REPORT CODE: BWK – SPS – 01

Strategic Biodiversity Impact Evaluation for the proposed Steelpoort Pumped Storage System

submitted by

July 2006

March 2007

Cellular: 082 3765 933
Tel: (012) 658 5579
email: bathusi@lantic.net
Address: PO Box 77448
Eldoglen
Centurion
0171

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).

Investigator:	Riaan Robbeson (Pr.Sci.Nat.) (Bathusi Environmental Consulting)
Capacity:	Floristic Investigator
Affiliation:	South African Council for Natural Scientific Professions
Registration number:	400005/03
Fields of expertise:	Botanical Scientist & Ecological Scientist.

Investigator:	Dewald Kamffer (Pr.Sci.Nat.) (Faunal Specialists Incorporated)
Capacity:	Faunal Investigator
Qualification:	M.Sc. (Conservation Biology)
Affiliation:	South African Council for Natural Scientific Professions
Registration number:	400204/05
Fields of expertise:	Ecological Scientist & Zoological Scientist.

Project Assistant:	Theo Mostert (Kaross Environmental Services cc)
Capacity:	Faunal Investigation, Project Assistant
Qualification:	M.Sc. (Mammology)
Registration:	Pending

DECLARATION

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

- 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;
- 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 general 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; and
- should we consider ourselves to be in conflict with any of the above declarations, we will formally submit a Notice of Withdrawal to all relevant parties and formally register as an Interested and Affected Party.

1 EXECUTIVE SUMMARY

This biodiversity investigation forms part of an environmental impact assessment of the proposed development area. ESKOM is planning the construction of a 1,000 MW pumped storage scheme along the escarpment between the Nebo Plateau and the Steelpoort River Valley, situated approximately 10km north west of Steelpoort, Mpumalanga Province.

ESKOM has appointed Bohlweki Environmental to undertake Environmental studies. Bathusi Environmental Consultants has been appointed, on behalf of Bohlweki Environmental, to conduct a strategic impact evaluation of the biological environment that will be affected by the proposed development. Faunal Specialists Incorporated (FSI) was responsible for the faunal discipline; BEC compiled the floristic assessment and provided the ecological interpretation and compiled the impact evaluation.

1.1 Floristic Attributes

The aim of the floristic assessment is to present the reader with a description of the flora that characterises the study areas, providing insight into the diversity, communities and how these relate to the environmental attributes. Red Data flora status and probabilities as well as the inherent floristic sensitivities of the plant communities is determined and ultimately incorporated into the ecological impact evaluation.

The floristic diversity of the area is high as a result of the topographical variations that give rise to communities that vary significantly in terms of physiognomic characteristics. Driving forces behind vegetation development in these areas are soil properties, slope, rockiness and moisture regime. More recently, human influences caused changes in the vegetation as a result of transformation, agriculture, grazing and management activities.

PRECIS information presented by SANBI indicates the presence of 290 plant species. A relative low percentage of these species are included in the species list that was compiled during the site investigation, clearly illustrating the huge diversity of the general region. A total of 234 plant species were identified in the study area. This exceptional high floristic diversity is attributed to the extreme variation in available habitat, ranging from mountain grassland to *Acacia* woodland and riparian vegetation. A total of 63 plant families were identified.

The vegetation is representative of the regional vegetation types, comprising the following communities and variations:

- Mountain Grassland Community;
    * Degraded Mountain Grassland Variation (Medium-low Floristic Sensitivity);
    * Pristine Mountain Grassland Variation (High Floristic Sensitivity);
    * Escarpment Variation (High Floristic Sensitivity);
- Woodland Community;
    * Mountain Woodland Variation (Medium-high Floristic Sensitivity);
    * *Acacia* Woodland Variation (Medium-low Floristic Sensitivity);
    * Rocky Outcrop Woodland Variation (Medium-high Floristic Sensitivity);

- Riparian Woodland Community (High Floristic Sensitivity); and
- Transformed Areas Community (Low Floristic Sensitivity).

The Mountain Grassland Community is characterised by grassland and scanty woody vegetation. The dominance of the herbaceous layer is the major physiognomic attribute and a high diversity of grasses and forbs are noted in areas of pristine vegetation. High grazing pressure results in selective grazing in some parts and species changes results, giving rise to the different variations that are encountered in this community.

The Woodland Community comprises terrestrial woodlands with a dominant woody layer. It is situated on the footslopes of the mountain that leads towards the Steelpoort River and the variations are determined by soil properties, rockiness and slope severity. The vegetation is fairly representative of the regional vegetation and management styles of the general area determine the status of the woodland. Floristic variations in this community are typically the result of slopes, rockiness and soil properties.

The Riparian Woodland Community is situated along the Steelpoort River and tributaries and is characterised by a dominant tree layer, particularly *Acacia galpinii* stands which may reach heights in excess of 20m. The herbaceous layer, as a result of the strong shade effect, is generally poorly developed and constitutes only few grass and forb species. This community, although moderately degraded and of medium floristic status, is still considered extremely sensitive, particularly since it is associated with the riparian system.

Other variations include the Rocky Outcrop Woodland Variation, which is situated on a localised and small rocky outcrop in the northern part of the study area, comprising moderately degraded woodland vegetation. The localised and atypical nature of this variation renders it moderately sensitive. Transformed areas are present in the form of agricultural fields.

The Interim Red Data List of South African Plant Species (Threatened Species Programme, 2004), indicate a total of 335 potential Red Data flora species for the Mpumalanga Province. PRECIS data indicate the presence of 15 Red Data flora species within the 2529BB grid in which the study area is situated.

A condensation of available data, including the Interim Red Data List of South African Plant Species (Threatened Species Programme, 2004), as well as the Environmental Screening Assessment for Steelpoort Pumped Storage Report indicates the following species of concern present within the study area:

- *Aloe castanea;*
- *Boscia albitrunca* ssp *minima*

Seasonal and project limitations placed severe restrictions on the location and identifying of some of these species. In addition to the protected status that is attributed to some plant species, SANBI has also produced a list of tree species that are deemed to have

certain attributes that make them worthy of protection. The following species were observed within the study area:

- *Boscia albitrunca;* and
- *Sclerocarya birrea.*

These species should receive special consideration during the development process, being avoided where possible and transplanted in selected cases.

1.2 Faunal Attributes

The aim of this faunal investigation is to present the reader with a description of the faunal attributes of the study area in terms of observed species, Red Data probabilities and the inherent faunal sensitivity of the observed ecological units. Results of this faunal assessment will ultimately be integrated with results of the floristic assessment in order to present an overview of likely impacts on the biological environment.

The study area is divided into four distinct ecological regions, namely:

- Transformed habitats;
- Woodland variations;
- Riparian habitats; and
- Grassland variations.

Woodland variations, forming part of the Sekhukhune Mountain Bushveld regional vegetation type, exhibit a medium faunal sensitivity. Available habitat is untransformed and potential habitat for red data species are present throughout. However, the Sekhukhune Mountain Bushveld is not threatened; 86% remains untransformed, and this part of the study area is not unique in terms of habitat characteristics.

Riparian associated habitats are highly sensitive in terms of faunal attributes and Red Data probabilities. This high sensitivity is attributed to ecological sensitivity of hydrological regimes in general. Furthermore, wetlands are significant and limited in Mpumalanga Province, particularly relatively untransformed riparian woodlands such as these areas. Due to the linear nature of the rivers, impacts on the rivers and tributaries in the study area will in all likelihood also influence faunal habitat further downstream.

Grassland variations in the study area forms part of the Rand Highveld Grassland regional vegetation type, which is of high faunal sensitivity where untransformed. A moderate faunal sensitivity is attributed to the degraded portions. Furthermore, the Rand Highveld Grassland is of high sensitivity because of its endangered nature; only 58% remains untransformed and only 1% is formally protected (VEGMAP).

Transformed habitats provide little ecological or faunal habitat and are considered to be of low faunal sensitivity.

The nature of the project makes mitigation of likely impacts extremely difficult. All sensitive areas would ideally be protected, but the effects are, in this particular case, unavoidable and would sterilize the entire project.

1.3 Ecological Impact Evaluation

The following impacts were identified that will result in degradation to the biological environment:

- Artificial increase in the biodiversity of the study area as a result of the establishment of atypical habitat;
- destruction of threatened species and habitat;
- destruction of sensitive habitat types (outcrops, riparian fringes, non-perennial streams, river, etc.) and areas of high biodiversity;
- destruction of pristine habitat; and
- impacts on surrounding natural habitat and species.

The nature of the proposed development makes the complete mitigation of likely impacts extremely difficult; the exclusion of high sensitivity areas will in effect sterilize the entire project and is therefore not considered a viable option. Relocation of the project to nearby areas will also not result in mitigation of impacts as surrounding areas exhibit similar ecological sensitivities.

Impacts are considered permanent and highly significant. Mitigation activities are expected to result in limited control of expected adverse effects within the receiving environment and mostly include the following actions:

- effective rehabilitation programmes within all areas of surface disturbances;
- implementation of constant environmental monitoring programmes during the construction phase:
- implementation of frequent bio-monitoring programmes during the operational phase;
- containment of impacts within the receiving environment; and
- adaptive management & conservation strategies.

In spite of the permanent transformation of large tracts of natural and sensitive environment, impacts will mostly be localised and site specific and can therefore be contained within a relative small area. Constant environmental monitoring will play a significant role in the timely identification of potential significant effects resulting from construction activities while periodic bio-monitoring will highlight effects such as species changes and infestation.

It is the conclusion of this report that, with the timely and successful implementation of environmental and bio-monitoring programmes, the resultant loss in biodiversity attributes and habitat is acceptable and within reason, taking the importance of the proposed development into consideration.

TABLE OF CONTENTS

2 INTRODUCTION

ESKOM is planning the construction of a 1,000 MW pumped storage scheme along the escarpment between the Nebo Plateau and the Steelpoort River Valley, situated approximately 10km north west of Steelpoort, Mpumalanga Province. A dam would be constructed in the Steelpoort River that would serve as the lower reservoir (on-channel). The upper reservoir would be created by damming a stream on the plateau. The machine hall, vertical and horizontal waterways would be underground.

ESKOM has appointed Bohlweki Environmental to undertake Environmental studies. Bathusi Environmental Consultants has been appointed, on behalf of Bohlweki Environmental, to conduct a strategic impact evaluation of the biological environment that will be affected by the proposed development.

3 AIMS & OBJECTIVES

This biodiversity impact evaluation assessment aims to present the client with broad descriptions of floristic and faunal elements encountered within the study area and to highlight sensitive biological and environmental attributes that might be affected adversely by the proposed development.

The Terms of Reference for the floristic assessment are as follows:

- Obtain all relevant Red Data flora information;
- Conduct a photo analysis of the proposed area;
- Identify preliminary floristic variations;
- Survey the area for floristic diversity (common flora species, Red Data flora species, alien and invasive plant species and medicinal plant species);
- Survey the area for plant community variations;
- Assess the presence of Red List flora species according to the list provided by SANBI during the growing season;
- Describe the variation in floristic communities in terms of physical attributes;
- Describe the status and importance of any primary vegetation;
- Compile a floristic sensitivity analysis;
- Map all relevant aspects; and
- Integrate results of the floristic assessment into the biodiversity impact evaluation.

The Terms of Reference for the faunal assessment are as follows:

- Obtain all relevant Red Data faunal information
- Survey the site for general faunal diversity by means of relevant trapping and observation methods;
- Assess the presence of Red Data fauna species according to the list provided by Directorate Conservation;
- Describe the status of available habitat;
- Compile a faunal sensitivity analysis; and
- Integrate results of the faunal assessment into the ecological impact evaluation.

4 METHODOLOGY

All methods implemented during this investigation are based on accepted scientific investigative techniques and principles and was performed to acceptable standards and norms, taking the limitations of this investigation into consideration. The Precautionary Principle was applied throughout these assessments.

4.1 General Floristic Attributes

The vegetation assessment is based on a variation of the Braun-Blanquet method whereby vegetation is stratified on aerial images with physiognomic[1] characteristics as a first approximation. These initial stratifications are then surveyed for floristic and environmental diversity during a site investigation and ultimately subjected to a desktop analysis to establish differences/ similarities between observed units.

In preparation for the site survey, physiognomic homogenous units are identified and delineated on digital aerial photos, using standard aerial photo techniques. Aerial images of the study area were obtained from Google Earth (www.googleearth.com). A basic desk-top analysis of the species dominance and richness was performed and plant communities were described in terms of these attributes, which also forms part of the floristic sensitivity analysis.

Maps were produced on Arcview GIS 3.2 utilizing data and images from various sources.

A floristic survey was conducted during February 2007 and cognisance was taken of the following environmental attributes and general information:

- biophysical environment, i.e. geology, land type units, topography, etc that is generally accepted to be driving forces behind vegetation development; including:
  - slope;
  - aspect;
  - topography;
  - rockiness; and
- holistic/ regional vegetation;
- the current status of available habitat forms;
- Red Data habitat suitability;
- digital photographs; and
- GPS reference points.

Phytosociological data accumulated include the following:

- all plant species and growth forms;
- dominant plant species;
- cover abundance values; and
- samples or digital images of unidentified plant species.

[1] Physiognomy refers to the visual appearance of vegetation in terms of different growth classes, biomass, height, etc.

A desktop analysis of sample data was conducted to establish differences/ similarities between delineated vegetation units, which were subsequently described in terms of floristic species composition and dominance as well as driving (developmental) environmental parameters. Preliminary results and species lists that are provided should be interpreted with normal project limitations in mind.

4.2 Red Data Flora Assessment

Baseline PRECIS data for the ¼ degree grid 2529BB, presented by SANBI (email application and response, November, 2006), was compared to the Interim Red Data List of South African Plant Species (Threatened Species Programme, 2004) to compile a list of Red Data flora species that could potentially occur within the study area.

A snapshot investigation of an area represents severe limitations in terms of locating and identification Red Data flora species. Hence, particular emphasis was placed on the identification of habitat deemed suitable for the potential presence of Red Data plant species by associating available habitat to known habitat types of Red Data flora species. The verification of the presence/ absence of these species from the study area are not perceived as part of this investigation as a result of project limitations.

4.3 Floristic Sensitivity Analysis

The method implemented to estimate the floristic sensitivity is considered effective in highlighting floristically significant attributes and is based on subjective assessments of floristic attributes and is rated across the spectrum of communities that typify the study area. Phytosociological attributes (species diversity, presence of exotic species, etc.) and physical characteristics, e.g. human impacts, size, fragmentation are important in assessing the floristic sensitivity of the various communities.

Criteria employed in assessing the floristic sensitivity may vary between different areas, depending on location, type of habitat, size, etc. For the purpose of this analysis the following factors were considered significant in determining the floristic sensitivity of this particular area:

- Habitat availability, status and suitability for the presence of Red Data species;
- Landscape or habitat sensitivity;
- Current floristic status;
- Floristic diversity; and
- Ecological performance/fragmentation.

Floristic Sensitivity Values are expressed as a percentage of the maximum possible value and placed in a particular class, namely:

- **High** 80 – 100%
- **Medium – high** 60 – 80%
- **Medium** 40 – 60%
- **Medium – low** 20 – 40%
- **Low** 0 – 20%

High Sensitivity Index Values indicate areas that are considered pristine, unaffected by human influences or generally managed in an ecological sustainable manner. These areas can be compared to nature reserves and even well managed farm areas. Low Sensitivity Index Values indicate areas of poor ecological status or importance in terms of floristic attributes, including areas that have been negatively affected by human impacts or poor management.

Each vegetation unit is subjectively rated on a scale of 1 to 10 (**Sensitivity Values**) in terms of the influence that the particular Sensitivity Criterion has on the floristic status of the plant community. Separate Values are multiplied with the respective Criteria Weighting, which emphasises the importance/ triviality that the individual Sensitivity Criteria have on the status of each community.

Ranked Values are then added and expressed as a percentage of the maximum possible value (**Floristic Sensitivity Value**) and placed in a particular class, namely:

High	80% – 100%
Medium – high	60% – 80%
Medium	40% – 60%
Medium – low	20% – 40%
Low	0% – 20%

The Precautionary Principle is applied throughout this investigation.

4.4 Faunal Diversity

Invertebrates

- **Scorpions:** Suitable habitat is investigated to establish the presence/ absence of Red Data species as well as compiling a list of species that occur in the area.
- **Spiders:** Trapping for Mygalomorphae spiders is done by placing pitfall traps in habitat that is considered suitable for the potential presence of these species.
- **Red Data Butterflies:** High potential habitat is investigated during the optimal season for Red Data butterflies.

Frogs

- Suitable areas are identified and sampled using pitfalls as well as active search and capture and acoustic identification methods.
- In case where high potential habitats of Red Data species are identified, recognized specialists are consulted in order to verify preliminary results.

Reptiles

- Suitable areas are identified and sampled using pitfalls and active search and capture methods.
- In case where high potential habitats of Red Data species are identified, recognized specialists are consulted in order to verify preliminary results.

Birds

- The study area is actively surveyed for the presence of Red Data birds.
- Visual and acoustic identification methods are used.
- All available habitats are assessed in terms of suitability for Red Data bird species.
- High potential Red Data bird habitat is flagged as sensitive.

Mammals

- Small mammal trapping is conducted to survey habitat for the of small mammal species.
- The study area is also actively surveyed for the presence of Red Data mammals.
- All available habitats are assessed in terms of suitability for potentially occurring Red Data species.
- High potential Red Data mammal habitat is flagged as sensitive.

4.5 Red Data Fauna Probabilities

Three parameters are used to assess the Probability of Occurrence of each Red Data species:

- Habitat requirements (HR) - Most Red Data animals have very 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.

4.6 Faunal Sensitivity

Faunal sensitivities are subjectively estimated based on the following criteria:

- Habitat status;
- Connectivity;
- Observed species composition; and
- Functionality,

and are place in one of the following classes:

- High;
- Medium; or
- Low

4.7 Biodiversity Impact Evaluations

Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue/ impact is also assessed according to the project stages from planning, through construction and operation to the decommissioning phase. Where necessary, the proposal for mitigation or optimisation of an impact is noted. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

A rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

Extent

- National 4
- Regional 3
- Local 2
- Site 1

Duration

- Permanent 4
- Long term 3
- Medium term 2
- Short term 1

Intensity

- Very high 4
- High 3
- Moderate 2
- Low 1

Probability of Occurrence

- Definite 4
- Highly probable 3
- Possible 2
- Impossible 1

Criteria for the classification of an impact:

Nature

A brief description of the environmental aspect being impacted upon by a particular action or activity is presented.

Extent (Scale)

Considering the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact.

Site	Within the construction site
Local	Within a radius of 2 km of the construction site
Regional	Provincial (and parts of neighbouring provinces)
National	The whole of South Africa

Duration

Indicates what the lifetime of the impact will be

Short-term	The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase
Medium-term	The impact will last for the period of the construction phase, where after it will be entirely negated
Long-term	The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter
Permanent	The only class of impact which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient

Intensity

Describes whether an impact is destructive or benign.

Low	Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected
Medium	Effected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way
High	Natural, cultural and social functions and processes are altered to extent that they temporarily cease
Very high	Natural, cultural and social functions and processes are altered to extent that they permanently cease

Probability

Describes the likelihood of an impact actually occurring

Improbable	Likelihood of the impact materialising is very low
Possible	The impact may occur
Highly probable	Most likely that the impact will occur
Definite	Impact will certainly occur

Significance

Significance is determined through a synthesis of impact characteristics. It is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Using the scoring from the previous section, the significance of impacts is rated as follows:

Low impact	4-7 points (No permanent impact of significance. Mitigatory measures are feasible and are readily instituted as part of a standing design, construction or operating procedure)
Medium impact	7-10 points (Mitigation is possible with additional design and construction inputs)
High impact	10-13 points (The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment)
Very high impact	13-16 points (The design of the site may be affected. Intensive remediation as needed during construction and/or operational phases. Any activity which results in a "very high impact" is likely to be a fatal flaw)

Status

Denotes the perceived effect of the impact on the affected area

Positive (+)	Beneficial impact
Negative (-)	Deleterious or adverse impact
Neutral	Impact is neither beneficial nor adverse

It is important to note that the status of an impact is assigned based on the *status quo* – i.e. should the project not proceed. Therefore not all negative impacts are equally significant.

The suitability and feasibility of all proposed mitigation measures will be included in the assessment of significant impacts. This will be achieved through the comparison of the significance of the impact before and after the proposed mitigation measure is implemented.

