BEC Report Reference:	LDW – TCA – 2014/11
Version:	2014.05.07.2
Authority Reference	NA

Proposed Continuous Disposal of Ash at the Tutuka Power Station, Mpumalanga Province©

Biodiversity

Environmental Impact Assessment Phase

compiled by

Bathusi Environmental Consulting

- 082 3765 933
- riaan@bathusi.org
- 012 658 5579
- 086 636 5455

May 2014

I PROJECT DETAILS

Client:	Lidwala Consulting Engineers, on behalf of Eskom Holdings SOC Limited
Report name:	Proposed Continuous Disposal of Ash at the Tutuka Power Station, Mpumalanga Province - Biodiversity Environmental Impact Assessment
Report type:	Strategic Biodiversity Impact Assessment Report
BEC Project number:	LDW – TCA – 2014/11
Report Version:	2014.05.07.2
Compiled by:	Riaan A. J. Robbeson (Pr.Sci.Nat.) - Bathusi Environmental Consulting

II 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).

The following specialists contributed to this report:

Botanical Investigator:	**Riaan Robbeson (Pr.Sci.Nat.)**
Qualification:	M.Sc. (Botany), UP
Affiliation:	South African Council for Natural Scientific Professions
Fields of Expertise:	Botanical Scientist & Ecological Scientist
Registration Number:	*400005/03*
Affiliation:	Grassland Society of Southern Africa
Membership Status:	Professional Member
Membership Number:	*667.08/08*
Faunal Investigator:	**Dewald Kamffer (Pr.Sci.Nat.)**
Qualification:	M.Sc. (Conservation Biology), UP
Affiliation:	South African Council for Natural Scientific Professions
Fields of expertise:	Ecological Scientist & Zoological Scientist
Registration number:	*400204/05*

III RESERVED COPYRIGHT

IV ACRONYMS & ABBREVIATIONS

BEC	Bathusi Environmental Consulting cc
BGIS	Biogeographical Information System
CBD	Convention of Biological Diversity
CITES	Convention on International Trade in Endangered Species
CR	Critically Endangered
DD	Data Deficient
DDD	Data Deficient (Insufficient Information)
DDT	Data Deficient (Taxonomically Problematic)
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
EN	Endangered
ENPAT	Environmental Potential Atlas
EWT	Endangered Wildlife Trust
FMP	Fire Management Plan
ha	hectares (10,000m^2)
HGM	Hydrogeomorphic
I&AP	Interested and Affected Party
IUCN	International Union for Conservation of Nature
km	kilometer
MAP	Mean Annual Precipitation
MBCP	Mpumalanga Biodiversity Conservation Plan
NEMWA	National Environmental Management Waste Act
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisation
NT	Near Threatened
PoC	Probability of Occurrence
POSA	Plants of Southern Africa
Pr.Sci.Nat.	Professional Natural Scientist
SACNASP	South African Council for Natural Scientific Professions
SADC	South African Development Community
SANBI	South African National Botanical Institute
SARCA	South African Reptile Conservation Assessment
VU	Vulnerable

V CONTENTS

VI LIST OF FIGURES

VII LIST OF TABLES

VIII LIST OF GRAPHS

1 EXECUTIVE SUMMARY

Ash generated by Tutuka Power Station is currently being disposed of by means of 'dry ashing' within the premises of the Tutuka Power Station (Tutuka), on Eskom owned land. The existing ashing facility was initially designed for the planned life of operation of Tutuka. Although the station has not reached the end of its life and the ashing operations have not used all the designed land, additional dry ashing facilities are required to be able to continuously ash to 2055 (based on an ash production rate of 4,624 million tonnes per annum).

In sourcing approval of the ashing plans, Eskom requires the licensing of the ash disposal facilities for its continuous operation in terms of the National Environmental Management Waste Act (NEMWA), Act no 59 of 2008. A technically suitable area was initially identified to the south and east of the existing ashing facility; this land was purchased before the commencement of Environmental laws, the Environment Conservation Act in particular. However, in order to allow for a robust environmental process, all land within a radius of 8 km was assessed during the scoping assessment and three (3) technically viable alternatives were identified, all of which are situated around the existing facility. This report will indicate the suitability and inherent biodiversity sensitivities of each of the three alternatives in terms of the planned activity. Since the mandate of this assessment is to consider the ecological/ biodiversity sensitivity of the receiving environment, financial and technical implications are not considered as it is addressed as a separate assessment.

