mitigation Measure 18 - Rehabilitation of disturbed areas subsequent to construction activities, taking cognisance of factors such as topsoil replacement, removal of introduced materials, local environmental factors;

Mitigation Measure 19 - Removal of dismantled structures, rubble, litter, refuse, temporary infrastructures, sanitation equipment, etc. subsequent to construction and rehabilitation; and

Mitigation Measure 20 - Final inspection in order to ensure adherence to EMP guidelines, completion of localised/ remaining areas of impact, monitoring of rehabilitation success, etc.

14.3 Site Specific Mitigation Measures

The following site/ action specific mitigation measures are recommended:

Mitigation Measure 21 - Conduct on-foot inspections in areas where access for vehicles are not possible/ feasible, particularly mountainous areas;

Mitigation Measure 22 - Prohibit construction of new access roads in areas of high environmental sensitivity. Use should be made of existing roads, ensuring proper maintenance/ upgrade. Alternative methods of construction/ access to sensitive areas is recommended;

Mitigation Measure 23 - Construction of new/ temporary bridges as part of access roads across non-perennial streams and larger rivers is regarded a prohibited activity, use should be made of existing crossings, ensuring proper maintenance/ upgrade;

Mitigation Measure 24 - Liaise with landowners in areas where dangerous large mammals/ predators may occur;

Mitigation Measure 25 - Install anti-climb devices in order to prevent primates gaining access to tower structures;

Mitigation Measure 26 - Ensure proper substrate anchorage, provide 'dummy pole' in order to prevent damage/ injury of mammals as a result of direct contact with pole structures, particularly large mammals in game farm areas;

Mitigation Measure 27 - Ensure that riparian areas are spanned/ pole structures are not placed within proximity to rivers, streams. Ensure placement of footprints outside 1:100 year floodlines. Crossing of riparian systems is only permitted at existing/ approved crossing points, taking due care to prevent additional/ new impacts;

Mitigation Measure 28 - Obtain permits for pruning, cutting or removal of protected trees. Protected trees should be identified and marked by the ECO/ ecologist during a final walk-through prior to commencement of construction;

Mitigation Measure 29 - Prevent impacts on any surface water as a result of hazardous materials, contamination, unnecessary crossing by vehicles or personnel, extraction, drinking or other human uses, construction and maintenance activities; and

Mitigation Measure 30 - Remove invasive and alien vegetation, particularly in vicinity of riparian zones where alien and invasive trees are known to occur. The implementation of a monitoring programme in this regard is recommended, being the responsibility of the ECO/ ecologist.

15 GENERIC ENVIRONMENTAL TECHNICAL NOTES ON POWER LINE & SUBSTATION CONSTRUCTION

Taken from a document compiled by PBA International (March 2009). Selected sections are presented as it relates to biodiversity and ecological aspects.

15.1 The Construction Process

The following is a process that will be adopted for the entire route, beginning at the starting point of the new line. Each activity will follow the previous one, such that at any one point an observer will see a chain of events, with different teams involved over time. At any one time some or all of the different teams may be working at different points along the line. There may be days of no activity in the process. There are some 35 active days of construction at any point, though this may take place over a period of two years.

An indication of the likely time spent by the team at a point (typically a tower location) is presented as they move along the route. These times may vary significantly depending on local conditions. As a rule of thumb, a single lead contractor can construct between 60 and 90km of new extra high voltage power line (400kV, 765kV) per year. This will vary according to terrain, tower type, number of bends, weather, availability of resources, etc.

Table 14: Generic activities during construction phase

Activity	Detail
Centre line pegging and identification of new gates - Light vehicle access	
Access Negotiations - Light vehicle access	Access plan is developed and agreed to by the landowner, Eskom and the contractor
	Rehabilitation measures are agreed
	photographs are taken before hand
	Access road will be established through recurring use (i.e. there will be no blading or scraping of a new road)
Bush Clearing - Heavy vehicle access	Identify with botanist on protected species and agree method on of clearing
	Bush cultivating
	Plant salvage & relocation
	Clearing of cut material
	Treating alien species
Tower Pegging - Light vehicle access	Contractor will appoint a surveyor to undertake this work
	Footing of the pylons will be set out
	Contractor will report back if anything odd is found and the tower will be moved accordingly
New gate installation - Light vehicle access	
Foundation nominations (for main structure and anchors) - Heavy vehicle access	Soil types are checked to determine foundation requirements
	Trial pits are dug at the main foundation points – usually using mechanical back-actor/auger methods, though in a few circumstances manual labour may be used.
Excavation of foundation - Heavy	Foundations of up to 4 m x 4 m square are excavated and up to 4m