5 LIMITATIONS TO THIS INVESTIGATION

Rare and endemic flora and fauna species do not normally occur in great densities and because of customary limitations in the search and identification of red data species, the detailed investigation of the presence of these species within the study area was not perceived as within the scope of this investigation. Estimations provided in this document only provide an indication of the Probability of the Occurrence of these species as the low levels of biological and distributional information inherently associated with Red Data species create large gaps in such estimations. These gaps can only be lessened by intense sampling conducted over long periods of time. However, all areas that were sampled during the site investigation were thoroughly investigated for the presence of these species and results obtained from these surveys were then extrapolated to present opinions for the remainder of the proposed areas.

This investigation, although based on proper scientific methods and performed to accepted standards and norms, was performed by means of stratified sampling of ecological attributes of the study areas and not on the detailed or long-term investigation of all environmental attributes and the varying degrees of biological diversity that may be present in the study area. Additional information may therefore come to light during a later stage of the process or development for which no allowance can be made at this stage of the investigation. No definite conclusions may therefore be drawn with regards to biological diversity or conservation strategies as far as the proposed areas are concerned.

6 THE BIOPHYSICAL ENVIRONMENT

6.1 Location

The study area is situated approximately 10 km north west of Steelpoort, Mpumalanga Province, on the farms Luipershoek 149, Keerom 151 and Steynsdrift 145. The lower section is situated in the Steelpoort River Valley and the higher section on the Nebo Plateau. General GPS co ordinates for the study area are S 25.123951° and E 28.827294° (lower section) and S 25.108910° and E 29.793849° (higher section).

The regional location of the study area is presented in Figure 1.

6.2 Geology

The study area is situated within the Rashoop Granite, Damwal Rhyolite and Roossenekal Gabbro geological formations. The rocks in the area fall within the Bushveld Igneous Complex. The distribution of geological formations in relation to the study areas is indicated in Figure 2.

Rashoop Granites are composed principally of granophyre, granophyric granite, granophyre porphyry and pseudo-granophyre. All these rocks are made up of quartz and orthoclase, with subordinate hornblende and biotite. These rocks overlay the mafic rocks

of the Upper and Main Zones of the Rustenburg Layered Suite. The high plateau is underlain by granophyre in the south of the area and by mixed granite and granophyre in the north. These granitic rocks are many hundreds of metres thick and form the steep scarp slopes.

The Damwal Rhyolite occurs in the central part of the study on the escarpment. This Formation is composed principally of black, variable, porphyritic and pseudospherulitic felsite, with interrupted interbeds of glassy rhyolite, amygdaloidal rhyolite, agglomerate and breccia, tuff and sandstone. At the base leptite, micrographic felsite and red, granophyric rhyolite is developed locally.

Roossenekal Gabbro contains magnetite in appreciable quantities. The Luipershoek Olivine Diorite, recognised in the study area, represents one of the units in this Subsuite. It is characterised by the appearance of iron-rich cumulus olivine and cumulus apatite, whereas the composition of the plagioclase changes from labradorite to andesine.

Below the escarpment the rocks are covered by colluvial (scree and hillwash) and alluvial (river deposit) boulders and sandy gravels up to many metres thick. Below these deposits the bedrock is weathered variably and irregularly to depths of less than a meter to tens of meters. Beneath the lower slopes the groundwater table may occur within a few meters of the surface.

6.3 Topography

The high-lying Nebo Plateau to the west of the Steelpoort Valley comprises gently undulating terrain at elevations of around 1,100 m at the lower sections, rising to 1,700 m at the higher section. To the east the plateau ends at a steep escarpment trending northeast-southwest. This cliff is incised by stream valleys flowing to the north and west away from the escarpment and by steep-sided fault-formed valleys flowing to the east and north over the escarpment into the Steelpoort Valley. The scarp face is near-vertical and falls hundreds of metres to a steep debris slope that flattens eastwards to a pediment slope descending slowly towards the river in the valley floor, before rising rapidly eastwards again beyond the river. The total drop in elevation from escarpment crest to the river is approximately 600 m.

6.4 Current Status & Land use

The higher section on the Nebo Plateau is currently used as grazing for cattle by the local community. The status is considered moderately degraded and constitutes grassland that exhibit clear indications of regression. Inaccessible areas, such as areas of high rockiness or severe slopes are characterised by pristine regional vegetation.

Land use in the lower section comprises either agriculture (irrigated) or game farming. Areas that are characterised by natural vegetation are considered moderately pristine and is classified as natural woodland and is mostly situated in areas of rockiness where ploughing is not possible, or in areas of higher slopes, for example on the footslopes of

the mountain. Transformed areas are mostly situated in relative close vicinity to the riverine system where deep arable soils are present.

6.5 Land Types

The study area comprises the following land type units (Figure 3):

- Ae26;
- Ba16;
- Ib19; and
- Ib24

Map units A refer to yellow and red soils without water tables and belonging in one ore more of the following soil forms: Inanda, Kranskop, Magwa, Hutton, Griffin and Clovelly. The map units refer to land which does not qualify as a plinthic catena and in which one or more of the above soil forms occupy at least 40% of the area. In Ae (red, high base status, >300mm deep, no dunes) yellow soils occupy less than 10% of the area while dystrophic and/or mesotrophic soils occupy a larger area than high base status red-yellow apedal soils.

The B- group include a large area of the South African interior that is occupied by a catena, which in its perfect form is represented by (in order from highest to lowest in the upland landscape) Hutton, Bainsvlei, Avalon and Longlands forms. The valley bottoms are occupied by one or other gley soil. Soils with hard plinthite are common over sandstones in the moist climate zones in the eastern part of the country. Depending on the extent to which water tables have been operative over a landscape, Longlands and Avalon and related grey and yellow soils may predominate, even to the exclusion of red soils. Where water tables have not extended beyond the valley bottoms, red soils may predominate with plinhtic soils restricted to narrow strips of land around valley bottoms or pans. Plinthic soils must cover more than 10% of the area for inclusion into Ba. Unit Ba indicates land in which red and/or yellow apedal soils (Hutton, Bainsvlei, Avalon, Glencoe and Pinedene forms) that are dystrophic and/ or mesotrophic predominate over red and/ or yellow soils that are eutrophic, and in which red soils occupy more than a third of the area. Soils of the Ba16 unit are regarded as unsuitable for arable agriculture but suitable for forestry or grazing where the climate permits.

Ib indicates land types with exposed rock (exposed country rock, stones or boulders) covering more than 80% of the area. The rocky portions may be underlain by soil which would have qualified the unit for inclusion in another broad soil pattern was it not for the surface rockiness. Soils of Ib24 and Ib19 are generally regarded as unsuitable for agriculture or commercial forestry, but are suitable for recreation, conservation or water catchments.

The clay content of the A horizon typically varies from 15 % in crest situations, while the bottomlands are characterised by clay content of approximately 35 % in the A horizon.

Figure 1: Location of the study area

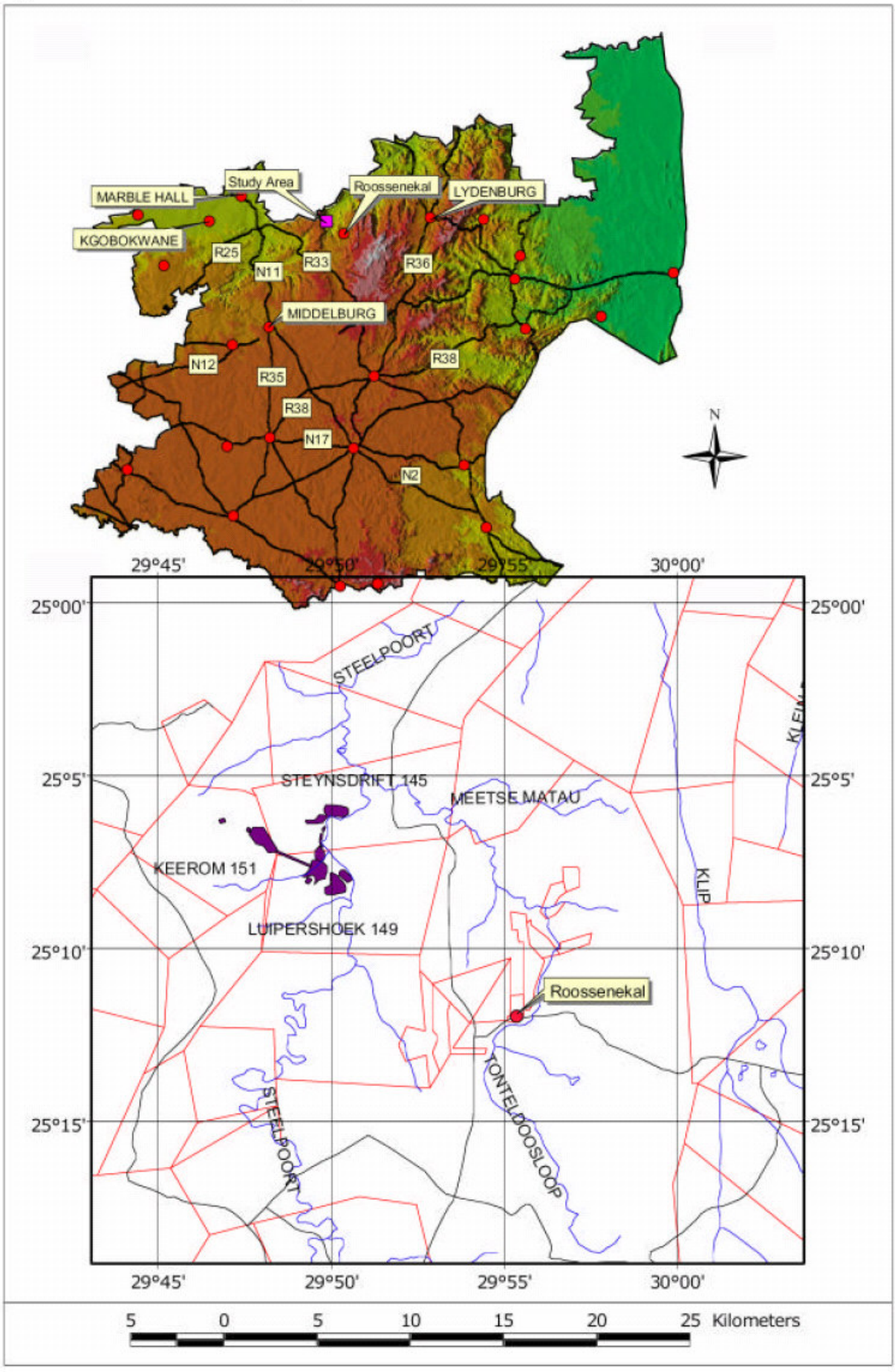
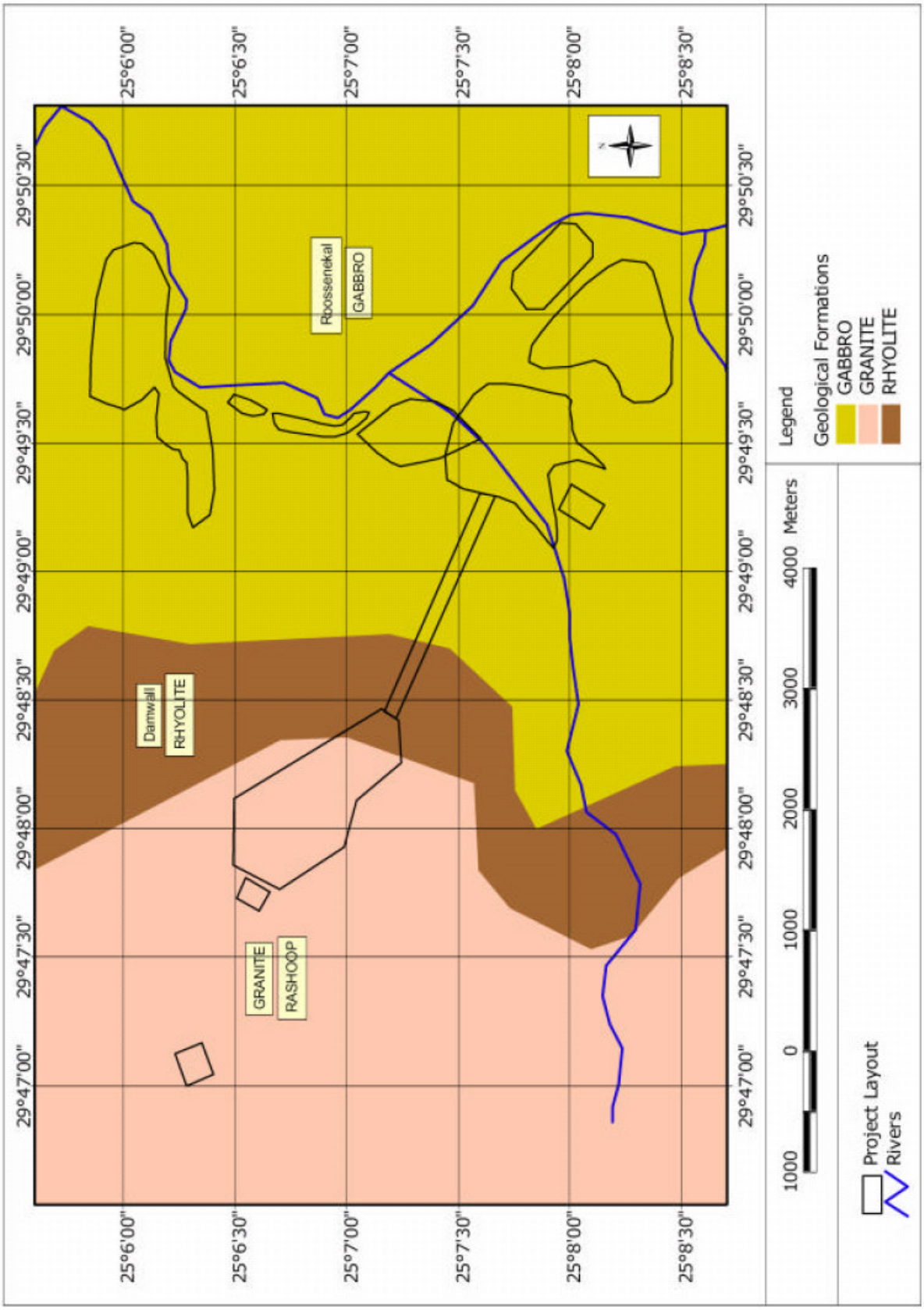


Figure 2: Geology of the study area



6.6 Surface Water

The Steelpoort River is situated immediately to the east of the infrastructure planned for the development and one of the major tributaries of the Steelpoort River is proposed to be dammed for the purpose of this development. Several small non-perennial drainage lines are present within the study area, particularly the lower section. These drainage lines are generally well defined with steep and deep banks, sometimes conforming to stabilized erosion gulleys.

6.7 Regional Overview of the Vegetation

The lower section of the proposed development is situated within the Mixed Bushveld vegetation type while the higher section is situated within the Moist Sandy Highveld Grassland vegetation type as described by Van Rooyen & Bredenkamp (Low & Rebelo, 1998).

The Savanna Biome is the largest biome in Southern Africa, occupying more than 46% of its area, and over one-third of the area of South Africa. It is characterized by a grassy ground layer and a distinct upper layer of woody plants. The environmental factors delimiting the biome are complex: altitude ranges from sea level to 2,000m; rainfall varies from 235 to 1,000mm per year; frost may occur 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. The shrub 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.

Mixed Bushveld, as is deduced from the name, represents a great variety of plant communities, with many variations and transitions. The vegetation varies from a dense, short bushveld to a rather open tree savanna. On shallow soils *Combretum apiculatum* dominates, occurring together with *Acacia caffra, Dichrostachys cinerea, Lannea discolour, Sclerocarya birrea* and various *Grewia* species. The grazing is sweet and the herbaceous layer is dominated by the grasses *Digitaria eriantha, Schmidtia pappophoroides, Anthephora pubescens, Stipagrostis uniplumis* and various *Aristida* and *Eragrotis* species. On deeper and more sandy soils *Terminalia sericea* becomes dominant, with *Ochna pulchra, Grewia flava, Peltophorum africanum* and *Burkea africana* often prominent species. The grass sward is scanty with *Eragrostis pallens* and *Perotis patens* characteristic. The structure of this vegetation type is determined by fire and grazing.

The Grassland Biome is found chiefly on the high central plateau of South Africa. It is dominated by a single layer of grasses. The amount of cover depends on rainfall and the degree of grazing. Threes are absent, except in a few localised habitats. Geophytes are often abundant. Frost, fire and grazing maintain the grass dominance and prevent the establishment of trees.

The Moist Sandy Highveld Grassland is found in the sandy plains west of the Belfast-Carolina-Ermelo area, and north of Volksrust in Mpumalanga, at an altitude of 1,600 to 1,800 m. The grassland is dominated by *Eragrostis plana, E. curvula, Heteropogon contortus, Trachypogon spicatus* and *Themeda triandra*. Dicotyledonous forbs are not abundant, thou many species occur in the area. The distribution of this vegetation type is controlled by rainfall on the cold, frosty, eastern Mpumalanga highveld together with sandy soils. It is generally very suitable for crop production while areas of natural vegetation are heavily grazed by sheep and cattle. The conservation status is considered very poor, being restricted to patchy remnants, which are often heavily grazed. Large parts are ploughed and hence transformed. The Nooitgedacht Dan Nature Reserve is the only official conservation area, but the Ermelo Game Park represents a good example of this vegetation type.

The delineation of the vegetation types is more defined by the VEGMAP database, described as Rand Highveld Grassland and Sekhukhune Mountain Bushveld, respectively. The Distribution of the VEGMAP vegetation types in relation to the study area is indicated in Figure 4, but descriptions are based on the Low and Rebelo classification.

Rand Highveld Grassland is classified by VEGMAP[2] as being 'Hardly Protected'. The ecosystem status is regarded as Endangered. Although 72% of this vegetation type remains fairly undisturbed, 0%is formally conserved. Sekhukhune Mountain Bushveld is considered to be 'Not Protected'; 86% remains but 0% is formally conserved. The ecosystem status is regarded Least Threatened. A biodiversity target of 24% is recommended for both these vegetation types.

6.8 Regional Sensitivity

- A cave system is present approximately 12km to the south east;
- The Sekhukhune Centre of Endemism comprises the eastern part of the study area, particularly the woodland regions; and
- Severe variation in available habitat and topography within the general surrounds, *i.e.* the escarpment.

[2] Remaining area and percentage remaining refer to the remaining area untransformed by croplands, mining, urban development and roads. The percentage of the original area currently under protection was calculated based on Type 1 protected areas only. The biodiversity target refers to the percentage of the original areas required to capture 75% of the species occurring in each vegetation type. Ecosystem status is based on the percentage of the original area remaining untransformed in relation to the biodiversity target and a threshold for ecosystem functioning (CE: Critically Endangered; EN: Endangered; VU: Vulnerable, LT: Least Threatened). Protection level is based on the % of the biodiversity target conserved in Type 1 protected areas.