Eskom has appointed Lidwala Consulting Engineers as the Environmental Assessment Practitioner (EAP) for the project. Bathusi Environmental Consulting cc was appointed as independent ecologists to conduct an ecological EIA assessment of the study sites and compile an impact rating report for the terrestrial biodiversity component of this project.

1.1 BIOPHYSICAL ASSESSMENT

The proposed site alternatives are situated within the Lekwa Local Municipality (LLM), which comprises 458,519 ha. The 2007 Biodiversity GIS (BGIS) assessment indicates that approximately 63.8 % of the municipality are currently considered untransformed, but this is regarded an overestimation of the true extent of remaining natural (pristine) grassland habitat in the region. Severity of impacts resulting from, particularly commercial agriculture (maize production), is evident from the mosaical land cover of the immediate region. Extremely limited pristine grassland habitat remains within the greater area, reflecting similar trends on a municipal and provincial level. Pockets of remaining natural grassland are in a moderately advanced state of degradation, while fragmentation and habitat isolation levels are high, ultimately rendering the ecological connectivity low in most parts. Road and railway infrastructure in the region contributed to the high degree of habitat fragmentation and isolation.

Although no formally declared area of conservation is present within the proximity of the study sites, two areas of conservation are present in the general region, including Bloukop and Reitvaal Nature Reserves. These areas are unlikely to be affected directly by the proposed development.

The Environmental Potential Atlas (2001) (ENPAT) database revealed no topographically variable habitat in the surrounds where slopes exceed 8 %. The regional topography is categorised as 'Slightly undulating plains' (ENPAT, 2001). Altitude of the study area varies around 1,600 m above sea level. Geological formations present in the study area include the Vryheid Arenites, Karoo Dolerites and Volksrust Shales and land types conform to the Ea17 land type unit.

The LLM, in which the study area is situated, comprises approximately 20,950 ha of wetlands. Areas of surface water are present within the study sites in the form of non-perennial steams, artificial and natural impoundments

and, in particular, an endorheic pan, moist grassland/ seepages and ephemeral grasslands. Larger rivers and streams that occur near the study sites include the Leeuspruit in the east and the Wolwespruit in the southeast. The study area is situated within the Vaal Primary Catchment area.

The study area comprises three of the Mpumalanga Biodiversity Conservation Plan (MBCP) categories, namely:

- Important & Necessary;
- No Natural Habitat Remaining; and
- Least Concern.

The MBCP (Lötter & Ferrar, 2006) indicates that these categories incorporate increasing options for different types of land use that should be decided by the application of EIA procedures and negotiation between stakeholders. The proposed development relates to 'Major Development Projects' (Land Use Type 15 – Surface Mining, Dumping & Dredging). Extensive parts of the study areas are situated within habitat where major developments should be restricted, according to the MBCP. Specialist studies are therefore required to show that the proposed development will not add to existing cumulative impacts, regional degradation and habitat transformation and the loss of biodiversity on a local or regional scale.

1.2 BOTANICAL ASSESSMENT

The three site alternatives are spatially represented in the Soweto Highveld Grassland ecological type. This vegetation type comprises a gently to moderately undulating landscape on the Highveld plateau supporting short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra*. This vegetation type is regarded Endangered; this status is reflected in the absence of extensive areas of natural grassland as well as the moderately degraded status of remaining patches of grassland habitat.

Information obtained from the SANBI database (POSA, 2012) indicates the known presence of approximately 390 plant species within the ¼-degree grids that are sympatric to the study area (2629CB & 2629CD). The high floristic diversity of the immediate region reflects the regional diversity context of the Grassland Biome. Only 118 plant species were recorded during the survey period. Although relative low, the diversity is regarded representative of floristic diversity on a regional scale, but does reflect the seasonal constraints of the survey and a moderately degraded status thereof. The grassland physiognomy is dominated by a species rich herb layer and grass sward. Typically, the herbaceous layer is prominent and is physiognomically dominated by the grass sward. A total of 33 grass species were recorded, indicating a significant divergence from the regional ecological type. The herbaceous layer is rich in species, comprising 54 herbs and forbs. With the exception of human abodes where exotic and introduced tree species are present, woody species are largely absent from the study area or occur as scattered shrubs. The presence of extensive wetland habitat is indicated by the presence of 7 sedges and 5 obligate hydrophilic species. The diversity of plants within the study area is represented by 38 plant families, typically dominated by Poaceae and Asteraceae.