Table 14: Generic activities during construction phase	
Activity	**Detail**
vehicle access	deep depending on soil conditions
	Foundation pit then need to be covered or fenced off until foundation is poured
Foundation steelwork (reinforcing) - Heavy vehicle access	Steelwork is usually made up at the base camp and brought on to site by truck
	All fitting, wiring is done on site (limited welding on site)
Foundation (concrete) pouring - heavy vehicle access.	Shuttering
	Standard concrete truck used
	If there are access problems, concrete will be mixed on site helicopters will be used in exceptional circumstances
	28 day setting period required after concrete has been poured
Delivery of tower steelwork - Heavy vehicle access	Steelwork is delivered in sections and assembled on site
	One truck can transport one tower
	Transported from the factory to site (the towers are individually designed for each location)
	Access roads are clearly marked to ensure the correct tower is delivered
Assembly team / Punching and painting	Steelwork is fitted together and assembled on the ground
	Nuts are punched and non-corrosive paint is placed on the nuts
Erection - Abnormal load vehicle access	Cranes (minimum of 50 tonne cranes) pick up the towers for final assembly
Stringing - Abnormal load vehicle access	Cable drums are placed next to each other within the servitude
	Stringing takes place in both directions from the drum stations –up to 4km can be strung from 1 station each way
	Working area at each drum station will be as long as 130m, but will be confined to the servitude width. Intensive vehicle movement may take place within this working area
	Pilot tractor will place the pilot cable on the ground: • cable is pulled up through the use of a pulley • conductors are never to touch the ground • in mountainous areas, a helicopter can be used or the pilot rope can be shot across valleys
Sag and tension - Heavy vehicle access	The line is tensioned from each cable station to ensure minimum ground clearance heights are achieved (15m for 765kv lines)
Rehabilitation - Heavy and light vehicle access	Rehabilitation is a continuous process during the construction phase
	Rehabilitation will typically only commence after the first 100 towers have been strung
	One year guarantee on the contractors work during which rehabilitation must be concluded– thereafter owner is paid the outstanding amount

15.2 Other Aspects/ Services from the Local Environment:

- Security – camp sites, lay down yards, storage areas, fuel depots, etc. 24h guarding.
- Catering & food supplies – provision of daily meals to teams at main camp and along the route(s).
- Machine servicing – 4x4 LDV's, heavy machinery (bull dozers, trucks, etc.), generators, etc.
- Welding services & steel provision – for gates, repairs, etc.
- Fencing services – for camps, storage areas, etc.
- Vehicle hire - 4x4 LDV's, heavy machinery.
- Accommodation – hotel rooms, B&B's, house rentals, office rental in nearest town.
- IT & communications – rentals, servicing.
- Concrete supplies – ready-mix, concrete mixing, batch plants.
- Ablution facilities – temporary (licensed) ablutions to be constructed at camp sites, portable facilities for each construction team.
- Waste management – collection, removal and disposal of solid waste, oils and hazardous wastes.
- Transport services – local distribution and long-distance haulage. Heavy goods vehicle and LDV's.

15.3 Construction Camps

The entire construction workforce is usually accommodated at various 'construction camps' that will be situated at various points along the route. The location is selected by the contractor who will take into account such aspects as access to the construction site, access to services, access to materials, etc. The contractor will enter into an agreement with a landowner for the establishment of the construction camp. The various teams will travel from the camp to the construction site each day. The site moves continuously with the progression of the line, so the teams will perhaps travel a different distance to the site each time. All materials are stored at the construction camp with the exception of the steel towers (which may come direct from the factory) and concrete (unless the site is very remote, when concrete may be mixed on site). As a rule of thumb, there is usually one construction camp per 100km of transmission line.

16 APPENDIX 1 – FLORA SPECIES OF CONSERVATION IMPORTANCE

All taxa with Least Concern status were excluded from this table.

Taxon	Family	Status	Growth Form
Acacia erioloba	Fabaceae	Declining	Shrub, tree
Adenia fruticosa subsp. *fruticosa*	Passifloraceae	Near Threatened	Climber, shrub, succulent, tree
Adenia gummifera var. *gummifera*	Passifloraceae	Declining	Climber, succulent
Alepidea peduncularis	Apiaceae	Data Deficient	Herb
Aloe thompsoniae	Asphodelaceae	Northern Sourveld Endemic	Succulent Herb
Argyrolobium muddii	Fabaceae	Endangered	Dwarf shrub, herb
Aster nubimontis	Asteraceae	Endemic	Herb
Berkheya carlinopsis subsp. *magalismontana*	Asteraceae	Northern Sourveld Endemic	Low Shrub
Boophane disticha	Amaryllidaceae	Declining	Geophyte, succulent
Bowiea volubilis subsp. *volubilis*	Hyacinthaceae	Vulnerable	Climber, geophyte, succulent
Brachystelma hirtellum	Apocynaceae	Near Threatened	Geophyte, succulent
Brachystelma inconspicuum	Apocynaceae	Rare	Herb
Brachystelma minor	Apocynaceae	Rare	Herb
Callilepis leptophylla	Asteraceae	Declining	Herb
Cassipourea malosana	Rhizophoraceae	Declining	Shrub, tree
Chorisochora transvaalensis	Acanthaceae	Central Bushveld Endemic	Soft Shrub
Combretum petrophilum	Combretaceae	Rare	Shrub, tree
Corchorus psammophilus	Malvaceae	Threatened	Herb
Crinum stuhlmannii	Amaryllidaceae	Declining	Geophyte
Crotalaria mollii	Fabaceae	Endemic	Shrub
Curtisia dentata	Cornaceae	Near Threatened	Shrub, tree
Delosperma macellum	Mesembryanthemaceae	Endangered	Dwarf shrub, succulent
Dicliptera minor subsp. *pratis-manna*	Acanthaceae	Endemic	Herb
Drimia altissima	Hyacinthaceae	Declining	Geophyte, succulent