Figure 3: Land Types in the general surrounds of the study area

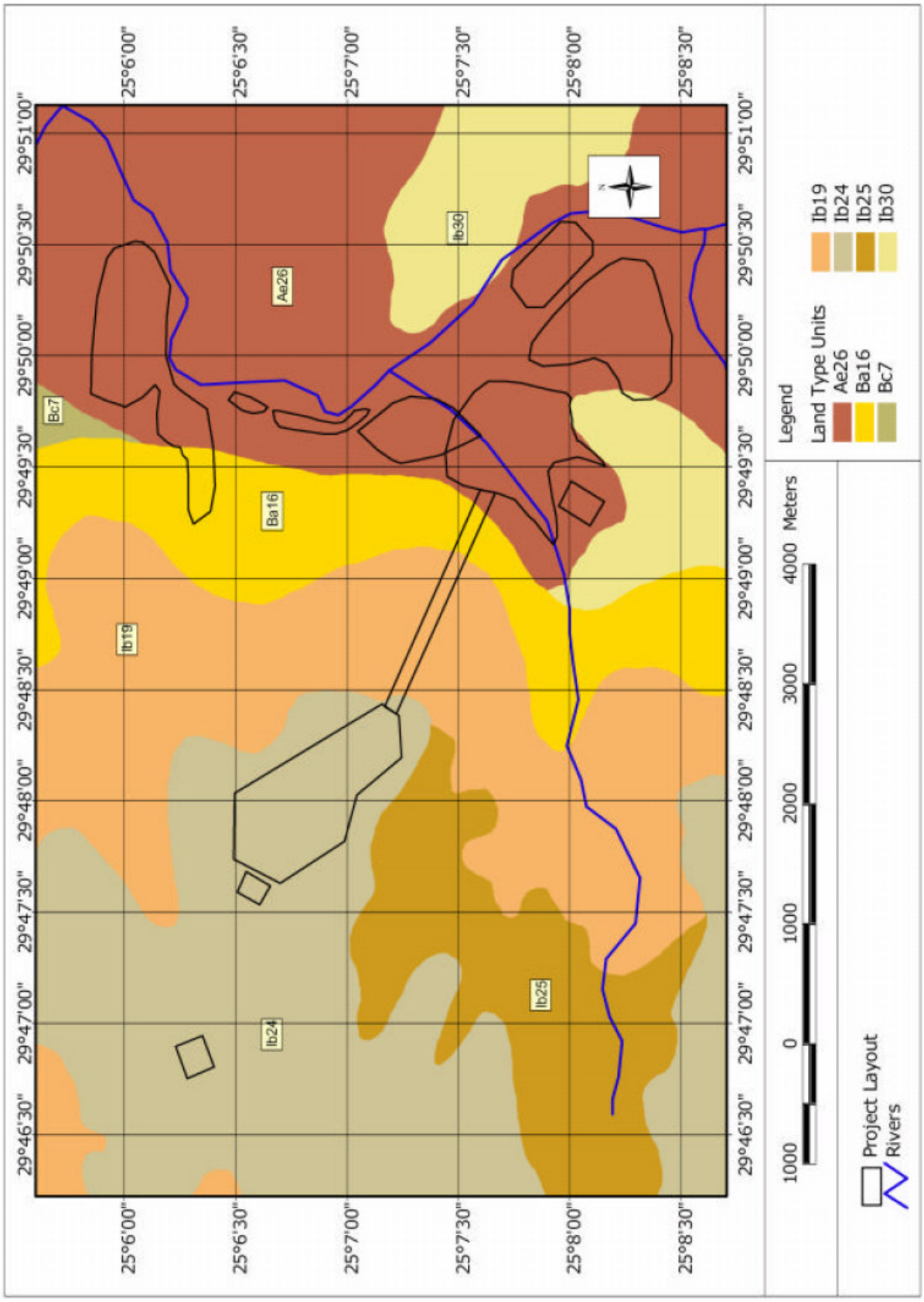
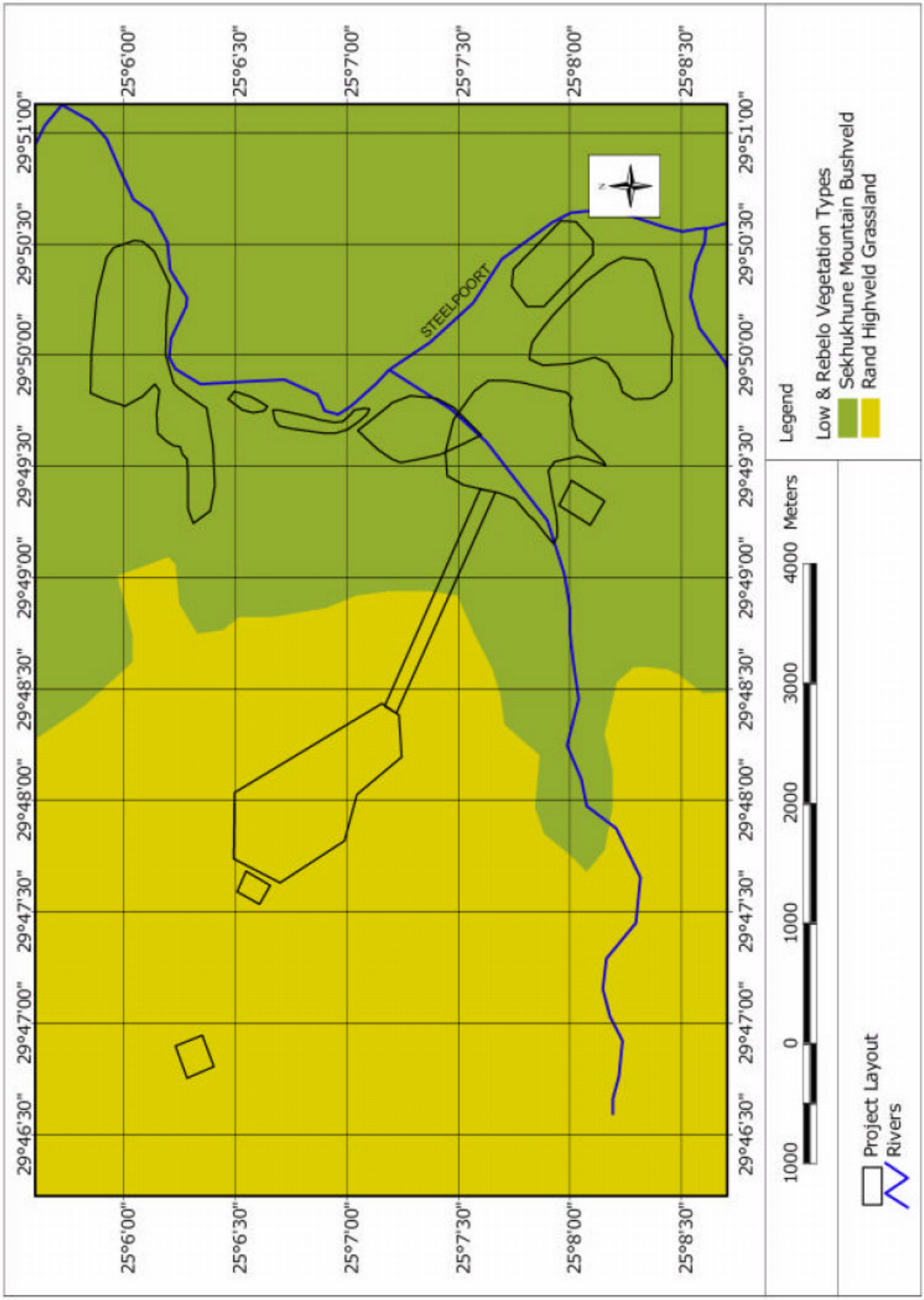


Figure 4: Distribution of VEGMAP vegetation types



7 FLORA OF THE STUDY AREA

A preliminary assessment has been completed as part of a previous investigation (Project Lima Supplementary Feasibility Study, Phase 1: Site Selection Study, May 2006) in which a basic description of the regional vegetation is presented. In addition, a description of the flora is also presented in the Environmental Screening Process, Background Information Document (May 2006), which provides a background to the flora of the general area in relation to detailed descriptions compiled by S. Siebert in his Philisophiae Doctor Degree (2001).

These descriptions are considered too broad to provide detailed and site specific information but nonetheless provide pertinent references to the status and sensitivities of identified units. Relevant parts of these descriptions will be included in the following sections.

The lower reservoir section is situated in the rain shadow of the Drakensberg, and is therefore relatively arid compared to the surrounding areas, while the upper reservoir is situated on the cold and frosty Nebo Plateau. The fundamental driving forces behind vegetation development in these areas are soil properties (compare land type units), slope (terrain), rockiness and moisture regime. More recently, human influences caused changes in the vegetation as a result of transformation, agriculture, grazing and management activities.

7.1 Floristic Species Composition

PRECIS information presented by SANBI (email application and response for the ¼ degree grid 2529BB, November 2006) indicate the presence of 290 plant species (Appendix 1). A relative low percentage of these species are included in the species list that was compiled during the site investigation, clearly illustrating the huge diversity of the general region.

A floristic species list for the study area is presented in Appendix 1.2. A total of 234 plant species were identified in the study area. This exceptional high floristic diversity is attributed to the extreme variation in available habitat, ranging from mountain grassland to *Acacia* woodland and riparian vegetation.

Based on the variation in habitat and vegetation units a high percentage of the species are considered natural to the region; approximately 78% of the species occur naturally in pristine vegetation of the region. The known medicinal properties of plants occurring in the study area are indicated in Appendix 2.

A total of 63 plant families were identified. The dominant families include Poaceae (grass family, 48 species, 20.5%) and Asteraceae (daisy family, 28 species, 12.0%). A list of plant families are presented in Appendix 3.

Because of the extreme variation in species composition and floristic physiognomy between the two major communities, a more detailed description of the growth forms and species composition is presented with the descriptions of the respective floristic variations.

7.2 Vegetation Communities

Based on physiognomy, moisture regime, rockiness, slope and soil properties, four main communities are recognised, containing the following variations (Figure 5):

- Mountain Grassland Community;
  - * Degraded Mountain Grassland Variation;
  - * Pristine Mountain Grassland Variation;
  - * Escarpment Variation;
- Woodland Community;
  - * Mountain Woodland Variation;
  - * *Acacia* Woodland Variation;
  - * Rocky Outcrop Woodland Variation;
- Riparian Woodland Community; and
- Transformed Areas.

7.2.1 Mountain Grassland Community

This community comprises the upper section of the proposed layout, more specifically the Nebo Plateau, crest and the cliffs that are characterised by grassland and scanty woody vegetation. The dominance of the herbaceous layer is the major physiognomic attribute and a high diversity of grasses and forbs are noted in areas of pristine vegetation. Common environmental parameters also include surface rockiness (generally exceeding 25%) and shallow top soils. The vegetation is fairly representative of the regional vegetation and grazing pressure and utilization determine the status of vegetation. Slopes and areas of high rockiness are generally less accessible for cattle and are subsequently subjected to lower grazing pressure. Hence, these particular parts are more pristine, characterised by a diverse and well developed herbaceous layer.

In contrast, high grazing pressure results in selective grazing and species changes results, characterised by the disappearance of palatable grass species that are non-competitive and non-stress-tolerant and the proliferation of forbs and grasses that have a competitive advantage under conditions of high stress. These species are also less palatable.

Gradual changes in the vegetation (species composition and physiognomy) are caused by high grazing pressure and in order to facilitate a transition back to a pristine condition, complete to near complete relaxation of grazing pressure is required. It is estimated that the elasticity and plasticity characteristics of these grasslands have not been exceeded and a transition back to pristine conditions is considered possible.

- **Degraded Mountain Grassland Variation**

Areas situated on top of the Nebo Plateau is characterised by a high grazing factor. Cattle from the nearby settlement utilise these areas throughout the year and the differences in species composition between these areas and area where lower grazing pressures are applied is evident. Selective grazing by cattle has resulted in a species change that is characterised by the prominence of species that signify poor habitat conditions. These species are generally referred to as indicator species.

The species composition of this community is indicated in Table 1 (dominant species are indicated in **bold**) and an indication of the growth forms are presented in Table 2.

A dominant grass layer and diverse forb stratum represent the main physiognomic attribute, but low shrubs and bushes occur throughout this variation in a mosaical pattern and the accurate mapping of these clumps is not possible. These small areas are characterised by a dominant and dense woody layer, consisting of the trees and shrubs *Acacia caffra, Aloe marlothii, Cussonia paniculata, Diospyros lycioides, Euclea crispa, Olea europaea, Rhus pyroides* and *Ziziphus mucronata.* An admixture of forbs characterise the lower stratum and few grasses are present as a result of the high shade factor. High rockiness (boulders) is a common attribute.

Moderate degradation of the herbaceous layer has led to an increase in the floristic diversity. Species of poor quality slowly invades pristine areas as a result of continued pressure on the herbaceous layer. It does take a fairly long period for less-competitive species to completely disappear from an area and the high floristic diversity noted in this variation is therefore not an indication of pristine vegetation, but points towards the results of sustained high grazing pressure.

Approximately 66% of the species that occur in this variation is representative of the regional vegetation. Conversely, 34% of the species that are present are indicative of poor habitat conditions. In many cases these species are also dominant, but not exclusively since a high number of co-dominant species are noted (Table 1). In assessing the floristic status and sensitivity of this variation, the dominance of certain species was taken into consideration.

No Red Data flora species were observed within this variation; the suitability of available habitat within this variation for the presence of Red Data flora species is MEDIUM-LOW.

Table 1: Species list for the Degraded Mountain Grassland

Species Name	Growth Form	Family	Alien Status
Abildgaardia ovata	Sedge	Cyperaceae	
Acacia caffra	Tree	Mimosaceae	
Acacia mearnsii	Tree	Mimosaceae	Category 2
Acalypha species	Forb	Euphorbiaceae	
Acanthospermum australe	Forb	Acanthaceae	
Aloe marlothii	Succulent	Liliaceae	
Aloe species	Succulent	Liliaceae	

Anthospermum rigidum	**Forb**	**Rubiaceae**	
Aristida congesta* ssp *barbicollis	**Grass**	**Poaceae**	
Aristida congesta* ssp *congesta	**Grass**	**Poaceae**	
Aristida species	Grass	Poaceae	
Artemisia afra	Shrub	Asteraceae	
Asclepias affinis	Forb	Asclepidaceae	
Asclepias aurea	Forb	Asclepidaceae	
Asparagus species	Forb	Liliaceae	
Babiana hypogea	Geophyte	Iridaceae	
Bewsia biflora	Grass	Poaceae	
Blepharis species	Forb	Acanthaceae	
Boophane disticha	Geophyte	Amaryllidaceae	
Brachiaria serrata	**Grass**	**Poaceae**	
Bulbine species	Geophyte	Liliaceae	
Bulbostylis burchellii	**Sedge**	**Cyperaceae**	
Chamaecrista comosa	Forb	Ceasalpiniaceae	
Clerodendrum triphyllum	Forb	Verbenaceae	
Clutia species	Forb	Euphorbiaceae	
Commelina africana	Forb	Commelinaceae	
Crabbea acaulis	Forb	Acanthaceae	
Crabbea angustifolia	**Forb**	**Acanthaceae**	
Crassula lanceolata	Succulent	Crassulaceae	
Cussonia paniculata	Tree	Araliaceae	
Cyanotis speciosa	Forb	Commelinaceae	
Cymbopogon plurinodis	**Grass**	**Poaceae**	
Cynodon dactylon	**Grass**	**Poaceae**	
Dianthus mooiensis	Forb	Capparaceae	
Dicoma anomala	**Forb**	**Asteraceae**	
Dicoma zeyheri	Forb	Asteraceae	
Digitaria monodactyla	**Grass**	**Poaceae**	
Digitaria tricholaenoides	Grass	Poaceae	
Diospyros lycioides	Tree	Ebenaceae	
Elephantorrhiza elephantina	Shrub	Mimosaceae	
Elionurus muticus	**Grass**	**Poaceae**	
Eragrostis capensis	Grass	Poaceae	
Eragrostis chloromelas	**Grass**	**Poaceae**	
Eragrostis gummiflua	Grass	Poaceae	
Eragrostis plana	**Grass**	**Poaceae**	
Eragrostis racemosa	Grass	Poaceae	
Eriosema cordatum	Forb	Fabaceae	
Euclea crispa	Tree	Ebenaceae	
Euphorbia clandestina	Succulent	Euphorbiaceae	
Fadogia tetraquetra	**Forb**	**Rubiaceae**	
Gazania krebsiana	Forb	Asteraceae	
Gladiolus species	Geophyte	Iridaceae	
Gnidia capitata	Forb	Thymelaeaceae	
Gnidia species	Forb	Thymelaeaceae	
Gomphocarpus fruticosus	Shrub	Asclepidaceae	
Gomphrena celosioides	**Forb**	**Amaranthaceae**	
Haplocarpha scaposa	Forb	Asteraceae	
Helichrysum caespititium	Forb	Asteraceae	

Helichrysum coriaceum	Forb	Asteraceae	
Helichrysum dasymallum	Forb	Asteraceae	
Helichrysum pallidum	Forb	Asteraceae	
Helichrysum pilosellum	Forb	Asteraceae	
Helichrysum rugulosum	**Forb**	**Asteraceae**	
Helichrysum species	Forb	Asteraceae	
Hermannia lancifolia	Forb	Sterculiaceae	
Hermannia transvaalensis	**Forb**	**Sterculiaceae**	
Heteropogon contortus	**Grass**	**Poaceae**	
Hyparrhenia hirta	**Grass**	**Poaceae**	
Hypoxis iridifolia	Geophyte	Hypoxidaceae	
Hypoxis rigidula	**Geophyte**	**Hypoxidaceae**	
Hypoxis species	Geophyte	Hypoxidaceae	
Indigofera species	Forb	Fabaceae	
Justicia anagalloides	**Forb**	**Acanthaceae**	
Kalanchoe paniculata	Succulent	Crassulaceae	
Lactuca species	Forb	Asteraceae	
Ledebouria ovalifolia	Geophyte	Liliaceae	
Ledebouria revoluta	**Geophyte**	**Liliaceae**	
Lopholaena coriifolia	**Shrub**	**Asteraceae**	
Lotononis eriantha	Forb	Fabaceae	
Loudetia simplex	Grass	Poaceae	
Melinis repens	Grass	Poaceae	
Monsonia angustifolia	Forb	Geraniaceae	
Mundulea sericea	Tree	Fabaceae	
Olea europaea	Tree	Oleaceae	
Oxalis species	Geophyte	Oxalidaceae	
Oxygonum dregeanum	Forb	Polygonaceae	
Panicum coloratum	**Grass**	**Poaceae**	
Parinari capensis	Forb	Chrysobalanaceae	
Paspalum scrobiculatum	Grass	Poaceae	
Pearsonia sessilifolia	Forb	Fabaceae	
Pelargonium luridum	Forb	Geraniaceae	
Pentanisia angustifolia	Forb	Rubiceae	
Perotis patens	Grass	Poaceae	
Peucedanum magalismontanum	Forb	Apiaceae	
Protea welwithchii	Shrub	Proteaceae	
Pteridium aquilinum	**Fern**	**Dennstaedtiaceae**	
Pupalia lappacea	Forb	Amaranthaceae	
Pygmaeothamnus chamaedendrum	Forb	Rubiaceae	
Raphionachme species	Forb	Peripoplacaceae	
Rhoicissus tridentata	Climber	Vitaceae	
Rhus dentata	Tree	Anacardiaceae	
Rhus discolor	Shrub	Anacardiaceae	
Rhus leptodictya	Tree	Anacardiaceae	
Rhus pyroides	Tree	Anacardiaceae	
Rubia horrida	Climber	Rubiaceae	
Scabiosa columbaria	**Forb**	**Dipsacaceae**	
Senecio cordifolius	Forb	Asteraceae	
Senecio species	Forb	Asteraceae	
Senecio venosus	**Forb**	**Asteraceae**	

Setaria sphacelata	**Grass**	**Poaceae**	
Sida alba	Forb	Malvaceae	
Sida species	Forb	Malvaceae	
Silene species	Forb	Caryophyllaceae	
Solanum panduriforme	Forb	Solanaceae	
Solanum sisymbrifolium	Forb	Solanaceae	Category 1
Sporobolus species	Grass	Poaceae	
Tapiphyllum parvifolium	Tree	Rubiaceae	
Tephrosia species	Forb	Fabaceae	
Teucrium trifidum	Forb	Lamiaceae	
Themeda triandra	**Grass**	**Poaceae**	
Tristachya leucothrix	Grass	Poaceae	
Turbina oblongata	Forb	Convolvulaceae	
Vangueria infausta	Tree	Rubiaceae	
Vernonia natalensis	Forb	Asteraceae	
Vernonia oligocephala	Forb	Asteraceae	
Wahlenbergia undulata	Forb	Campanulaceae	
Walafrida densiflora	Forb	Selaginaceae	
Xerophyta viscosa	Geophyte	Velloziaceae	
Ziziphus mucronata	Tree	Rhamnaceae	
Ziziphus zeyheriana	**Shrub**	**Rhamnaceae**	
Zornia linearis	Forb	Fabaceae	

Table 2: Growth forms		
Growth Form	**Number**	**Percentage**
Climbers	2	2%
Ferns	1	1%
Forbs	64	48%
Geophytes	12	9%
Grasses	26	20%
Shrubs	7	5%
Trees	13	10%
Sedges	2	2%
Succulents	5	4%
Total	**132**	**100%**

SENSITIVITY ASPECTS

- This variation is situated adjacent to a sensitive environment;
- The vegetation of this area is moderately degraded;
- Few declared invasive plant species are present;
- High species diversity – 132 species noted;
- The floristic status of this variation is MEDIUM-LOW;
- No Red Data flora species were observed within this variation;
- Suitability of available habitat for Red Data flora species is MEDIUM-LOW;
- Likely impacts on the floristic environment will be significant on a local scale;
- **The floristic sensitivity of this vegetation unit is MEDIUM-LOW.**

- **Pristine Mountain Grassland Variation**

This variation is present along most of the escarpment, comprising grassland areas where slopes increase towards the cliffs of the Nebo Plateau. A small portion of this variation is present in the upper section of the propose development. High rockiness (exceeding 50%, boulders) is characteristic of this variation. The physiognomy is grassland with scattered trees. A well developed grass layer and diverse forb stratum is noted (Table 4).

The floristic diversity of this variation is lower than the adjacent Degraded Mountain Grassland Variation, but this is attributed to the absence of poor quality species. Vegetation in this variation is pristine and in a good condition. Grazing pressures that affects nearby areas are not a feature of this variation due of the presence of surface rocks and severe slopes that makes these areas less accessible for cattle.