Existing data records indicate the presence of only two plant species of conservation importance within the ¼-degree grids that are spatially represented in the study area, namely *Drimia elata* (Data Deficient) and *Cineraria austro-transvaalensis* (Near Threatened). In addition to the species currently captured in the SANBI infobase (POSA, 2011), seven provincially protected plants are known to occur within the region of the study area (Mpumalanga Nature Conservation Act No.10 of 1998). Three conservation important plant taxa were recorded during the survey period:

- *Boophone disticha* (Bushman Poison Bulb (e), Gifbol (a))
- *Crinum bulbispermum* (Orange River Lily (e), Oranjerivierlelie (a)); and
- *Hypoxis hemerocallidea* (African Potato (e), Afrika aartappel (a)).

Numerous weeds and poor quality species were recorded in the study area, reflecting the transformed and degraded nature of much of the study area, with particular reference to the agricultural fields and transformed areas.

Results of the photo analysis and site observations revealed the presence of the following macro habitat types, communities and variations:

- Transformed Habitat Types, including;
  - Agricultural Fields (Low floristic sensitivity);
  - Infrastructure/ Transformed Areas (Low floristic sensitivity);
  - Stands of Exotic Trees (Low floristic sensitivity);
- Wetland Habitat, including:
  - Ephemeral Grasslands (High floristic sensitivity);
  - Valley Bottoms & Drainage Lines (High floristic sensitivity);
- Terrestrial Grassland Habitat Types, including
  - Degraded Grassland (Medium-low floristic sensitivity);
  - Natural Grassland (Medium-high floristic sensitivity); and
  - Poor Status Grasslands (Medium-low floristic sensitivity).

Alternative A comprises 673.9 ha, of which 10.6 % is deemed highly sensitive. Significantly, 66.3 % of the site exhibit attributes of medium-high floristic sensitivity (natural terrestrial grasslands). This large extent of high and medium-high sensitivities is not only the result of relative pristine grasslands on this portion, but also due to the presence of highly sensitive habitat near to the site; specifically the pan system situated directly to the south of the site. Impacts from the existing ashing facility have already resulted in severe effects on the status and functionality of the wetland system. Further habitat transformation closer to the wetland will inevitably result in increased cumulative adverse impacts and further deterioration of this system. In order to preserve the integrity of this ecological type, it is strongly recommended that water drainage originating from the existing impacts be contained and evacuated to a designated treatment area and not released into the wetland systems. Persistent high stocking rates are having adverse effects on the status of the terrestrial grasslands, but the status is nonetheless regarded moderately representative of the regional ecological type. The protected species *Hypoxis hemerocallidea* and *Boophone disticha* were recorded in these parts. This alternative is therefore regarded the least preferred option for the proposed development.

Alternative B comprises 766.3 ha; 1.3 % and 31.0 % are included in the high and medium-high floristic sensitivity categories, respectively. These portions are situated in the eastern and western parts of the site. In particular, the Natural Grassland habitat portions situated in the eastern part of the study area are regarded the most representative and pristine portions of grassland encountered in the entire study area and should, ideally, be conserved. Significantly, 56.2 % of this site comprise of habitat of low floristic sensitivity. However, much of this low sensitivity habitat is situated around and in close proximity to high and medium-high sensitivity areas; development of these portions is therefore highly likely to affect sensitive areas significantly. The only habitat of particular importance that was identified in the immediate vicinity of this alternative is represented by the non-perennial drainage line that leads to the northeast. Development of this option is therefore likely to affect these wetland features and this option is therefore recommended as the second preferred alternative.

Alternative C comprises the lowest extent of high and medium-high sensitivity areas; 3.0 % and 13.6 % respectively. However, ephemeral grassland of this alternative is regarded to be of moderate quality, with relative severe impacts resulting from insowing of the adjacent terrestrial grassland as well as from the surrounding agricultural fields. Medium-high sensitivity grasslands situated in the southeastern section of this land parcel is,

similar to Alternative A, situated in relative close proximity to the wetland system to the east and impacts resulting from the potential use of these areas are likely to affect this wetland system adversely. This alternative is recommended as the preferred option, in terms of floristic sensitivity. However, it is strongly recommended that medium-high sensitivity grasslands in the southeastern section be excluded from the development and additional land of lower sensitivity be sourced from Alternative B located to the north of this alternative.