Taxon	Family	Status	Growth Form
Drimia elata	Hyacinthaceae	Data Deficient	Geophyte
Elaeodendrum transvaalense	Celastraceae	Near Threatened	Shrub, tree
Encephalartos eugene-maraisii	Zamiaceae	Endangered	Shrub, tree
Eulalia aurea	Poaceae	Near Threatened	Graminoid
Eulophia speciosa	Orchidaceae	Declining	Geophyte, herb, succulent
Euphorbia clivicola	Euphorbiaceae	Critically rare	Shrub, succulent
Euphorbia groenewaldii	Euphorbiaceae	Critically Endangered	Shrub
Euphorbia louwii	Euphorbiaceae	Rare	Shrub, succulent
Euphorbia restricta	Euphorbiaceae	Rare	Shrub, succulent
Euphorbia waterbergensis	Euphorbiaceae	Rare	Shrub, succulent
Freylinia tropica	Scrophulariaceae	Rare	Shrub
Gladiolus dolomiticus	Iridaceae	Rare	Geophyte, herb
Gunnera perpensa	Gunneraceae	Declining	Herb, hydrophyte
Helichrysum uninervium	Asteraceae	Northern Sourveld Endemic	Low Shrub
Hypoxis hemerocallidea	Hypoxidaceae	Declining	Geophyte
Ilex mitis var. *mitis*	Aquifoliaceae	Declining	Shrub, tree
Isoetes transvaalensis	Isoetaceae	Near Threatened	Geophyte, herb, hydrophyte
Justicia minima	Acanthaceae	Rare	Dwarf shrub, herb
Khadia media	Mesembryanthemaceae	Endemic	Shrub
Ledebouria crispa	Hyacinthaceae	Central bushveld endemic	Geophyte
Mosdenia leptostachys	Poaceae	Central bushveld endemic	Graminoid
Myrothamnus flabellifolius	Myrothamnaceae	Data Deficient	Dwarf shrub, shrub
Oxygonum dregeanum subsp. *canescens* var. *dissectum*	Polygonaceae	Central bushveld endemic	Herb
Pachystigma triflorum	Rubiaceae	Endemic	Herb
Panicum dewinteri	Poaceae	Near Threatened	Graminoid
Piaranthus atrosanguinalis	Asclepidaceae	Central bushveld endemic	Herb
Protea rubropilosa	Proteaceae	Northern Sourveld Endemic	Small Tree
Prunus africana	Rosaceae	Vulnerable	Tree
Rapanea melanophloeos	Myrsinaceae	Declining	Tree

Taxon	Family	Status	Growth Form
Sartidia juncada	Poaceae	Vulnerable	Grass
Tetradenia barberae	Lamiaceae	Rare	Shrub, succulent
Thesium gracilentum	Santalaceae	Endemic	Semiparasitic Shrub
Thorncroftia media	Lamiaceae	Endemic	Succulent Shrub
Vitex obovata subsp. *wilmsii*	Verbenaceae	Northern Sourveld Endemic	Tall Shrub
Warburgia salutaris	Canellaceae	Endangered	Tree

17 PHOTOGRAPHIC RECORDS

Photo 1: Existing lines traversing areas of topographical importance

Photo 2: Localised areas of topographical importance

Photo 3: Existing transformation

Photo 4: Smaller drainage lines and rivers

Photo 5: Areas of significant topographical and biodiversity importance and sensitivity

Photo 6: Example of primary/ pristine regional woodland

Photo 7: Example of effect of servitude clearance in woodland areas

Photo 8: Effect of high grasing pressure

Photo 9: Localised stands of Mopane (*Colophospermum mopane*), near farm Morgenzon 512

Photo 10: Example of *Adenia spinosa* individual on farm Vught

Photo 11: Unique habitat of *Sansevieria* & *Pachypodium saundersii* (cf)

Photo 12: Example of *Adansonia digitata* on farm Groot Denteren

Photo 13: Evidence of Pufadder (*Bitis arietans*)

Photo 14: Evidence of Sivet (*Civetticus civetta*)

Photo 15: Evidence of Honey Badger (*Mellivora capensis*)

Photo 16: Evidence of Brown Hyeana (*Hyaena brunnea*)

Photo 17: Evidence of Leopard (*Panthera pardus*)

Photo 18: Evidence of Small Spotted Genet (*Genetta genetta*)