A total of 84 plant species were observed in this variation of which approximately 88% are considered representative of the regional vegetation (Table 3, dominant species indicated in **bold**). This variation is considered a pristine example of the regional vegetation. The general physiognomy provides some indication towards this pristine status; the average height of the grass layer ranges from 0.75 to 1.25 m, as opposed to an average height of less than 0.5m in areas where the grazing pressure is considerably higher. A high floristic status is attributed to this variation.

No Red Data flora species were observed within this variation; the suitability of available habitat within this variation for the presence of Red Data flora species is MEDIUM.

Table 3: Species list for the Pristine Mountain Grassland			
Species Name	**Growth Form**	**Family**	**Alien Status**
Abildgaardia ovata	Sedge	Cyperaceae	
Acalypha species	Forb	Euphorbiaceae	
Alloteropsis semialata	**Grass**	**Poaceae**	
Aloe marlothii	Succulent	Liliaceae	
Anthospermum rigidum	Forb	Rubiaceae	
Artemisia afra	Shrub	Asteraceae	
Asclepias affinis	Forb	Asclepidaceae	
Asclepias aurea	Forb	Asclepidaceae	
Asclepias species	Forb	Asclepidaceae	
Babiana hypogea	Geophyte	Iridaceae	
Bewsia biflora	Grass	Poaceae	
Blepharis species	Forb	Acanthaceae	
Boophane disticha	Geophyte	Amaryllidaceae	
Brachiaria serrata	**Grass**	**Poaceae**	
Bulbine species	Geophyte	Liliaceae	
Bulbostylis burchellii	Sedge	Cyperaceae	
Chamaecrista comosa	Forb	Ceasalpiniaceae	
Clutia species	Forb	Euphorbiaceae	
Commelina africana	Forb	Commelinaceae	
Crabbea angustifolia	Forb	Acanthaceae	

Crassula lanceolata	Succulent	Crassulaceae	
Crassula species	Succulent	Crassulaceae	
Ctenium concinnum	**Grass**	**Poaceae**	
Cymbopogon plurinodis	Grass	Poaceae	
Dianthus mooiensis	Forb	Capparaceae	
Dicoma anomala	Forb	Asteraceae	
Dicoma zeyheri	Forb	Asteraceae	
Elephantorrhiza elephantina	Shrub	Mimosaceae	
Englerophytum magalismontanum	**Tree**	**Sapotaceae**	
Eragrostis capensis	Grass	Poaceae	
Eragrostis racemosa.	Grass	Poaceae	
Eriosema cordatum	Forb	Fabaceae	
Faurea saligna	Tree	Proteaceae	
Gazania krebsiana	Forb	Asteraceae	
Gladiolus species	Geophyte	Iridaceae	
Gnidia capitata	Forb	Thymelaeaceae	
Gomphocarpus fruticosus	Shrub	Asclepidaceae	
Gomphrena celosioides	Forb	Amaranthaceae	
Haplocarpha scaposa	Forb	Asteraceae	
Harpochloa falx	**Grass**	**Poaceae**	
Helichrysum aureonitens	**Forb**	**Asteraceae**	
Helichrysum pallidum	**Forb**	**Asteraceae**	
Helichrysum pilosellum	Forb	Asteraceae	
Helichrysum rugulosum	Forb	Asteraceae	
Hermannia lancifolia	Forb	Sterculiaceae	
Hermannia transvaalensis	**Forb**	**Sterculiaceae**	
Heteropogon contortus	**Grass**	**Poaceae**	
Hypoxis iridifolia	Geophyte	Hypoxidaceae	
***Hypoxis* species**	**Geophyte**	**Hypoxidaceae**	
Indigofera species	Forb	Fabaceae	
Justicia anagalloides	Forb	Acanthaceae	
Lotononis eriantha	Forb	Fabaceae	
Loudetia simplex	**Grass**	**Poaceae**	
Microchloa caffra	**Grass**	**Poaceae**	
Monocymbium ceresiiforme	**Grass**	**Poaceae**	
Monsonia angustifolia	Forb	Geraniaceae	
Mundulea sericea	Tree	Fabaceae	
Parinari capensis	**Forb**	**Chrysobalanaceae**	
Pearsonia sessilifolia	Forb	Fabaceae	
Pelargonium luridum	Forb	Geraniaceae	
Pentanisia angustifolia	Forb	Rubiceae	
Peucedanum magalismontanum	Forb	Apiaceae	
Pygmaeothamnus chamaedendrum	Forb	Rubiaceae	
Raphionachme species	Forb	Peripoplacaceae	
Rhus discolor	Shrub	Anacardiaceae	
Rhus pyroides	Tree	Anacardiaceae	
Schistostephium crataegifolium	Forb	Asteraceae	
Scilla natalensis	**Geophyte**	**Liliaceae**	
Senecio cordifolius	Forb	Asteraceae	
Senecio venosus	Forb	Asteraceae	
Silene species	Forb	Caryophyllaceae	

Tapiphyllum parvifolium	Tree	Rubiaceae	
Themeda triandra	**Grass**	**Poaceae**	
Trachypogon spicatus	**Grass**	**Poaceae**	
Trichoneura grandiglumis	Grass	Poaceae	
Tristachya leucothrix	**Grass**	**Poaceae**	
Tristachya rehmannii	**Grass**	**Poaceae**	
Turbina oblongata	Forb	Convolvulaceae	
Urelytrum agropyroides	**Grass**	**Poaceae**	
Vernonia natalensis	Forb	Asteraceae	
Vernonia oligocephala	Forb	Asteraceae	
Wahlenbergia undulata	Forb	Campanulaceae	
Xerophyta viscosa	Geophyte	Velloziaceae	
Zanthoxylum capense	Tree	Rutaceae	

Table 4: Growth forms

Growth Form	Number	Percentage
Forbs	43	51%
Geophytes	8	10%
Grasses	18	21%
Sedges	2	2%
Shrubs	4	5%
Succulents	3	4%
Trees	6	7%
Total	**84**	**100%**

SENSITIVITY ASPECTS

- This variation is situated adjacent to a sensitive environment;
- The vegetation of this area is pristine;
- Few declared invasive plant species are present;
- High species diversity – 84 species noted;
- The floristic status of this variation is HIGH;
- No Red Data flora species were observed within this variation;
- Suitability of available habitat for Red Data flora species is MEDIUM;
- Likely impacts on the floristic environment will be significant on a local scale;
- **The floristic sensitivity of this vegetation unit is HIGH.**

- **Escarpment Variation**

No sampling was conducted as a result of inaccessibility of these areas, but general observations are considered sufficient in highlighting the floristic attributes and general floristic sensitivity of this variation.

This variation comprises cliff areas where the slope exceeds 75% and rockiness is extremely high (>75%, boulders). The vegetation that characterise these areas are considered diverse, absolutely pristine and extremely sensitive.

The physiognomy is characterised by a well developed tree layer and grasses in areas where deeper soils prevail, indicating that this variation is a transitional type between the grasslands of the Nebo Plateau and the woodlands of the lower sections.

SENSITIVITY ASPECTS

- This variation is situated within a sensitive environment;
- The vegetation of this area is pristine;
- High species diversity;
- The floristic status of this variation is HIGH;
- Suitability of available habitat for Red Data flora species is MEDIUM-HIGH;
- Likely impacts on the floristic environment will be significant on a local scale;
- **The floristic sensitivity of this vegetation unit is HIGH.**

7.2.2 Woodland Community

This community comprises the lower section of the proposed development, more specifically the Steelpoort River Valley that is characterised by terrestrial woodlands with a closed canopy. It is situated on the footslopes of the mountain that leads towards the Steelpoort River.

The vegetation is fairly representative of the regional vegetation and management styles of the general area determine the status of the woodland. It would appear as if fire is not a frequent occurrence and it would explain the dominance of the woody layer. The canopy cover in most areas exceeds 50%, implying a strong shade effect and the establishment of an herbaceous stratum that is characterised by relative poor diversity.

Floristic variations that are noted in this community are typically the result of slopes, rockiness and soil properties. Rocky areas where higher slopes prevail are generally characterised by soils with low clay content (sandy soils), which typically give rise to a sour vegetation type. This is the result of the leaching of nutrients from the soil. Plants that grow in these areas are generally less palatable and also dominated by broadleaf woody species.

In contrast, areas lower on the mountain slopes, situated on the plains, are characterised by deeper soils with higher clay content. The availability of nutrients in the soil results in more palatable grass species and typically a fine-leaf (*Acacia*) vegetation type. Due to the prevalence of palatable species, higher accessibility and proximity to water, these variations are frequently over-utilized by game and cattle, leading to a depletion of the grass stratum and an increase in the density of the woody layer, typically of the 1.0 to 3.0 m class(shrubs and low trees).

- **Mountain Woodland Variation**

This variation represents the typical sourveld, broadleaf vegetation that prevail on shallow, sandy soils. The higher slopes, rockiness and sour veld characteristics result relative inaccessible areas and unpalatable vegetation, hence the vegetation is relative unaffected by grazing pressure. A visual assessment of the structural layers of this

variation revealed that the woody layer is not exclusively dominant and a diverse and well developed herbaceous layer is present. Furthermore, a well proportioned population structure is noted with a proper distribution of aged and younger individuals.
The species composition of this variation is presented in Table 5 (dominant and significant species indicated in **bold**). A total of only 20 species were observed during the site investigation. This is not considered particularly diverse, but is nonetheless representative of this type of vegetation. This variation is considered pristine and no species or growth form was found to be exclusively dominant. Furthermore, approximately 86% of the species that were observed are considered to be indicative of a pristine example of this vegetation type. Poor quality species were present at low cover abundance values.

Low grazing pressures are evident, attributed to slopes, rockiness, vegetation type and distance from available water. As a result, the vegetation dynamics are relative stable and any long-term changes that take place in terms of floristic composition, species dominance, vegetation structure and physiognomy are extremely gradual.

No Red Data flora species were observed within this variation, but available habitat is considered moderately suitable for the presence of Red Data flora species, particularly since this variation is situated within the Sekhukhuneland Centre of Endemism.

This variation is represented along the footslopes of the mountain and is therefore adequately represented in the general region.

Table 5: Species list for the Mountain Woodland Variation

Species Name	Growth Form	Family	Alien Status
Acacia caffra	Tree	Mimosaceae	
Aloe castanea	**Succulent**	**Liliaceae**	
Aloe marlothii	**Succulent**	**Liliaceae**	
Asclepias species	Forb	Asclepidaceae	
Combretum apiculatum	**Tree**	**Combretaceae**	
Commiphora marlothii	Tree	Burseraceae	
Cussonia transvaalensis	**Tree**	**Araliaceae**	
Dichrostachys cinerea	Tree	Mimosaceae	
Digitaria argyrograpta	Grass	Poaceae	
Eragrostis superba	**Grass**	**Poaceae**	
Euclea crispa	Tree	Ebenaceae	
Grewia occidentalis	**Shrub**	**Tiliaceae**	
Jatropha zeyheri	Forb	Euphorbiaceae	
Lannea discolor	Tree	Anacardiaceae	
Ormocarpum kirkii	**Shrub**	**Fabaceae**	
Rhus leptodictya	Tree	Anacardiaceae	
Sclerocarya birrea	**Tree**	**Anacardiaceae**	
Setaria sphacelata	**Grass**	**Poaceae**	
Themeda triandra	Grass	Poaceae	
Vernonia species	Forb	Asteraceae	

Table 6: Growth forms		
Growth Form	**Number**	**Percentage**
Forb	3	15%
Grass	4	20%
Shrub	2	10%
Succulent	2	10%
Tree	9	45%
Total	**20**	**100%**

SENSITIVITY ASPECTS

- This variation is situated adjacent to a sensitive environment;
- This variation is situated within the Sekhukhuneland Centre of Endemism;
- The vegetation of this area is pristine;
- Low species diversity – 20 species;
- The floristic status of this variation is HIGH;
- Suitability of available habitat for Red Data flora species is MEDIUM-LOW;
- Likely impacts on the floristic environment will be moderately significant on a local scale;
- **The floristic sensitivity of this vegetation unit is MEDIUM-HIGH.**

- ***Acacia* Woodland Variation**

Areas that are characterised by deeper soils and lower slopes constitute *Acacia* woodlands. The dominance of the woody layer is severe; in most cases the canopy cover was found to be in excess of 50%. The excessively dense woody layer is presumed to be the result of management in the woodland areas. Fire is generally not an acceptable management tool and is generally prevented at all costs. Consequently woodland areas only burn at extremely long intervals. High grazing pressures together with withholding fire results in an increase in the density and frequency of woody individuals. This is noted in the excessive high frequency of individual in the 1.5 to 3.5m height class. A casual inspection of the population structure revealed an excessive number of younger individuals. Should no dedicated management programme be implemented to combat the increase in this part of the woody layer, the density of woody species will continue to increase to the detriment of the herbaceous layer. These habitat changes cause significant effects on the ecology, including species chances in the herbaceous layer, decreased grazing capacity, selective grazing, lower species diversity, increased erosion, etc.

In spite of the pristine appearance of this variation, it is considered to be moderately degraded and a medium-low floristic status is attributed. Distribution of species in the respective growth forms provide some evidence to this; 'normal' conditions would dictate that the herb and grass component will dominate the species composition, but in this case the woody layer dominates the physiognomy as well as the species composition (50% trees and shrubs), indicating a species changes (Table 8).

Other changes in the species composition and frequency of species are evident with the increase in density of the woody layer. The grass layer becomes less diverse, being dominated by grass species that are more adapted to shaded conditions, such as *Panicum maximum*. Furthermore, the higher density of the woody layer implies that less habitat is available for grazing purposes, resulting in higher grazing pressure on available habitat even without a physical increase in the stocking units. The effect is a decline in the frequency of palatable species (Decreaser species) with an increase in the presence and frequency of less palatable species (Increaser II & III species).

Poor quality species include *Aristida congesta* ssp *barbicollis, Enneapogon scoparius, Eragrostis lehmanniana, E. rigidior, Setaria verticillata, Sporobolus pyramidalis* and *Urochloa mosambicensis.* Forb species that indicate poor habitat conditions are also evident in this variation and include *Alternanthera pungens, Hibiscus microcarpus, Kyphocarpa angustifolia, Pergularia daemia, Schkuhria pinnata* and *Zinnia peruviana.*

A total of 62 plant species were identified during the site investigation (Table 7, dominant species are indicated in **bold**). The floristic diversity is considered fairly low as a pristine example of this vegetation type is expected to be more diverse; particularly the grass and forb components. This variation is adequately represented in the general surrounds and more pristine examples are present in the region.

No red data flora species were observed and a medium-low suitability of available habitat for the presence of Red Data flora species is estimated.

Table 7: Species list for the *Acacia* Woodland

Species Name	Growth Form	Family	Alien Status
Abutilon austro-africanum	Forb	Malvaceae	
Acacia erubescens	**Tree**	**Mimosaceae**	
Acacia galpinii	Tree	Mimosaceae	
Acacia karroo	**Tree**	**Mimosaceae**	
***Acacia* species**	**Tree**	**Mimosaceae**	
Aloe marlothii	Succulent	Liliaceae	
Alternanthera pungens	Forb	Amaranthaceae	
Aristida congesta* ssp *barbicollis	**Grass**	**Poaceae**	
Asparagus species	Forb	Liliaceae	
Berchemia zeyheri	Tree	Rhamnaceae	
Boscia albitrunca	Tree	Capparaceae	
Boscia foetida	**Shrub**	**Capparaceae**	
Cenchrus ciliaris	**Grass**	**Poaceae**	
Clerodendrum glabrum	**Tree**	**Verbenaceae**	
Combretum hereroense	Tree	Combretaceae	
Combretum molle	Tree	Combretaceae	
Commelina erecta	Forb	Commelinaceae	
Commelina species	Forb	Commelinaceae	
Commiphora pyracanthoides	**Tree**	**Burseraceae**	
Cussonia spicata	Tree	Araliaceae	

Cyperus esculentus	Sedge	Cyperaceae	
Dactyloctenium giganteum	Grass	Poaceae	
Dichrostachys cinerea	**Tree**	**Mimosaceae**	
Digitaria argyrograpta	Grass	Poaceae	
Dombeya rotundifolia	Tree	Sterculiaceae	
Ehretia rigida	Tree	Ehretiaceae	
Enneapogon scoparius	**Grass**	**Poaceae**	
Eragrostis lehmanniana	**Grass**	**Poaceae**	
Eragrostis rigidior	**Grass**	**Poaceae**	
Eragrostis species	Grass	Poaceae	
Eragrostis superba	**Grass**	**Poaceae**	
Euclea divinorum	**Tree**	**Ebenaceae**	
Euphorbia ingens	Tree	Euphorbiaceae	
Grewia flava	**Shrub**	**Tiliaceae**	
Grewia flavescens	**Shrub**	**Tiliaceae**	
Grewia monticola	Shrub	Tiliaceae	
Gymnosporia buxifolia	**Tree**	**Celastraceae**	
Hibiscus microcarpus	Forb	Malvaceae	
Kyphocarpa angustifolia	Forb	Amaranthaceae	
Melhania forbesii	Forb	Malvaceae	
Ormocarpum kirkii	Shrub	Fabaceae	
Panicum maximum	**Grass**	**Poaceae**	
Pappea capensis	Tree	Sapindaceae	
Peltophorum africanum	**Tree**	**Ceasalpiniaceae**	
Pergularia daemia	Climber	Asclepidaceae	
Phyllanthus species	Forb	Euphorbiaceae	
Rhoicissus tridentata	Climber	Vitaceae	
Rhus leptodictya	Tree	Anacardiaceae	
Schkuhria pinnata	Forb	Asteraceae	
Schmidtia pappophoroides	Grass	Poaceae	
Schotia brachypetala	Tree	Caesalpiniaceae	
Schrebera alata	Tree	Oleaceae	
Sclerocarya birrea	Tree	Anacardiaceae	
Setaria verticillata	Grass	Poaceae	
Sporobolus pyramidalis	Grass	Poaceae	
Stachys species	Forb	Lamiaceae	
Themeda triandra	Grass	Poaceae	
Urochloa mosambicensis	**Grass**	**Poaceae**	
Ximenia americana	Tree	Olacaceae	
Zinnia peruviana	Forb	Asteraceae	
Ziziphus mucronata	**Tree**	**Rhamnaceae**	
Ziziphus rivularis	Tree	Rhamnaceae	

Table 8: Growth forms

Growth Form	Number	Percentage
Climbers	2	3%
Forbs	12	19%
Grasses	15	24%
Sedges	1	2%
Shrubs	5	8%
Succulents	1	2%

Trees	26	42%
Total	**62**	**100%**

SENSITIVITY ASPECTS

- This variation is situated adjacent to a sensitive environment;
- The vegetation of this area is moderately degraded;
- No declared invasive plant species are present;
- Moderate species diversity;
- The floristic status of this variation is MEDIUM-LOW;
- Suitability of available habitat for Red Data flora species is MEDIUM-LOW;
- Likely impacts on the floristic environment will be moderately significant on a local scale;
- **The floristic sensitivity of this vegetation unit is MEDIUM-LOW.**

- **Rocky Outcrop Woodland Variation**

A small koppie is situated in the northern part of the study area. It is characterised by a dominant woody layer and well developed and diverse herbaceous stratum (Table 10), taking the small size of this variation into account. A total of 42 plant species were identified (Table 9, **significant** species indicated in **bold**), 75% of which are considered representative of a pristine example of this vegetation type. However, the vegetation that is encountered in this variation has been degraded as a result of a high utilization factor.

Surrounding areas are severely degraded, including a quarry and nearby residence. These impacts, together with a high grazing component contribute to the degradation of this koppie. The proliferation of poor quality species and the disappearance of species indicative of pristine vegetation are noted to some extent. A medium floristic status is thus attributed.

This koppie is an atypical topographical feature and contains vegetation that is dissimilar to the general surrounds in terms of species composition. The conservation value that is attributed to this variation is high, in spite of a slightly degraded appearance and moderate floristic status.

No red data flora species were observed, but available habitat is considered moderately suitable for the presence of Red Data flora species.