1.3 FAUNAL ASSESSMENT

Grassland, being the habitat of large herds of antelope and numerous smaller animals, are currently one of the most threatened in South Africa; forestry, mining and development industries have irreversibly transformed 60-80 % of grasslands in South Africa with only 2 % formally conserved. It is therefore important to view the study area on an ecologically relevant scale. All sensitive animal species (specific faunal groups) known from the Mpumalanga Province, were therefore included in this assessment. Animals known to persist in the ¼-degree grids 2629CB and 2629CD were also considered potential inhabitants of the study area.

A total of 119 Red Data animals are known to occur in Mpumalanga (dragonflies, damselflies, butterflies, frogs, reptiles and mammals) and in the ¼-degree grids 2629CB and 2629CD (birds). An assessment of the Probability of Occurrence (PoC) for these animals yielded the following results:

- 48 species have a low PoC;
- 17 species have a moderate-low PoC;
- 26 species have a moderate PoC;
- 15 species have a moderate-high PoC; and
- 9 species have a high PoC.

In addition to the above-mentioned Red Data species of Mpumalanga, 31 animal taxa (some overlap does occur) have protected status (NEMBA) within Mpumalanga (www.speciesstatus.sanbi.org). The estimated PoC for these species was estimated as follows:

- 8 species have a low PoC;
- 18 species have a moderate-low PoC;
- 1 species has a moderate PoC;
- 1 species has a moderate-high PoC; and
- 2 species have a high PoC.

The presence of 86 animal taxa was confirmed during the 2013 summer investigation by means of visual sightings, tracks, scats, burrows and species-specific calls as well as camera and small mammal trapping. The following results were recorded:

- 9 invertebrates;
- 2 reptile species;
- 63 bird species; and
- 12 mammals.

The diversity of animals recorded in the study area included four Red Data species, namely:

- Greater Flamingo (*Phoenicopterus roseus*);
- Grey Crowned Crane (*Balearica regulorum*);
- Black-winged Pratincole (*Glareola nordmanni*); and
- Serval (*Leptailurus serval*).

The diversity of animals recorded in the study area included one Provincially Protected species, namely the Serval (*Leptailurus serval*) as well as one Alien and Invasive species (AIS); the Spotted Maize Beetle (*Astylus atromaculatus*).

Faunal community structure and ecological diversity cannot be viewed in isolation and is nearly always strongly represented by major vegetatal patterns of an area. Therefore, the plant communities or macro habitat types described in this document are regarded representative of the main faunal habitats within the study area. Faunal sensitivities ascribed to the habitat types are as follows:

- Transformed Habitat Types, including;
  - Agricultural Fields (Medium-low faunal sensitivity);
  - Infrastructure/ Transformed Areas (Low faunal sensitivity);
  - Stands of Exotic Trees (Medium-low faunal sensitivity);
- Wetland Habitat, including:
  - Ephemeral Grasslands (High faunal sensitivity);
  - Valley Bottoms & Drainage Lines (High faunal sensitivity);
- Terrestrial Grassland Habitat Types, including
  - Degraded Grassland (Medium faunal sensitivity);
  - Natural Grassland (Medium-high faunal sensitivity); and
  - Poor Status Grasslands (Medium faunal sensitivity).

The presence of many obligate grassland and wetland fauna species attest to the ecological functionality of remaining natural grassland and wetland ecosystems. These species include Rinkhals, Common Quail, Spur-winged Goose, South African Shelduck, Cape Shoveler, Little Grebe, Glossy Ibis, African Darter, Kittlitz's Plover, African Snipe, Common Greenshank, Marsh Owl, Rufous-naped Lark, Cloud Cisticola, Highveld Gerbil and Marsh Mongoose. The sensitivity of these natural faunal habitats of the study area were further emphasised by the confirmed presence of four Red Data species, namely the Greater Flamingo, Grey Crowned Crane, Black-winged Pratincole and Serval. Despite significant transformation pressures existing in the study area, the natural faunal habitats are still considered to have significant biodiversity value; not only as breeding and feeding habitat for many grassland and wetland animals (particularly for sensitive faunal taxa), but also as migration corridors and sink habitats between larger fragments of wetlands and grasslands in the surrounding regions.