Table 9: Species list for the Rocky Outcrop			
Species Name	**Growth Form**	**Family**	**Alien Status**
Acacia caffra	Tree	Mimosaceae	
Aloe castanea	**Succulent**	**Liliaceae**	
Aristida congesta ssp *barbicollis*	Grass	Poaceae	
Berchemia zeyheri	**Tree**	**Rhamnaceae**	
Boscia albitrunca	Tree	Capparaceae	

Combretum apiculatum	Tree	Combretaceae	
Combretum hereroense	**Tree**	**Combretaceae**	
Dichrostachys cinerea	Tree	Mimosaceae	
Dicoma macrocephala	Forb	Asteraceae	
Digitaria argyrograpta	Grass	Poaceae	
Dombeya rotundifolia	**Tree**	**Sterculiaceae**	
Enneapogon scoparius	Grass	Poaceae	
Eragrostis superba	Grass	Poaceae	
Gerbera jamesonii	**Forb**	**Asteraceae**	
Grewia flava	Shrub	Tiliaceae	
Grewia flavescens	Shrub	Tiliaceae	
Gymnosporia buxifolia	Tree	Celastraceae	
Helichrysum rugulosum	Forb	Asteraceae	
Helichrysum species	Forb	Asteraceae	
Heteropogon contortus	Grass	Poaceae	
Hibiscus microcarpus	Forb	Malvaceae	
***Huernia* species**	**Succulent**	**Asclepidaceae**	
Kyphocarpa angustifolia	Forb	Amaranthaceae	
Leonotis ocymifolia var *raineriana*	Forb	Lamiaceae	
Malva species	Forb	Malvaceae	
Panicum maximum	Grass	Poaceae	
Pappea capensis	**Tree**	**Sapindaceae**	
Pellaea calomelanos	Fern	Adianthaceae	
Phyllanthus species	Forb	Euphorbiaceae	
Rhoicissus tridentata	Climber	Vitaceae	
Rhus leptodictya	Tree	Anacardiaceae	
***Sansevieria* species**	**Forb**	**Liliaceae**	
Sarcostemma viminale	Climber	Asclepidaceae	
Scadoxus puniceus	Geophyte	Amaryllidaceae	
Senecio species	Forb	Asteraceae	
Stachys species	Forb	Lamiaceae	
Themeda triandra	Grass	Poaceae	
Triaspis hypericoides	Forb	Malpighiaceae	
Urochloa mosambicensis	Grass	Poaceae	
Vangueria infausta	Tree	Rubiaceae	
Ximenia americana	Tree	Olacaceae	
Ziziphus mucronata	Tree	Rhamnaceae	

Table 10: Growth forms

Growth Form	Number	Percentage
Climber	2	5%
Fern	1	2%
Forb	13	31%
Geophyte	1	2%
Grass	8	19%
Shrub	2	5%
Succulent	2	5%
Tree	13	31%
Total	**42**	**100%**

SENSITIVITY ASPECTS

- This variation represents a sensitive environment;
- The vegetation of this area is moderately degraded;
- No declared invasive plant species are present;
- Moderate species diversity;
- The floristic status of this variation is MEDIUM;
- Suitability of available habitat for Red Data flora species is MEDIUM;
- Likely impacts on the floristic environment will be significant on a local scale;
- **The floristic sensitivity of this vegetation unit is MEDIUM-HIGH.**

7.2.3 Riparian Woodland Community

The Steelpoort River and tributaries are characterised by well developed woodland, dominated by tall *Acacia galpinii* stands. Smaller tributaries contain a higher diversity of woody species as a result of the close association with nearby woodlands, slightly higher slopes on the banks of the streams that results in more defined ecotonal zones and narrower levee areas.

The herbaceous layer, as a result of the shade effect, is poorly developed and comprises few grass and forb species (Table 12). The species composition (Table 11, dominant species indicated in **bold**), although low in diversity is considered representative of this type of vegetation. Nearby areas are present where the habitat conditions and physiognomy change significantly and the species diversity increases. These areas are however situated outside the study area, but will nonetheless be considered in the sensitivity analysis as it forms part of this ecological unit.

The extensive presence of the grass species *Panicum maximum* provides evidence of the shaded conditions, the fertile nature of the soils and high grazing pressure is thus not uncommon.

This community, although moderately degraded and of medium floristic status, is still considered extremely sensitive and

Table 11: Species list for the Riparian Woodland

Species Name	Growth Form	Family	Alien Status
Acacia caffra	Tree	Mimosaceae	
Acacia galpinii	**Tree**	**Mimosaceae**	
Acacia karroo	Tree	Mimosaceae	
Acacia nilotica	Tree	Mimosaceae	
Acacia species	Tree	Mimosaceae	
Asparagus species	Forb	Liliaceae	
Celtis africana	**Tree**	**Ulmaceae**	
Chenopodium album	Forb	Chenopodiaceae	
Combretum apiculatum	Tree	Combretaceae	
Combretum erythrophyllum	**Tree**	**Combretaceae**	
Dombeya rotundifolia	Tree	Sterculiaceae	
Euclea crispa	Tree	Ebenaceae	
Euclea divinorum	Tree	Ebenaceae	

Euphorbia ingens	Tree	Euphorbiaceae	
Ficus ingens var *ingens*	Tree	Moraceae	
Galinsoga parviflora	Forb	Asteraceae	
Grewia flavescens	Shrub	Tiliaceae	
Gymnosporia buxifolia	**Tree**	**Celastraceae**	
Heteropyxis natalensis	Tree	Heteropyxidaceae	
Hibiscus species	Forb	Malvaceae	
Opuntia ficus-indica	Succulent	Cactaceae	Category 1
Panicum maximum	**Grass**	**Poaceae**	
Peltophorum africanum	Tree	Ceasalpiniaceae	
Persicaria lapathifolia	Hydrophilic	Polygonaceae	
Rhus leptodictya	Tree	Anacardiaceae	
Sclerocarya birrea	Tree	Anacardiaceae	
Setaria sphacelata	Grass	Poaceae	
Ziziphus mucronata	Tree	Rhamnaceae	
Ziziphus rivularis	**Tree**	**Rhamnaceae**	

Table 12: Growth forms		
Growth Form	**Number**	**Percentage**
Forbs	4	14%
Grasses	2	7%
Hydrophilics	1	3%
Shrubs	1	3%
Succulent	1	3%
Trees	20	69%
Total	**29**	**100%**

SENSITIVITY ASPECTS

- This variation represents a sensitive environment;
- The vegetation of this area is moderately degraded;
- Some declared invasive plant species are present;
- Moderate species diversity;
- The floristic status of this variation is MEDIUM;
- Suitability of available habitat for Red Data flora species is MEDIUM;
- Likely impacts on the floristic environment will be significant on a local scale;
- **The floristic sensitivity of this vegetation unit is HIGH.**

7.2.4 Transformed Areas

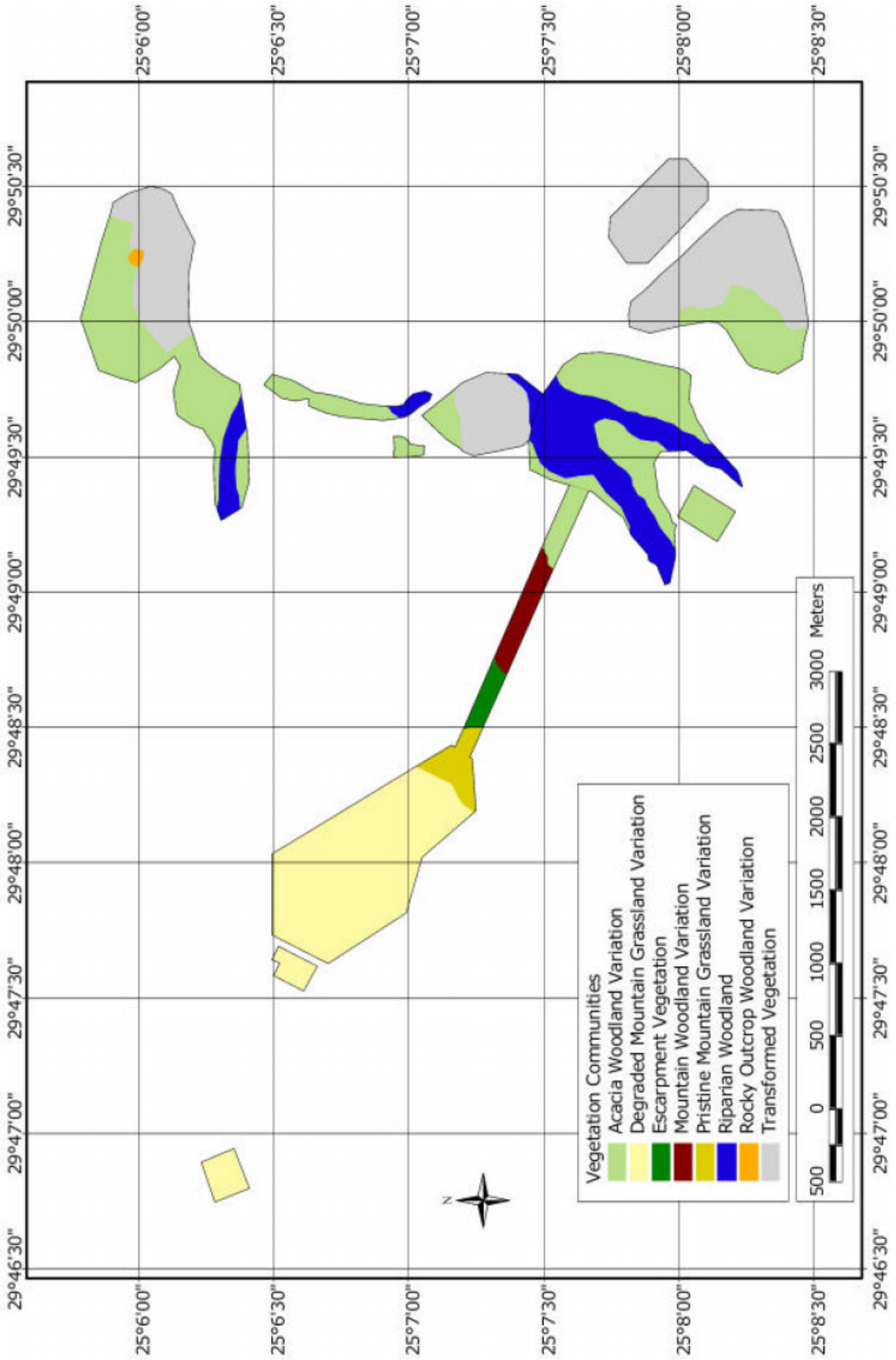
This community comprises areas where the natural vegetation has been removed for specific purposes, mostly agriculture. Since no natural vegetation is left no sampling was conducted in these areas.

SENSITIVITY ASPECTS

- This community does not contain any natural vegetation;
- Some parts are situated in close proximity to sensitive riparian environments;
- Some declared invasive plant species are present;
- The floristic status of this variation is LOW;

- Suitability of available habitat for Red Data flora species is LOW;
- Likely impacts on the floristic environment will be insignificant on a local scale;
- **The floristic sensitivity of this vegetation unit is LOW.**

Figure 5: Vegetation communities of the study area



7.3 Species of Importance

PLEASE NOTE:

1 Use of Red Data species information is restricted exclusively to this report and may not be used for any other purpose.

2 Red Data information may not be published anywhere.

3 Red Data information may not be copied, either as a hard or electronic copy.

4 Red Data information is to remain confidential. Any report containing Red Data information must be supplied as an appendix to the main document, marked confidential **and may not be attached to any document available for public perusal.** The main document may only indicate the number of Red Data species recorded on the site and their statuses, *i.e.* the species names may not appear in the main document.

The World Conservation Organisation (IUCN) has three threatened categories, namely Critically Endangered, Endangered and Vulnerable. Species that have been evaluated according to the IUCN criteria and do not fall into one of the threatened categories can be classified as Least Concern, Near Threatened or Data Deficient. Species classified as Least Concern have been evaluated and do not qualify for the Critically Endangered, Endangered, and Vulnerable or Near Threatened categories. Species that are widespread and abundant are normally included in this category.

Species are classified as Near Threatened when they do not meet the criteria for the threatened categories, but are close to classifying as threatened or will likely classify as threatened in the near future. A species is classified as Data Deficient when there is a lack of appropriate data on the distribution and/ or population status of the species. The species may well be studied, and the biology known, but data on the abundance and/ or distribution are not available. The category indicates that more data is needed and that there is a possibility that the species may be classified into one of the threat categories in the future. Vulnerable species are facing a high risk of extinction in the wild, Endangered a very high risk and Critically Endangered and extremely high risk (Minter et al, 2004).

Plant species data received from the South African National Biodiversity Institute (SANBI) has been classified according to the old IUCN Red Data categories of 1986. The categories used in the old Red Data classification are Extinct, Endangered, Vulnerable, Rare, Indeterminate, Insufficiently Known, Not Threatened and No Information. Endangered taxa are taxa in danger of extinction and are unlikely to survive if the current situation continues. Vulnerable species are taxa that are likely to move into the Endangered category in the near future if the factors causing the decline continue to be present.

Rare taxa are taxa with small populations that are not classified as Endangered or Vulnerable, but are at risk as an unexpected threat may cause a decline in the population. Indeterminate taxa are taxa known to be in one of the four above categories, but insufficient information is available to determine which of the four categories.

Insufficiently Known taxa are suspected to belong to one of the above categories, but this is not known for certain as there is a lack of information available on the species (Hilton-Taylor, 1996).

Not Threatened taxa are taxa that are no longer included in any of the threatened categories due to an increase in the population size or the discovery of more individuals or populations. No Information includes taxa without any information available. The Rare categories is seen as similar to the Near Threatened category in the new classification and the Insufficiently Known category seems to be similar to the Data Deficient category in the new classification.

The Interim Red Data List of South African Plant Species (Threatened Species Programme, 2004), indicate a total of 335 potential Red Data flora species for the Mpumalanga Province. PRECIS data indicate the presence of 15 Red Data flora species within the 2529BB grid in which the study area is situated.

A condensation of available data, including the Interim Red Data List of South African Plant Species (Threatened Species Programme, 2004), as well as the Environmental Screening Assessment for Steelpoort Pumped Storage Report indicates the following species of concern for the study area (Numbers indicated in **bold** are confirmed in the study area.

Table 13: Red Data flora species present within ¼degree grid 2529BB	
Summary	**Number of Taxon Present**
Near Threatened	7
Insufficiently Known	5
Rare	3
Near Endemic	**2**
Threatened in other SA regions	**1**

Seasonal and project limitations placed severe restrictions on the location and identifying of some of these species. No Threatened species were observed during the site investigation, but available habitat in the study area, particularly the Riparian community, is considered moderately suitable for some of the species.

In addition to the protected status that is attributed to some plant species, SANBI has also produced a list of tree species that are deemed to have certain attributes that make them worthy of protection. Two species were observed within the study area.

Species of importance that were observed during the site investigation are considered well represented in the general region outside the study area. Although the presence of these species will not influence the outcome of this particular assessment, specific recommendations will be made to protect individuals that will be affected by the proposed development.

7.4 Floristic Sensitivity Analysis

7.4.1 Results

Calculation of the Floristic Sensitivity Analysis is presented in Table 14. Results of the Floristic Sensitivity Analysis are visually presented in Figure 6.

7.4.2 Results

Obvious high sensitivities are attributed to the Riparian Woodland areas as a result of the environmental sensitivity associated with these ecological systems. Similarly, the Pristine Mountain Grassland, Escarpment Vegetation and the Mountain Woodland variations contain pristine regional vegetation and are also situated within sensitive environments (areas of high slopes, mountains). These vegetation variations are relatively small and are also adequately represented in the general surrounds.

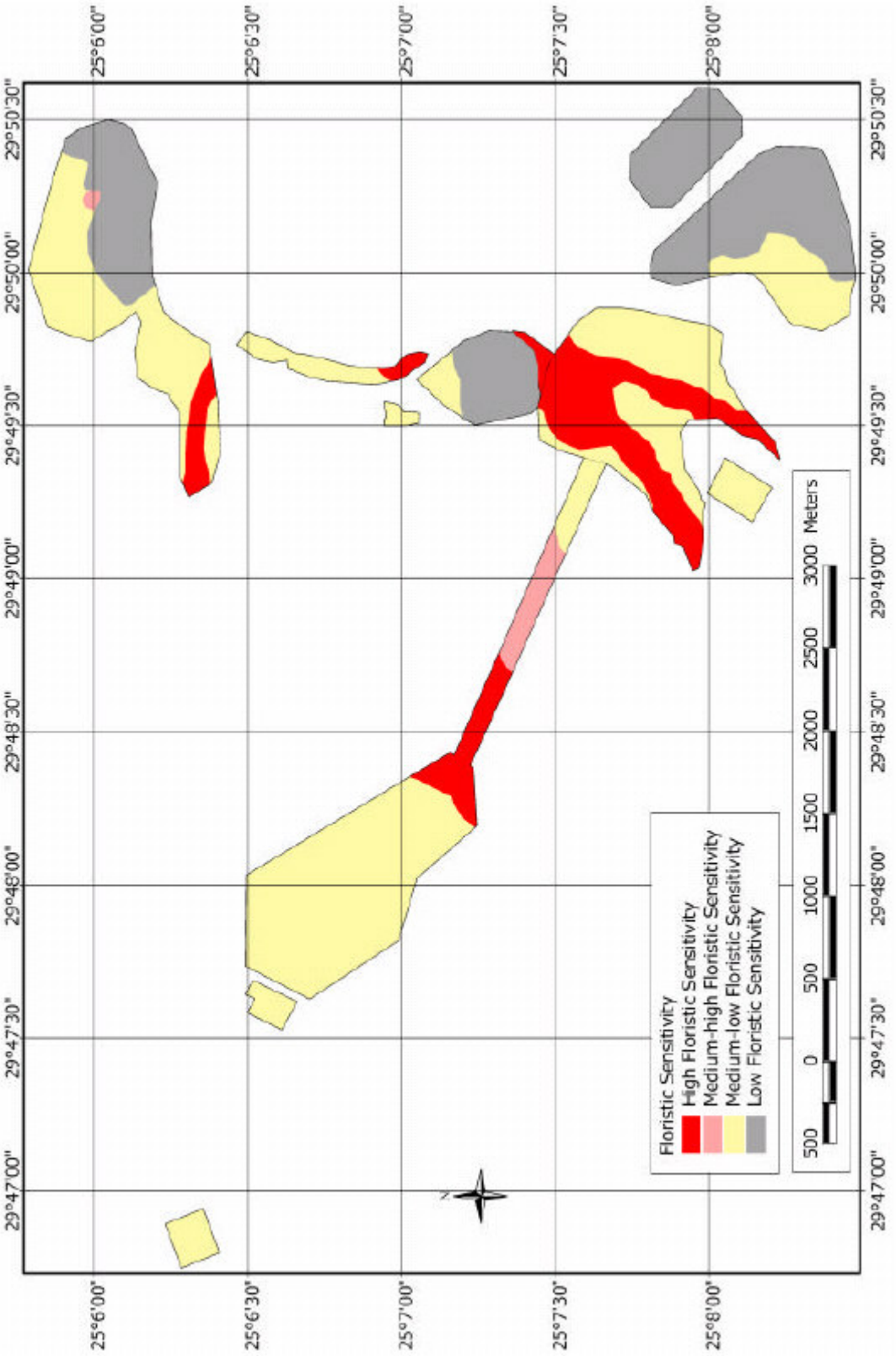
The Rocky Outcrop exhibit medium-high floristic sensitivities, but are extremely localised and small.

Areas of lower floristic sensitivity are represented by the Degraded Mountain Grassland and *Acacia* Woodland variations, both of which do not contain any floristic elements of particular significance.

Transformed areas are not of any significance in terms of floristic elements. It should however be noted that, one area in particular, is situated in close vicinity to the Riparian Woodland, implying a general concern to this sensitive system.

Table 14: Floristic Sensitivity Analysis for the study area								
Criteria	**RD species**	**Landscape sensitivity**	**Status/Ecological quality**	**Floristic diversity**	**Functionality/ fragmentation**	**TOTAL**	**SENSITIVITY INDEX**	**SENSITIVITY CLASS**
Community	**Criteria Ranking**							
Degraded Mountain Grassland	2	4	2	4	8	88	30%	**MEDIUM-LOW**
Pristine Mountain Grassland	7	9	10	10	10	253	87%	**HIGH**
Escarpment Variation	7	10	10	10	10	260	90%	**HIGH**
Mountain Woodland	6	7	9	9	10	218	75%	**MEDIUM-HIGH**
Acacia Woodland	3	3	4	6	8	113	39%	**MEDIUM-LOW**
Rocky Outcrop Woodland	5	9	6	5	5	179	62%	**MEDIUM-HIGH**
Riparian Woodland	6	10	9	9	10	239	82%	**HIGH**
Transformed Areas	0	1	1	0	2	15	5%	**LOW**

Figure 6: Floristic Sensitivities of the study area



8 FAUNAL ASSESSMENT

The survey was conducted in February 2007.

8.1 Recorded Fauna Species

8.1.1 Invertebrates

A total of 15 invertebrates were recorded during the site investigation, including:

- 1 grasshopper;
- 4 beetles; and
- 10 butterflies.

Table 15: Invertebrate species recorded in the study area			
Phylum: Arthropoda; Class: Insecta			
ORDER	FAMILY	BIOLOGICAL NAME	ENGLISH NAME
Orthoptera	Pyrgomorphidae	*Zonocerus elegans*	Elegant Grasshopper
Coleoptera	Scarabaeidae	*Dischista cintcta*	Common Savanna Fruit Chafer
		Rhabdotis aulica	Emerald Fruit Chafer
		Pedinorhina plana	Yellow-belted Fruit Chafer
	Melyridae	*Astylus atromaculatus*	Spotted Maize Beetle
Lepidoptera	Nymphalidae	*Danaus chryssipus*	African Monarch
		Melanitis leda	Common Evening Brown
		Precis archesia	Garden Commodore
		Precis hierta	Yellow Pansy
	Pieridae	*Eurema brigitta*	Broad-bordered Grass Yellow
		Belenois aurota	Brown-veined White
		Belenois creona	African Common White
		Catopsilla florella	African Migrant
	Papilionidae	*Princeps demodocus*	Citrus Swallowtail
		Papilio nireus	Green-banded Swallowtail

All of the invertebrates found during the field survey are common savanna and grassland insects that are not restricted in terms of habitat or distribution.

8.1.2 Herpetofauna

One frog and two reptiles were recorded during the site investigation.

Table 16: Herpetofauna species recorded in the study area			
Phylum: Vertebrata; Class: Amphibia			
ORDER	FAMILY	BIOLOGICAL NAME	ENGLISH NAME
Anura	Bufonidae	*Schismaderma carens*	Red Toad
Phylum: Vertebrata; Class: Reptilia			
ORDER	FAMILY	BIOLOGICAL NAME	ENGLISH NAME
Squamata	Chamaeleontidae	*Chamaeleo dilepis*	Flap-neck Chameleon
	Agamidae	*Agama atra*	Southern Rock Agama

All three herpetofauna species found in the study area is known from the q-grid of the study area (SARCA database, Frog Atlas) and are not limited in distribution. The Red Toad is generally associated with wet habitats (breeding) but is also found in drier areas in both savanna and grassland biomes (it was found within the grassland region of the study area). Although only one frog species were encountered, many other are undoubtedly present in the riverine vegetation habitat of the study area.

8.1.3 Avifauna

A total of 62 bird species were recorded during the site investigation.

Table 17: Bird species recorded in the study area			
Phylum: Vertebrata; Class: Aves			
ORDER	FAMILY	BIOLOGICAL NAME	ENGLISH NAME
Ciconiiformes	Ardeidae	*Bubulcus ibis*	Cattle Egret
	Scopidae	*Scopus umbretta*	Hamerkop
	Threskiornithidae	*Bostrychia hagedash*	Hadeda Ibis
Falconiformes	Accipitridae	*Milvus aegyptius*	Yellow-billed Kite
		Aquila wahlbergi	Wahlberg's Eagle
	Falconidae	*Falco amurensis*	Amur Falcon
		Falco naumanni	**Lesser Kestrel**
Galliformes	Phasianidae	*Dendroperdix sephaena*	Crested Francolin
		Pternistis natalensis	Natal Francolin
Charadriiformes	Charadriidae	*Vanellus coronatus*	Crowned Lapwing
Columbiformes	Columbidae	*Streptopelia semitorquata*	Red-eyed Dove
		Streptopelia capicola	Cape Turtle-Dove
		Streptopelia senegalensis	Laughing Dove
		Turtur chalcospilos	Emerald-spotted Wood-Dove
Musophagiformes	Musophagidae	*Corythaixoides concolor*	Grey Go-away-bird
Cuculiformes	Cuculidae	*Clamator jacobinus*	Jacobin Cuckoo
Strigiformes	Strigidae	*Bubo lacteus*	Verreaux's Eagle-Owl
Apodiformes	Apodidae	*Apus barbatus*	African Black Swift
		Apus caffer	White-rumped Swift
		Apus affinis	Little Swift
Coliiformes	Coliidae	*Colius striatus*	Speckled Mousebird
		Urocolius indicus	Red-faced Mousebird
Coraciiformes	Dacelonidae	*Halcyon senegalensis*	Woodland Kingfisher
		Halcyon albiventris	Brown-hooded Kingfisher
	Meropidae	*Merops apiaster*	European Bee-eater
		Merops bullockoides	White-fronted Bee-eater
Upupiformes	Phoeniculdae	*Phoeniculus purpureus*	Green Wood-Hoopoe
Bucerotiformes	Bucerotidae	*Tockus nasutus*	African Grey Hornbill
		Tockus leucomelas	Southern Yellow-billed Hornbill
Piciformes	Lybiidae	*Lybius torquatus*	Black-collared Barbet
		Pogoniulus chrysoconus	Yellow-fronted Tinkerbird
		Trachyphonus vaillantii	Crested Barbet
	Picidae	*Campethera abingoni*	Golden-tailed Woodpecker
		Dendropicos namaquus	Bearded Woodpecker
Passeriformes	Alaudidae	*Mirafra africana*	Rufous-naped Lark
	Hirundinidae	*Hirundo rustica*	Barn Swallow

	Dicruridae	*Dicrurus adsimilis*	Fork-tailed Drongo
	Oriolidae	*Oriolus larvatus*	Black-headed Oriole
	Sylviidae	*Turdoides jardineii*	Arrow-marked Babbler
	Pycnonotidae	*Pycnonotus tricolor*	Dark-capped Bulbul
	Sylviidae	*Sylvietta rufescens*	Long-billed Crombec
	Cisticolidae	*Cisticola juncidis*	Zitting Cisticola
		Cisticola ayresii	Wing-snapping Cisticola
		Cisticola chinianus	Rattling Cisticola
		Prinia subflava	Tawny-flanked Prinia
		Prinia flavicans	Black-chested Prinia
	Muscicapidae	*Bradornis mariquensis*	Marico Flycatcher
	Malaconotidae	*Batis molitor*	Chinspot Batis
	Monarchidae	*Terpsiphone viridis*	African Paradise-Flycatcher
	Motacillidae	*Anthus cinnamomeus*	African Pipit
	Laniidae	*Lanius collaris*	Common Fiscal
		Lanius collurio	Red-backed Shrike
	Malaconotidae	*Laniarius ferrugineus*	Southern Boubou
		Laniarius atrococcineus	Crimson-breasted Shrike
		Dryoscopus cubla	Black-backed Puffback
		Tchagra senegala	Black-crowned Tchagra
		Prionops retzii	Retz's Helmet-Shrike
	Sturnidae	*Acridotheres tristis*	Common Myna
		Cinnyricinclus leucogaster	Violet-backed Starling
		Onychognathus morio	Red-winged Starling
	Ploceidae	*Plocepasser mahali*	White-browed Sparrow-Weaver
	Estrildidae	*Uraeginthus angolensis*	Blue Waxbill

8.1.4 Mammals

A total of seven mammal species were recorded during the site investigation, including:

- four mice;
- one primate; and
- two bovids.

Table 18: Mammal species recorded in the study area			
Phylum: Vertebrata; Class: Mammalia			
ORDER	FAMILY	BIOLOGICAL NAME	ENGLISH NAME
Primates	Cercopithecidae	*Papio ursinus*	Chacma Baboon
Rodentia	Muridae	*Mus minutoides*	Pygmy Mouse
		Mastomys coucha	Multimammate Mouse
		Saccostomys campestris	Pouched Mouse
		Aethomys namaquensis	Namaqua Rock Mouse
Artiodactyla	Bovidae	*Tragelaphus strepsiceros*	Kudu
		Sylvicapra grimmia	Common Duiker

All of the mammals found to occur in the study area are commonly found in both grassland and savanna biomes and are not particularly limited in habitat or distribution.

8.2 Red Data Fauna Species

The following probabilities were estimated for Red Data fauna species (Status = Red Data Status, HR = Habitat Requirements, HS = Habitat Status, HL = Habitat Linkage).

8.2.1 Red Data Invertebrates

One butterfly is considered a potential inhabitant of the study area; a high likelihood of occurrence is estimated for the study area. This species is known to occur in grasslands between Stoffberg and Roossenekal. Suitable habitat for this species is present in the Pristine Mountain Grassland- and Degraded Mountain Grassland variations. Although not observed during the field survey, it still estimated to have a high likelihood of occurrence for the study area.

Table 19: Red Data Invertebrate Assessment for the study area

SPECIES DETAILS			HABITAT			RESULT
Biological Name	English Name	Status	HR	HS	HL	Likelihood
Aloeides rossouwi	Rossouw's Copper	VU	h	h	h	high

8.2.2 Herpetofauna

The Southern African Python is considered a potential inhabitant of the study area; a high likelihood of occurrence is estimated for the study area. This species is known to occur in the study area and highly suitable habitat for this species is present throughout the savanna and riparian vegetation. Hence a high likelihood of occurrence is estimated for this species.

Table 20: Red Data Herpetofauna Assessment for the study area

SPECIES DETAILS			HABITAT			RESULT
Biological Name	English Name	Status	HR	HS	HL	Likelihood
Python natalensis	Southern African Python	VU	h	h	h	high

8.2.3 Avifauna

Eleven Red Data bird species are considered highly likely inhabitants of the study area. Of the 61 bird species observed in the study area, only one species are considered to be of concern. The Lesser Kestrel (*Falco naumanni*) is listed as globally Vulnerable and is confined to lightly wooded and open habitats. This species generally avoids foraging in transformed areas; they do not breed in the Subregion and only utilizes Southern African grasslands as foraging habitat. It is estimated that the population in South Africa may have decreased by 50% between 1960 and 1990; the decline being attributed to habitat loss as a result of agriculture, afforestation and urbanization.

Most of these species are grassland and riparian associated, but some are general savanna species and could utilize the untransformed savanna habitat in the study area.

Table 21: Red Data Bird Assessment for the study area						
SPECIES DETAILS			HABITAT			RESULT
Biological Name	English Name	Status	HR	HS	HL	Likelihood
Botaurus stellaris	Eurasian Bittern	CR	m	m	m	medium
Ciconia nigra	Black Stork	NT	m	m	m	medium
Leptoptilos crumeniferus	Marabou Stork	NT	l	m	m	medium
Mycteria ibis	Yellow-billed Stork	NT	m	m	m	medium
Geronticus calvus	Southern Bald Ibis	VU	h	h	h	high
Phoenicopterus ruber	Greater Flamingo	NT	l	l	l	low
Phoenicopterus minor	Lesser Flamingo	NT	l	l	l	low
Nettapus auritus	African Pygmy-Goose	NT	l	m	l	low
Sagittarius serpentarius	Secretarybird	NT	h	h	h	high
Gyps coprotheres	Cape Vulture	VU	m	h	h	high
Hieraaetus ayresii	Ayres's Hawk-Eagle	NT	m	m	h	medium
Polemaetus bellicosus	Martial Eagle	VU	h	h	h	high
Stephanoaetus coronatus	African Crowned Eagle	NT	h	h	h	high
Circus ranivorus	African Marsh-Harrier	VU	m	m	m	medium
Circus macrourus	Pallid Harrier	NT	m	m	m	medium
Circus maurus	Black Harrier	VU	m	l	l	low
Falco peregrinus	Peregrine Falcon	NT	h	h	h	high
Falco biarmicus	Lanner Falcon	NT	h	h	h	high
Falco naumanni	**Lesser Kestrel**	**VU**	**presence confirmed**			
Grus carunculatus	Wattled Crane	CR	l	m	h	medium
Anthropoides paradisea	Blue Crane	VU	h	h	h	high
Crex crex	Corn Crake	VU	m	m	m	medium
Podica senegalensis	African Finfoot	VU	h	h	h	high
Neotis denhami	Denham's Bustard	VU	m	m	h	medium
Eupodotis barrowii	Barrow's Korhaan	VU	m	m	m	medium
Rostratula benghalensis	Greater Painted-snipe	NT	m	m	m	medium
Vanellus melanopterus	Black-winged Lapwing	NT	h	h	m	high
Tyto capensis	African Grass-Owl	VU	l	m	m	medium
Alcedo semitorquata	Half-collared Kingfisher	NT	h	h	h	high
Mirafra cheniana	Melodious Lark	NT	m	m	l	medium
Heteromirafra ruddi	Rudd's Lark	CR	l	m	h	medium
Buphagus erythrorhynchus	Red-billed Oxpecker	NT	m	l	l	low

8.2.4 Mammals

A total of sixteen Red Data mammal species that could potentially occur in the region of the study area have a high likelihood of occurring within the study area.

Table 22: Red Data Mammal Assessment for the study area						
SPECIES DETAILS			HABITAT			RESULT
Biological Name	English Name	Status	HR	HS	HL	Likelihood
Amblysomus hottentotus	Hottentot's Golden Mole	DD	m	m	m	medium
Atelerix frontalis	South African Hedgehog	NT	h	h	h	high
Crocidura cyanea	Reddish-grey Musk Shrew	DD	h	h	h	high
Crocidura fuscomurina	Tiny Musk Shrew	DD	h	h	h	high
Crocidura hirta	Lesser Red Musk Shrew	DD	h	h	h	high
Crocidura mariquensis	Swamp Musk Shrew	DD	h	h	h	high
Crocidura silacea	Lesser Grey-brown Musk Shrew	DD	h	h	h	high
Dasymys incomtus	Water Rat	NT	h	m	m	medium
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	DD	h	h	h	high
Graphiurus platyops	Rock Dormouse	DD	h	h	h	high
Hipposideros caffer	Sundevall's Leaf-nosed Bat	DD	m	h	m	medium
Hyaena brunnea	Brown Hyaena	NT	m	m	m	medium
Lemniscomys rosalia	Single-striped Mouse	DD	h	h	h	high
Leptailurus serval	Serval	NT	h	h	h	high
Lutra maculicollis	Spotted-necked Otter	NT	m	m	m	medium
Manis temminckii	Pangolin	VU	h	m	h	high
Mellivora capensis	Honey Badger	NT	h	h	h	high
Miniopterus schreibersii	Schreiber's Long-fingered Bat	NT	m	h	h	high
Myosorex cafer	Dark-footed Forest Shrew	DD	h	h	h	high
Myosorex varius	Forest Shrew	DD	m	m	m	medium
Myotis tricolor	Temminck's Hairy Bat	NT	m	h	m	medium
Myotis welwitschii	Welwitsch's Hairy Bat	NT	h	h	h	high
Poecilogale albinucha	African Weasel	DD	m	m	m	medium
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	NT	m	h	m	medium
Rhinolophus darlingi	Darling's Horseshoe Bat	NT	m	h	m	medium
Rhinolophus hildebrantii	Hildebrant's Horseshoe Bat	NT	m	h	m	medium
Rhynchogale melleri	Meller's Mongoose	DD	m	m	m	medium
Suncus infinitesimus	Least Dwarf Shrew	DD	m	m	m	medium
Suncus lixus	Greater Dwarf Shrew	DD	m	m	m	medium
Suncus varilla	Lesser Dwarf Shrew	DD	m	m	m	medium
Tatera leucogaster	Bushveld Gerbil	DD	h	h	h	high

All of the red data mammals of the area that are regarded as highly likely inhabitants are either listed as data deficient (DD) or Near Threatened (NT), with the exception of the Pangolin (VU). Most of these species are small rodents and not much is known about their biology or habitat requirements.

In general, the diverse ecological elements, largely untransformed nature of the study area and high linkage of the study area to other ecologically intact habitats, has led to the estimation that almost half of the red data animals listed for the area, are considered highly likely inhabitants.

8.3 Peripheral Information

8.3.1 Invertebrates

Taxonomic groups surveyed include:

- Beetles
- Scorpions
- Butterflies

8.3.2 Herpetofauna

None of the species recorded were considered for capture and relocation.

No release site was identified.

No buffer zones were identified

No domestic animal restrictions plan is proposed.

8.3.3 Birds

The closes Important Birding Areas are Velorenvlei NR and Dullstroom areas to the South. These areas should not be influenced by the proposed project.

No buffer zones were identified.

The Common (Indian) Myna was recorded on the site.

No alien species eradication and control plan is recommended.

No domestic animal restrictions plan is recommended. National and provincial legislation regarding the control of domestic animals applies.

8.3.4 Mammals

No species were identified that should be considered for relocation.

No buffer zones were identified.

None of the species recorded were considered for capture and relocation.

No release site was identified.

No domestic animal restrictions plan is recommended. National and provincial legislation regarding the control of domestic animals applies.

8.4 Discussion

Ecologically, the study area is divided into four distinct ecological regions, namely:

- Transformed habitats;
- Woodland variations;
- Riparian habitats; and
- Grassland variations.

Transformed habitats provide little ecological or faunal habitat and are considered to be of low faunal sensitivity.

Woodland variations, forming part of the Sekhukhune Mountain Bushveld regional vegetation type, exhibit a medium faunal sensitivity. Available habitat is untransformed and potential habitat for red data species are present throughout. However, the Sekhukhune Mountain Bushveld is not threatened; 86% remains untransformed, and this part of the study area is therefore not unique in terms of habitat characteristics.

Riparian habitats are generally regarded as highly sensitive in terms of faunal attributes and Red Data probabilities. Furthermore, wetlands are fairly limited in Mpumalanga Province, particularly relatively untransformed riparian woodlands such as these areas. Due to the linear nature of the rivers, impacts on the rivers and tributaries in the study area will in all likelihood also influence faunal habitat further downstream.

Grassland variations in the study area forms part of the Rand Highveld Grassland regional vegetation type and are considered to be of high sensitivity where untransformed. A moderate faunal sensitivity is attributed to the degraded portions as it is considered likely that these portions could be rehabilitated to a pristine condition. Furthermore, the Rand Highveld Grassland is of high sensitivity because of its endangered nature; only 58% remains untransformed and only 1% is protected.

The nature of the project makes mitigation of likely impacts extremely difficult. All sensitive areas would ideally be protected, but the effects are, in this particular case, unavoidable and would sterilize the entire project.

A total of 65 Red Data fauna species are considered likely to occur in the study area, taking availability of habitat, the current status of habitat and the status of surrounding habitat types into consideration.

Table 23: Summary of Red Data Probabilities

Likelihood	Total	Percentage
Low	5	8%
Medium	30	46%
High	29	45%
Confirmed	1	2%

8.5 Faunal Sensitivities

Faunal sensitivities are based on the assessment of the following habitat attributes:

- Biophysical habitat status
- Red Data probabilities
- Ecological linkages

The association of faunal species and assemblages with the floristic and physical environment has been proven. The assessment and discussion of faunal sensitivity issues are therefore based on the distribution of floristic communities and variations.

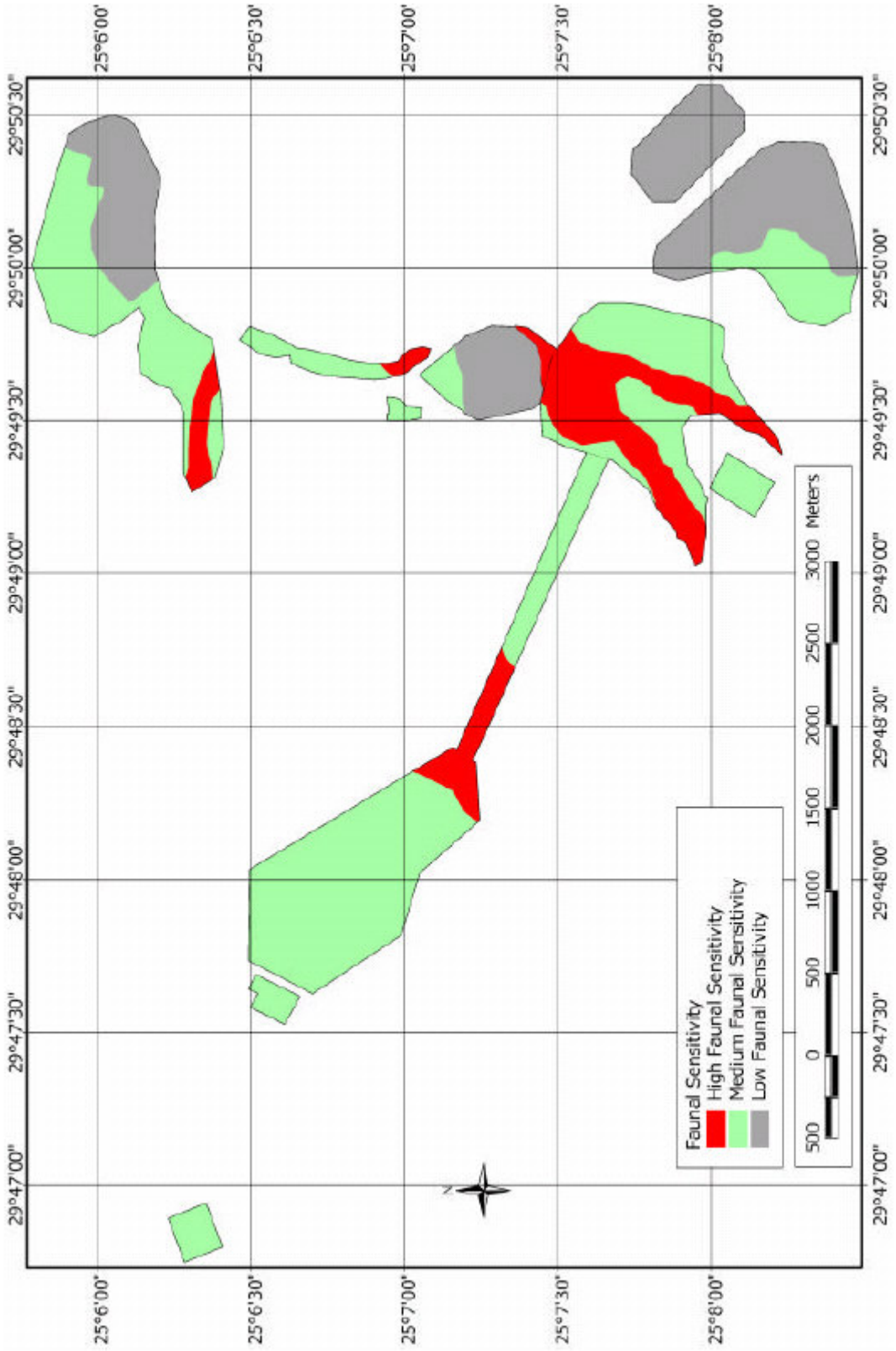
The calculation of faunal sensitivities are presented in Table 23 and visually presented in Figure 7.

Table 24: Faunal Habitat Sensitivities for the study area

Community	Status	Linkage	RD Likelihood	Average	SENSITIVITY CLASS
Degraded Mountain Grassland	4	6	8	60%	**Medium**
Pristine Mountain Grassland	9	8	9	87%	**High**
Escarpment Variation	10	10	5	83%	**High**
Mountain Woodland	7	7	5	63%	**Medium**
Acacia Woodland	6	8	4	60%	**Medium**
Rocky Outcrop Woodland	4	3	4	37%	**Medium**
Riparian Woodland	8	9	9	87%	**High**
Transformed Areas	1	1	1	10%	**Low**

Habitat types that are pristine are regarded as high quality faunal habitat and the likelihood of Red Data species occurring within these areas is generally high. These habitat types are often associated with environmental features that are also regarded as sensitive, such as riparian zones, ridges, mountains, etc.

Figure 7: Faunal Sensitivities for the study area.



9 ECOLOGICAL INTERPRETATION

Respective results of the floristic and faunal sensitivity analysis are combined to present an overview of the ecological sensitivity of the study area.

In order to present the reader with an indication of the ecological sensitivity of the respective communities, the highest sensitivity for each ecological unit is selected as being representative of the ecological sensitivity of the specific ecological unit. Results are determined in Table 25 and visually presented in Figure 8.

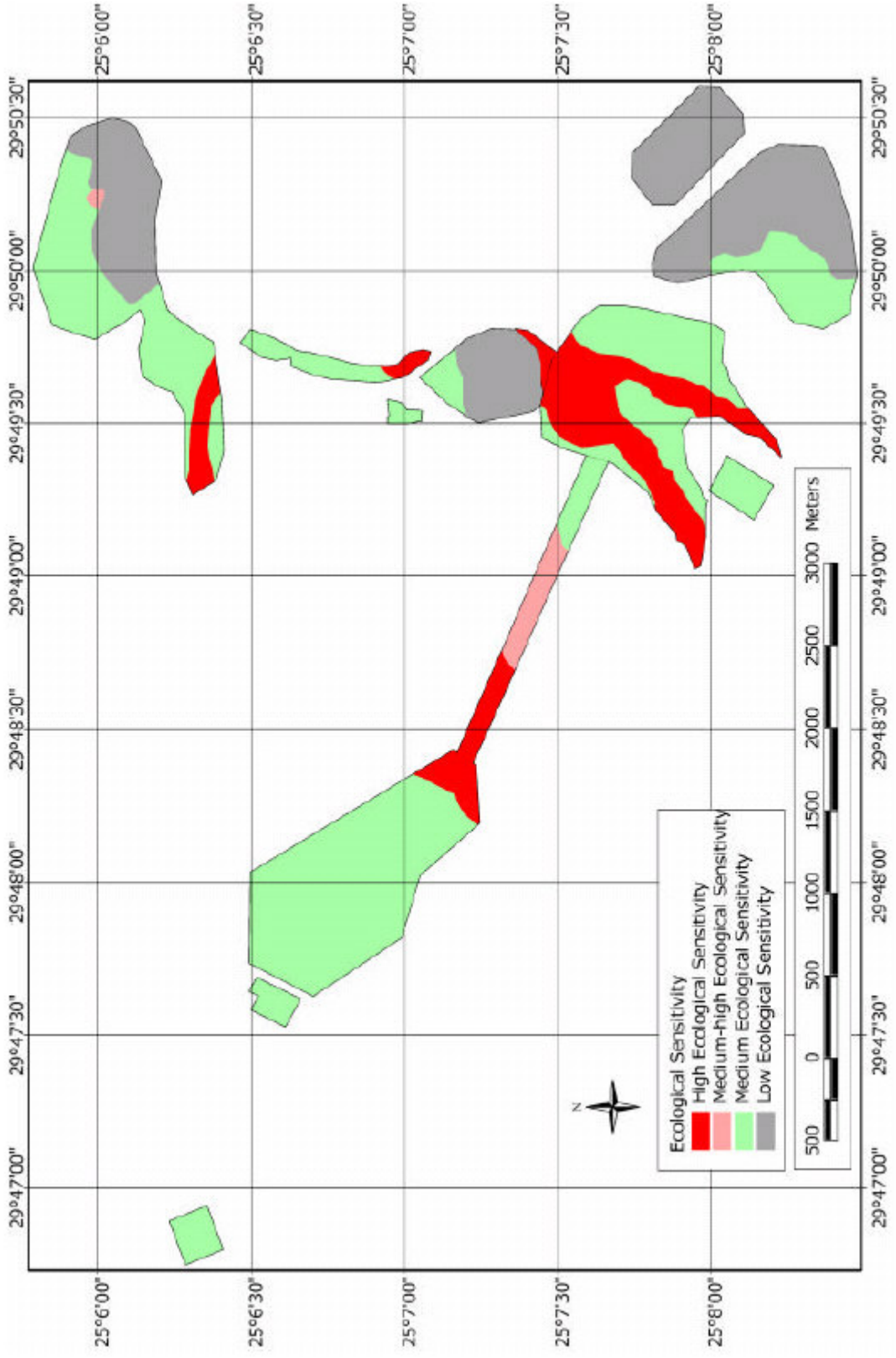
Table 25: Ecological Sensitivity of the study area

Community	Floristic	Faunal	Ecological
Degraded Mountain Grassland	MEDIUM-LOW	MEDIUM	**MEDIUM**
Pristine Mountain Grassland	HIGH	HIGH	**HIGH**
Escarpment Variation	HIGH	HIGH	**HIGH**
Mountain Woodland	MEDIUM-HIGH	MEDIUM	**MEDIUM-HIGH**
Acacia Woodland	MEDIUM-LOW	MEDIUM	**MEDIUM**
Rocky Outcrop Woodland	MEDIUM-HIGH	MEDIUM	**MEDIUM-HIGH**
Riparian Woodland	HIGH	HIGH	**HIGH**
Transformed Areas	LOW	LOW	**LOW**

Combined results from the floristic and faunal sensitivity analysis indicate the medium-high and high sensitivity of the areas associated with wetland regimes and high slopes. The status of these areas is pristine and are therefore considered suitable habitat for a variety of Red Data species. Fortunately these areas are relative small in size, are fairly well represented in the general region and are therefore not regarded as unique. In order to consider the impact of the proposed development these areas are selected to represent the 'worst-case-scenario' and will be evaluated in the following section.

The largest extent of the study area exhibit medium and low ecological attributes and the proposed activity is not expected to result in significant impacts in these areas. These areas will be excluded from the impact evaluation as they will moderate the extent of impacts on the sensitive environments by using the selected method of impact assessment.

Figure 8: Ecological sensitivity of the study area



10 IMPACT EVALUATION

Results of the floristic and faunal investigations are incorporated in order to present an overview of the impacts on the ecological environment (see Section 9). Only ecological units that exhibit medium-high and high sensitivities are considered in this section. The omission of low sensitivity areas is due to the proposed development not representing any significant threat to these ecological units.

The preferred method of impact evaluation required that impacts be considered separately for the entire area (sensitive environments) and not for the respective ecological units.

The following sections are presented to describe the nature, extent and potential mitigation of identified impacts on the biological environment. A summary of these discussions are presented in Section 10.4 in the form of an Impact Rating Matrix for each identified impact.

10.1 Nature of Impacts

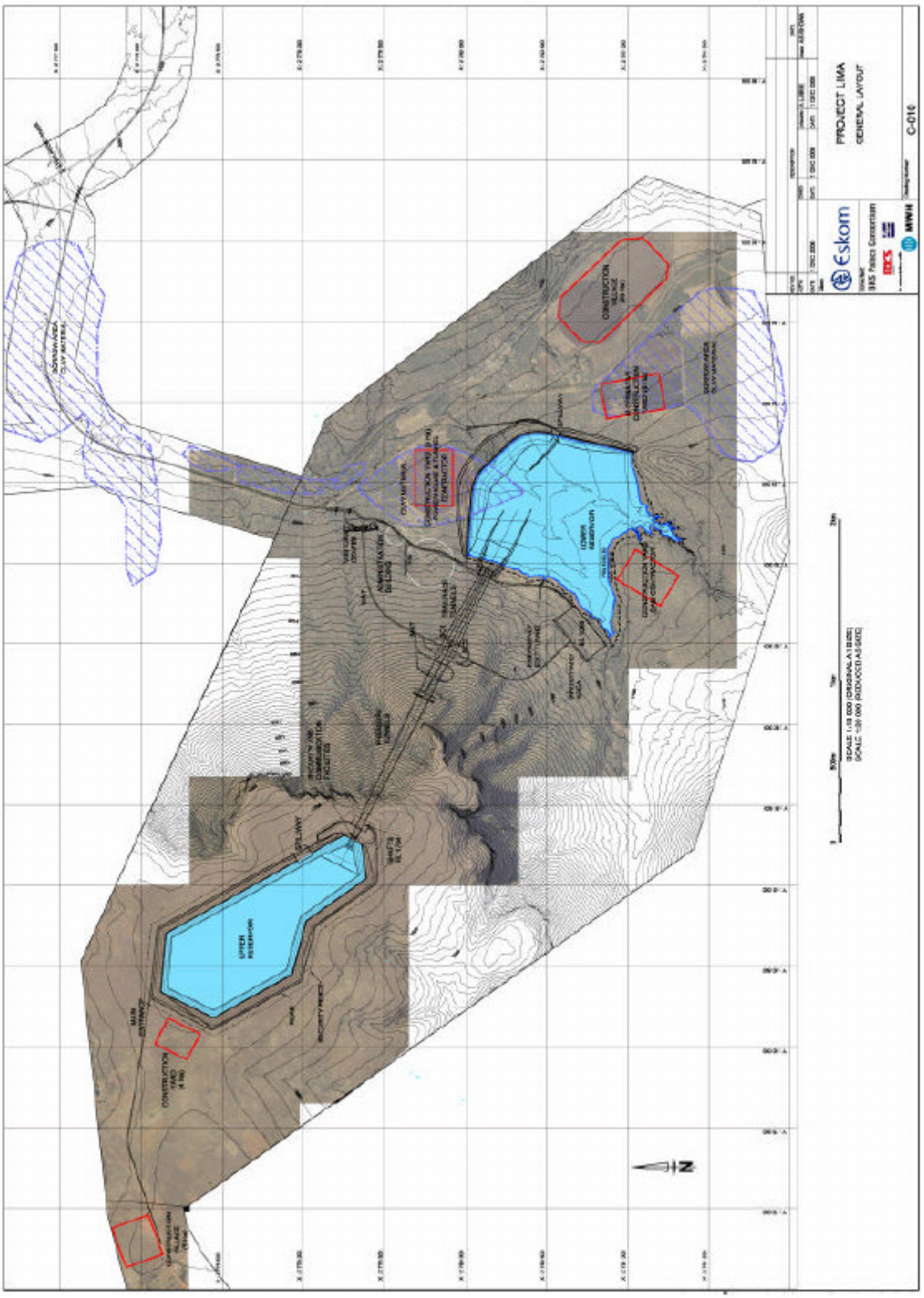
No impacts were identified that could lead to a potentially beneficial impact on the ecology of the study area since the proposed development is largely destructive to the natural environment. The following impacts/ issues were identified that could potentially affect the ecology of the study area adversely:

- Artificial increase in the biodiversity of the study area as a result of the establishment of atypical habitat;
- destruction of threatened species and habitat;
- destruction of sensitive habitat types (outcrops, riparian fringes, non-perennial streams, river, etc.) and areas of high biodiversity;
- destruction of pristine habitat; and
- impacts on surrounding natural habitat and species.

A proposed layout plan is presented in Figure 8.

The Precautionary Principal has been applied throughout this assessment

Figure 8: Layout plan for the proposed development (Bohlweki Environmental)



10.1.1 Artificial increase in habitat diversity & biodiversity

The Riparian Woodland Ecological unit is of particular concern. Artificial habitat types that will be introduced during this development include areas of open and standing water, infrastructure, transformed habitat and rehabilitated habitat.

Dams that are constructed of on both the upper and lower sections will serve as habitat for aquatic biota that does not currently inhabit the area; large tracts of open water do not exist in the study area. Faunal disciplines that will likely inhabit these areas of open water include aquatic birds, aquatic invertebrates, fishes and amphibians, leading to an increase in the general biodiversity of the region. This increase in biodiversity is artificial and might lead to long-term impacts on the current endemic fauna and flora inhabitants of the region.

This impact might be interpreted as a positive impact as it is likely to lead to an increase in habitat and biodiversity. A high number of animals that inhabit an area are generally considered an indication of effective ecological functioning and a positive and attractive ecological attribute. However, by allowing animals to inhabit areas that were not previously suitable for them, the effect on the current inhabitants is likely to be detrimental as a result of increased competition.

Furthermore, as a result of 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 have developed separate gene structures as a result of habitat selection and geographical separation and the introduction of animals that might be genetically similar to the endemic species (even the same species) might lead to different genetic selection structures, eventually affecting the genetic structure of current populations.

Also of particular concern are invasive aquatic plants that are associated with areas of open water, particularly plants that will invade from upstream areas.

10.1.2 Destruction of threatened species & habitat

Ecological units that are considered threatened by this impact include Pristine Mountain Grassland, Escarpment Variation and Mountain Woodland.

The loss of threatened species or habitat that is considered suitable for these species is a significant impact on the biodiversity of a region. These species, in most cases, do not contribute significantly to the sheer numbers of communities or assemblages on a local or regional scale as there are generally few of them, but they are extremely important in terms of the biodiversity of an area and high ecological value is placed on the presence of such species in an area.

Threatened species are particularly sensitive to changes in their environment, having adapted to 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 impacts resulting from the proposed activity will lead to changes that will affect the area, resulting in deterioration of existing habitat. Effects of this impact are usually permanent and recovery is generally not possible. Vegetation contained within the study area is not considered particularly suitable for Red Data flora species; a medium probability is attributed for the potential occurrence of these species in the larger extent of the study area. However, available habitat is considered highly suitable for the presence of Red Data fauna species.

The Rand Highveld Grassland (VEGMAP), representing part of the upper section, is attributed an Endangered status and represents a threatened ecosystem.

10.1.3 Destruction of sensitive habitat types and areas of high biodiversity

Ecological units that are considered threatened by this impact include Pristine Mountain Grassland, Escarpment Variation, Mountain Woodland, Rocky Outcrop Woodland and Riparian Woodland.

A number of habitat types encountered in the study area are considered extremely sensitive. These include the riparian zones, ridges, mountains and cliff areas. These areas are however frequently encountered within the general region and are not considered unique. It is also emphasised that the lower section is situated within the Sekhukhune Centre of Endemism.

The flora and fauna composition of these areas is typically unique and is also not frequently encountered. A high conservation value is attributed to these communities as they contribute significantly to the biodiversity of a region. Furthermore, such 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 result in fragmentation and isolation of existing ecological units, affecting the migration potential of some fauna species adversely, pollinator species in particular.

10.1.4 Destruction of pristine habitat types

Ecological units that are considered threatened by this impact include Pristine Mountain Grassland, Escarpment Variation, Mountain Woodland and Riparian Woodland.

The largest extent of the study area comprises natural habitat and is furthermore considered pristine in selected cases. All habitat types that are present within the study area are relatively frequently encountered in the general region and no single habitat type is considered unique.

10.1.5 Impacts on surrounding natural habitat and species

A possibility exists that surrounding areas and species present in surrounding areas could be affected by impacts resulting from construction activities. These impacts could include all of the above impacts, depending on the nature and status of the surrounding habitat and species.

10.2 Significance of Impacts

The significance of impacts is determined by a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.

10.2.1 Artificial increase in habitat diversity & biodiversity

This impact is considered highly significant as it will result in permanent and unavoidable changes to the physical attributes of the receiving environment. While the extent and intensity is not expected to be particularly high, the effects are expected to be permanent. Furthermore, the likelihood of these effects occurring is definitive.

Water resources are generally quickly inhabited by aquatic species, particularly when a constant flow of water will import species from upstream areas. The proliferation of invasive aquatic in riparian areas is an aspect of particular concern. Standing water usually provide suitable habitat for a number of invasive species. The spread of these species to downstream areas should be prevented at all costs.

Artificial habitat created as a result of infrastructure is not considered particularly significant.

10.2.2 Destruction of threatened species & habitat

Surface changes within areas that are regarded as sensitive or that could act as suitable habitat for threatened flora and fauna species could result in the loss of biophysical and biological attributes. These effects are mostly permanent.

These areas are fortunately not unique in the region, but the impacts are still regarded as highly significant. Rehabilitation will play an important part as surface impacts leads to impacts such as proliferation of weeds and invasive plant species and erosion in areas of high slopes.

10.2.3 Destruction of sensitive habitat types and areas of high biodiversity

Surface changes within areas that are regarded as sensitive or that could act as suitable habitat for threatened flora and fauna species could result in the loss of biophysical and biological attributes. These effects are mostly permanent.

These areas are fortunately not unique in the region, but the impacts are still regarded as highly significant. Rehabilitation will play an important part as surface impacts leads to impacts such as proliferation of weeds and invasive plant species and erosion in areas of high slopes.

10.2.4 Destruction of pristine habitat types

Surface changes within areas that are regarded as sensitive or that could act as suitable habitat for threatened flora and fauna species could result in the loss of biophysical and biological attributes. These effects are mostly permanent.

These areas are fortunately not unique in the region, but the impacts are still regarded as highly significant. Rehabilitation will play an important part as surface impacts leads to impacts such as proliferation of weeds and invasive plant species and erosion in areas of high slopes.

10.2.5 Impacts on surrounding natural habitat and species

All surrounding natural habitat is likely to be affected by the proposed development. Of particular importance are the riparian areas and areas of high slopes. This impact is most significant during the constructional phase as a result of human activities and movement. It is less significant during the operational phase and includes some long-term impacts such as invasive species spreading from the receiving environment and erosion affecting nearby areas.

10.3 Mitigation of Impacts

The suitability and feasibility of all proposed mitigation measures are included in the assessment of significant impacts. This is achieved through the comparison of the significance of the impact before and after the proposed mitigation measure is implemented.

10.3.1 Artificial increase in habitat diversity & biodiversity

Moving the area of impact to another area will not prevent the impact from occurring as it is associated with the construction and not with the habitat attributes. The successful implementation of mitigation measures will only allow for limited mitigation as these impacts can, to a large extent, not be avoided.

The implementation of a bio-monitoring programme is recommended; the objectives of which should be to monitor the increase or changes in species diversity and recommend pertinent management actions in order to control any adverse impacts on the endemic plants and animals within as well as downstream of the receiving environment.

10.3.2 Destruction of threatened species & habitat

Moving the causing activities to another area will not limit or prevent this impact from occurring as surrounding areas are similar in attributes and ecological sensitivity. Mitigation measures will allow only for limited control over negative impacts as the impacts are unavoidable.

Site specific investigations should be conducted prior to construction activities starting in order to identify species that could potentially be removed and used for rehabilitation or landscaping purposes. Rehabilitation of all surface disturbances is considered critical. Every effort should be made to restore surface conditions to the original condition. The use of indigenous plants is recommended and all rehabilitation areas should be included in a bio-monitoring programme to monitor and control the spread of unwanted species.

10.3.3 Destruction of sensitive habitat types and areas of high biodiversity

Moving the causing activities to another area will not limit or prevent this impact from occurring as surrounding areas are similar in attributes and ecological sensitivity. Mitigation measures will allow only for limited control over negative impacts as the impacts are unavoidable.

Site specific investigations should be conducted prior to construction activities starting in order to identify species that could potentially be removed and used for rehabilitation or landscaping purposes. Rehabilitation of all surface disturbances is considered critical. Every effort should be made to restore surface conditions to what it was prior to construction. The use of indigenous plants is recommended and all rehabilitation areas should be included in a bio-monitoring programme to monitor and control the spread of unwanted species.

10.3.4 Destruction of pristine habitat types

Moving the causing activities to another area will not limit or prevent this impact from occurring as surrounding areas are similar in attributes and ecological sensitivity. Mitigation measures will allow only for limited control over negative impacts as the impacts are unavoidable.

Site specific investigations should be conducted prior to construction activities starting in order to identify species that could potentially be removed and used for rehabilitation or landscaping purposes. Rehabilitation of all surface disturbances is considered critical. Every effort should be made to restore surface conditions to the original condition. The use of indigenous plants is recommended and all rehabilitation areas should be included in a bio-monitoring programme to monitor and control the spread of unwanted species.

10.3.5 Impacts on surrounding natural habitat and species

Moving the causing activities to another area will not limit or prevent this impact from occurring as surrounding areas are similar in attributes and ecological sensitivity. Mitigation measures will allow only for limited control over negative impacts as the impacts are unavoidable.

Intensive monitoring of all surrounding areas during the construction period as well as during the operational phase is recommended. Pertinent remedial actions can be taken before the impact reaches high levels. The movement of personnel and vehicles should be limited to the receiving environment.

10.4 Summary

Table 26: Rating Matrix for Ecology Impacts	
Impact - Increase in habitat diversity & biodiversity	
Criteria	**Rating**
Extent	2
Duration	4
Intensity	2
Probability of occurrence	4
Total	**12**
This is rated as a **High** Negative Impact before the implementation of mitigation and management measures	
Mitigation and Management measures	
Implementation of bio-monitoring programmes	
Adaptive management & conservation strategies	
Rehabilitation and control programmes	
Criteria	**Rating**
Extent	1
Duration	4
Intensity	2
Probability of occurrence	2
Total	**9**
This is rated as a **Medium** Negative Impact after the successful implementation of mitigation and management measures	

Table 27: Rating Matrix for Ecology Impacts	
Impact - Destruction of threatened species & habitat	
Criteria	**Rating**
Extent	2
Duration	4
Intensity	3
Probability of occurrence	2
Total	**11**
This is rated as a **High** Negative Impact before the implementation of mitigation and management measures	
Mitigation and Management measures	
Site specific surveys prior to development	
Removal and translocation of sensitive flora species	
Use of plants in landscaping	
Confine impacts to development area	
Implementation of site specific rehabilitation programmes	
Criteria	**Rating**
Extent	1
Duration	3
Intensity	2
Probability of occurrence	1
Total	**7**
This is rated as a **Medium** Negative Impact after the successful implementation of mitigation and management measures	

Table 28: Rating Matrix for Ecology Impacts	
Impact - Destruction of sensitive habitat types and areas of high biodiversity	
Criteria	**Rating**
Extent	3
Duration	4
Intensity	2
Probability of occurrence	2
Total	**11**
This is rated as a **High** Negative Impact before the implementation of mitigation and management measures	
Mitigation and Management measures	
Confine impacts to development area	
Include sensitive areas as conservation areas	
Limit movement of vehicles and personnel through areas of sensitivity	
Implementation of site specific rehabilitation programmes	
Implementation of bio-monitoring programme	
Criteria	**Rating**
Extent	1
Duration	3
Intensity	2
Probability of occurrence	1
Total	**7**
This is rated as a **Medium** Negative Impact after the successful implementation of mitigation and management measures	

Table 29: Rating Matrix for Ecology Impacts	
Impact - Destruction of pristine habitat types	
Criteria	**Rating**
Extent	3
Duration	4
Intensity	2
Probability of occurrence	2
Total	**11**
This is rated as a **High** Negative Impact before the implementation of mitigation and management measures	
Mitigation and Management measures	
Confine impacts to development area	
Implementation of site specific rehabilitation programmes	
Limit movement of vehicles and personnel through areas of sensitivity	
Implementation of bio-monitoring programme	
Criteria	**Rating**
Extent	1
Duration	2
Intensity	2
Probability of occurrence	1
Total	**6**
This is rated as a **Low** Negative Impact after the successful implementation of mitigation and management measures	

Table 30: Rating Matrix for Ecology Impacts	
Impact - Impacts on surrounding natural habitat and species	
Criteria	**Rating**
Extent	2
Duration	3
Intensity	2
Probability of occurrence	2
Total	**9**
This is rated as a **Medium** Negative Impact before the implementation of mitigation and management measures	
Mitigation and Management measures	
Confine impacts to development area	
Limit movement of vehicles and personnel through areas of sensitivity and within receiving environment	
Awareness programmes for construction and operational personnel	
Implementation of site specific rehabilitation programmes	
Implementation of bio-monitoring programme	
Criteria	**Rating**
Extent	1
Duration	2
Intensity	2
Probability of occurrence	1
Total	**6**
This is rated as a **Low** Negative Impact after the successful implementation of mitigation and management measures	

10.5 Discussion

The nature of the proposed development makes the complete mitigation of likely impacts extremely difficult; the exclusion of high sensitivity areas will in effect sterilize the entire project and is therefore not considered a viable option.

Impacts resulting from the development will result in transformation of large tracts of natural and sensitive environment and will be permanent. These impacts are therefore significant and cannot be mitigated effectively.

However, impacts will mostly be localised and site specific and can therefore be contained within a relative small area. Constant environmental monitoring will play a significant role in the timely identification of potential significant effects resulting from construction activities while periodic bio-monitoring will highlight effects such as species changes and infestation by invasive species.

It is therefore the conclusion of this report that, with the successful implementation of environmental and bio-monitoring programmes, the resultant loss in biodiversity attributes and habitat is acceptable and within reason.

11 ROAD INFRASTRUCTURE

11.1 General

There are four different types of permanent roads on this project as well as temporary site roads, namely:

- **Main Access Road:** A permanent access road leading from the existing provincial road R555 to the power house and lower reservoir. There is one existing road-over- river bridge on this access road.
- **Connector Road between Lower and Upper Site:** A connector road between the lower reservoir site and the upper reservoir site. This road will carry light traffic and relatively low traffic volumes will occur on this road section. Depending on which alternative route is finally selected for this road, there could be road-over-river bridges on this road.
- **Upper Site Access Road:** The access road leading from the existing provincial road R579, to the upper reservoir. This road will run through an existing local village. The road will be used by heavy construction vehicles during the implementation phase and also by the local residents. After the completion of the implementation phase, only light vehicles and the local people will be using the road. There are no bridges on this road but there are storm water culverts in the village. A 2,5m paved shoulder is to be provided on the one side of the road for pedestrians.
- **Permanent Site Roads:** Permanent roads on the reservoir sites are to be permanently paved and will provide access to the various components of the project such as the visitor centre, the administration building, etc. Small parking areas are included under this road category.
- **Temporary Site Roads:** These roads are to be designed, constructed and maintained by the contractor. The areas where these roads are constructed are to be reinstated afterwards.

Two main options were considered for the road infrastructure as indicated in Figures 9 and 10.

11.2 Discussion

Neither of the two options is considered to represent a significant and obvious impact on the biological environment. The most likely impacts are expected to result in areas of high slopes and riparian zones. Generic construction and management mitigation measures should suffice in preventing adverse impacts. These would include, but not necessarily be limited to:

- Proper contour sloping;
- Erosion control;
- Perpendicular crossing of rivers and streams;
- Confining construction activities and infrastructure to low impact areas; and
- Avoiding unnecessary peripheral impacts.

Figure 9: Option 1 for the road infrastructure (map provided by Bohlweki)

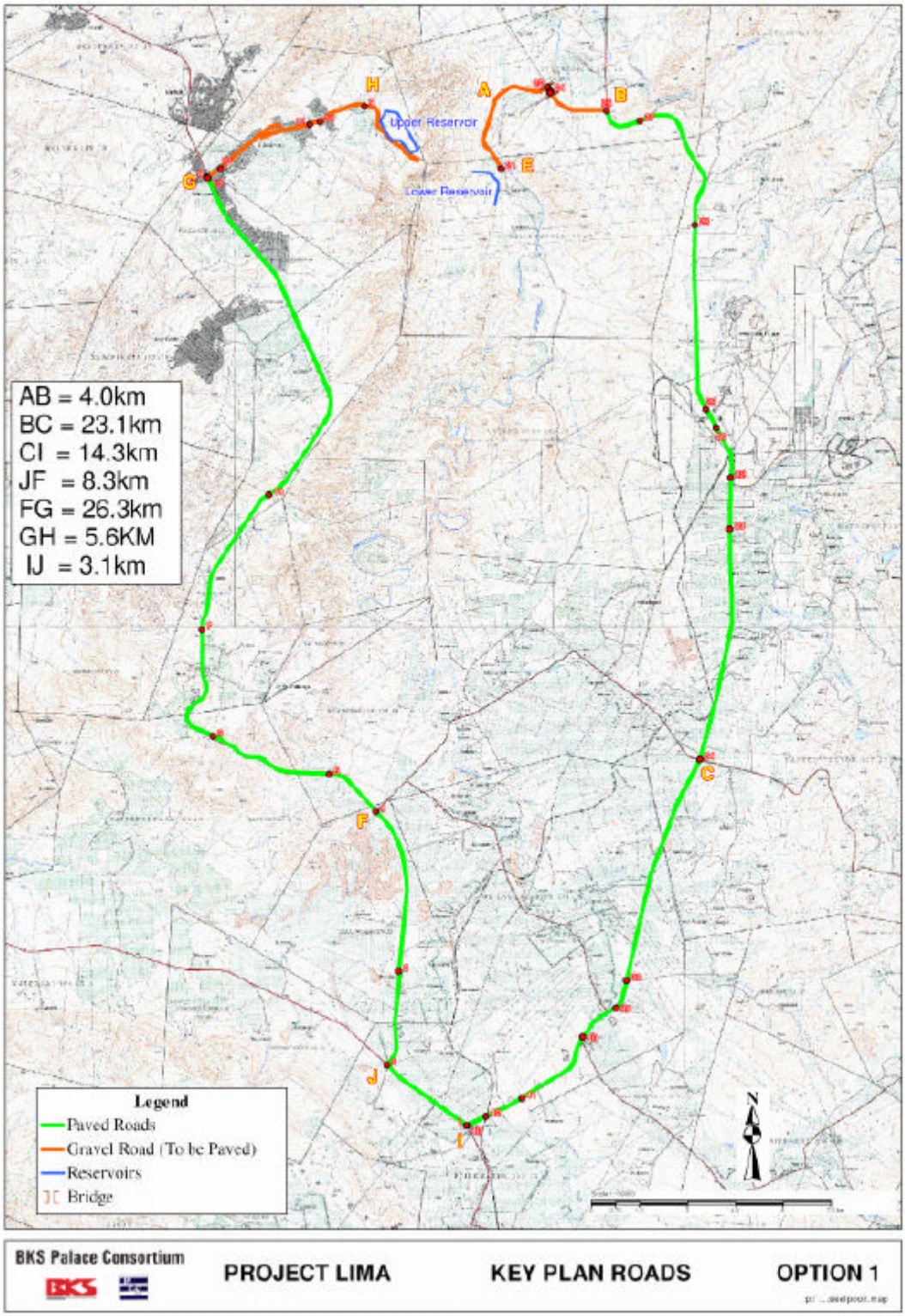
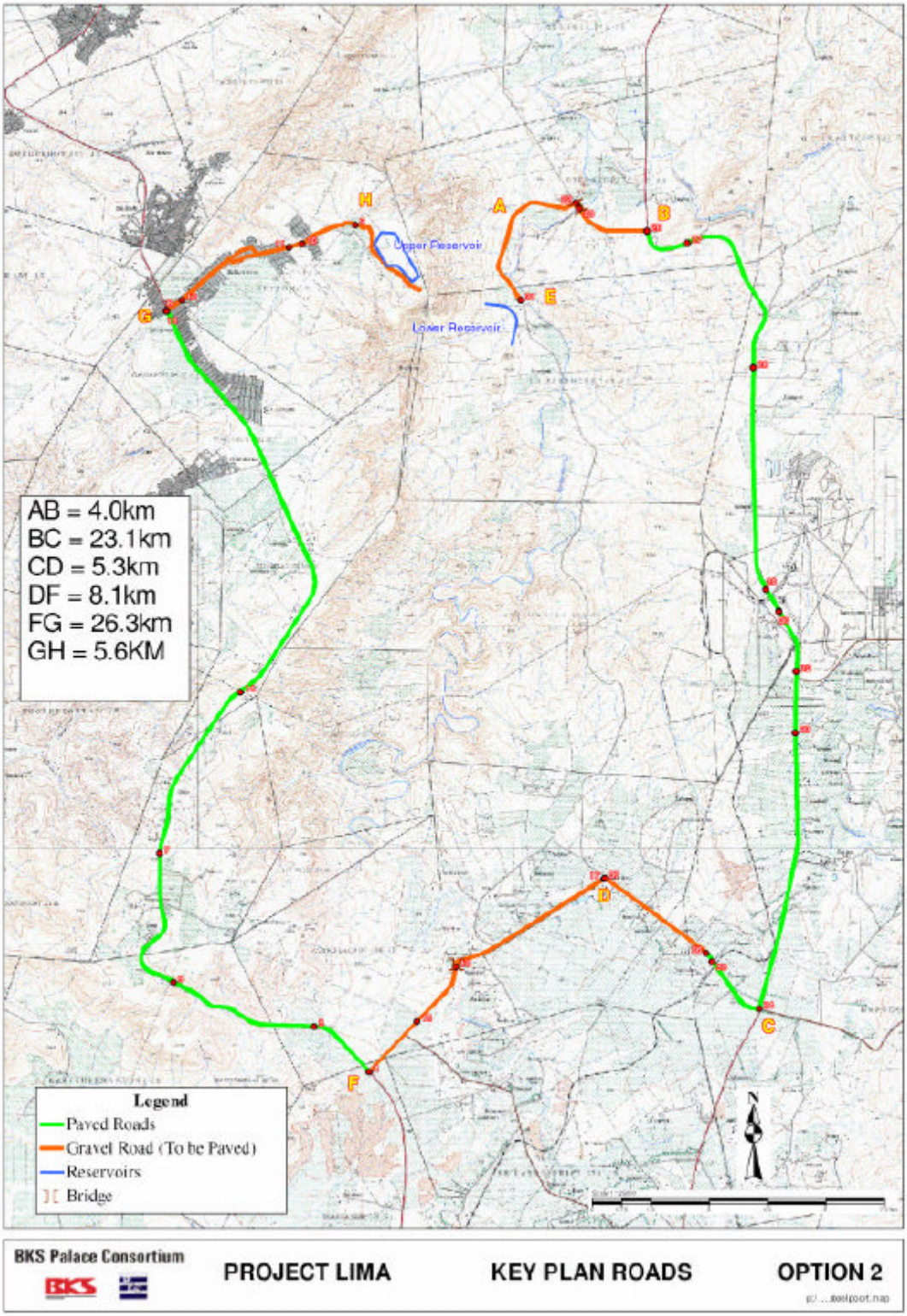


Figure 10: Option 2 for the road infrastructure (map provided by Bohlweki)



APPENDIX 5 REFERENCES

Begon, M., Harper, J.L. & Townsend, C.R. 1990. Ecology. Individuals, Populations and Communities. Blackwell Scientific Publications, USA.

Branch, B. 1998. Field Guide to Snakes and Other Reptiles of Southern Africa. Struik Publishers, Cape Town.

Branch, W.R. 1998. South African Red Data Book – Reptiles and Amphibians. National Scientific Programmes Report No 151.

Carruthers, V. 2001. Frogs and Frogging in Southern Africa. Struik Publishers, Cape Town.

Channing, A. 2001. Amphibians of Central and Southern Africa. Protea Book House, Pretoria.

Chief Directorate Surveys and Mapping. (1981). 1:10,000, Orthophotos 2230DB, Hamakuya. Department: Land Affairs. Republic of South Africa.

Dippenaar-Schoeman, A.S. & Jocque, R. 1997. African Spiders, An Identification Manual. ARC – Plant Protection Institute, Pretoria.

Dippenaar-Schoeman, A.S. 2002. Baboon and Trapdoor Spiders of Southern Africa: An Identification Manual. ARC – Plant Protection Institute, Pretoria.

Department of Environmental Affairs and Tourism, 2001. Environmental Potential Atlas. DEAT, Pretoria.

Endangered Wildlife Trust. 2002. The Biodiversity of South Africa 2002. Indicators, Trends and Human Impacts. Struik Publishers, Cape Town.

Endangered Wildlife Trust. 2004. Red Data Book of the Mammals of South Africa: A Conservation Assessment. CBSG Southern Africa, Parkview, South Africa.

Evans, H.E. 1984. Insect Biology, Addison-Wesley Publishing Company, USA.

Gibbon, G. 2003. Roberts' Multimedia Birds of Southern Africa. Version 3. Southern African Birding cc, Westville.

Henning, S.F. & Henning, G.A. 1989. South African Red Data Book – Butterflies. South African National Scientific Programmes Report No 158.

Holm, E. & Marais, E. 1992. Fruit Chafers of southern Africa. Ekogilde, Hartebeespoort.

Interim Red Data List of South African Plant Species. (2004). Produced by the Threatened Species Programme (TSP) in collaboration with National Botanical Institute (NBI), NORAD and the Department of Environment Affairs and Tourism (DEAT). www.sanbi.org.

IUCN. 2001. IUCN Red List Categories and Criteria. In: Red Data Book of the Mammals of South Africa: A Conservation Assessment. CBSG Southern Africa, Parkview, South Africa.

IUCN 2003. 2003. IUCN Red List of Threatened Species.

Kamffer, D. 2004. Community-level effects of fragmentation of the afromontane grassland in the escarpment region of Mpumalanga, South Africa. MSc. Theses, University of Pretoria, Pretoria.

Knobel, J. 1999. The magnificent natural heritage of South Africa. Sunbird Publishing, South Africa.

Leeming, J. 2003. Scorpions of Southern Africa. Struik Publishers, Cape Town.

Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J. & Loafer, D., eds. 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington DC.

PRECIS Data. 2230DB. (2006). South African National Biodiversity Institute. Email application and response. www.sanbi.org.

Pringle, E.L.L., Henning, G.A. & Ball, J.B. 1994. Pennington's Butterflies of Southern Africa. Struik Publishers, Cape Town.

Picker, M., Griffiths, C. & Weaving, A. 2002. Field Guide to Insects of Southern Africa. Struik Publishers, Cape Town.

Scholtz, C.H. & Holm, E. 1 989. Insects of Southern Africa. Butterworths, Durban.

Skinner, J.D. & Smithers, R.H.N. 1990. The Mammals of the Southern African Subregion. University of Pretoria, Pretoria.

Smithers, R.H.N. 1986. South African Red Data Book – Terrestrial Mammals. South African National Scientific Programmes Report No 125.

Spector, S. 2002. Biogeographic crossroads as priority areas for biodiversity conservation. Conservation Biology 16(6): 1480-1487.

Stuart, C. & Stuart, T. 2000. A field Guide to the Tracks and Signs of Southern and East African Wildlife. Struik Publishers, Cape Town.

Stuart, C. & Stuart, T. 2000. A field Guide to Mammals of Southern Africa. Struik Publishers, Cape Town.

Taylor, P.J. 2000. Bats of Southern Africa. University of Natal Press, South Africa.

Van Rooyen, N. & Bredenkamp, G. 1996. Sour Lowveld Bushveld. In Low A.B. & Rebelo A.G. (eds) *Vegetation of South Africa, Lesotho and Swaziland.* Dept. Environmental Affairs and Tourism, Pretoria.

Van Wyk B. & Gericke N. (2000). *People's Plants.* Briza Publications. Pretoria.

Visser D.J.L. (1984). *The Geology of the Republics of South Africa, Transkei, Bophutatswana, Venda and Ciskei en the Kingdoms of Lesotho and Swaziland. Fourth Edition.* Department of Mineral and Energy Affairs. Republic of South Africa.