The three site alternatives are situated around the current ashing facility at Tutuka Power Station, but exhibit significant variation in terms of presence of faunal habitats, and therefore faunal sensitivity. Ultimately, based on these differences, a preference rating is assigned to each alternative in terms of faunal sensitivity:

- **Alternative A –** 66.3 % of the site exhibit attributes of medium-high faunal sensitivity (natural grassland habitat) and 10.6 % of high faunal sensitivity (wetland habitat). This large extent of high and medium-high sensitivity is not only the result of relative pristine grasslands on this portion, but also due to the presence of highly sensitive habitat near to the site; specifically the pan system situated directly to the south of the site. Four Red Data fauna taxa observed during the field investigation were recorded within the pan system south of Alternative A. Alternative A is therefore considered the least preferred alternative (most sensitive alternative);
- **Alternative B -** includes 1.3 % high and 31.0 % medium-high faunal sensitivity. Significantly, 67.8 % of this site comprises habitat of low and medium-low faunal sensitivity. Furthermore, Alternative B is situated the furthest from the sensitive pan system located south of the current ashing facility (host to at least four red data animal species). Based on this assessment, Alternative B is considered the least sensitive and therefore the most preferred alternative; and
- **Alternative C -** comprises the smallest extent of high and medium-high sensitivity areas; 3.0 % and 13.6 % respectively, but does include ephemeral grassland of moderate quality. Alternative C is also situated

reasonably close to the sensitive wetland system located south of Alternative A, which is host to at least four Red Data species (potentially more). The proximity of this wetland system to Alternative C significantly affects the preference and sensitivity of this alternative in terms of faunal sensitivity. In spite of the lowest extent of high and medium-high faunal sensitivity habitat, this alternative is considered the second preferred alternative, in terms of faunal sensitivity (second-most sensitive alternative).

1.4 ECOLOGICAL IMPACT ASSESSMENT

The impact assessment is aimed at presenting a description of the nature, extent significance and potential mitigation of identified impacts on the ecological environment. No impacts were identified that could lead to a beneficial impact on the ecological environment of the study area since the proposed development is largely destructive, involving the alteration of natural habitat or degradation of habitat that is currently in a climax status.

The following impacts were therefore identified as relevant to this proposed development:

- Impacts on flora species of conservation importance (including habitat suitable for these species);
- Impacts on fauna species of conservation importance (including habitat suitable for these species);
- Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation);
- Displacement of fauna species, human-animal conflicts & interactions;
- Impacts on ecological connectivity and ecosystem functioning;
- Indirect impacts on surrounding habitat;
- Cumulative impacts on conservation obligations & targets (including national and regional);
- Cumulative increase in local and regional fragmentation/ isolation of habitat; and
- Cumulative increase in environmental degradation, pollution.

Based on floristic and faunal attributes that persist within each of the alternatives, as well as taking cognisance of the potential importance and conservation value of the site in the larger landscape (in terms of ecological contribution and intrinsic ecological value), the site alternatives are therefore ranked as follows:

Alternative A 2 (Not Preferred Option)
Alternative B 4 (Preferred Option)
Alternative C 3 (Acceptable Option)

However, based on the disparity of habitat types within each of the site alternatives, as well as the requirement of approximately 800 ha for the proposed development, it is strongly suggested that suitable portions (moderate to low floristic and faunal sensitivity) be used for development purposes. It is important to note that habitat of medium-high and high floristic and faunal sensitivity be excluded as well as placing the proposed ashing facility as far away from the sensitive wetland habitat type situated south of Alternative A.

2 TERMS OF REFERENCE

Objectives of this Biodiversity Impact Assessment are to establish the presence/ absence of ecologically sensitive areas or species within the proposed project areas. Secondly, in order to assist with, and guide, the planning of the proposed development it is necessary to assess potential impacts of the development on the biological environment (terrestrial biodiversity), comment on the suitability of the area for the proposed project and to provide development guidance to limit impacts as far as possible.

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

- Obtain all relevant Précis and Red Data flora information;
- Conduct a photo analysis of the proposed area;
- Identify floristic variations;
- Survey habitat types to obtain a broad understanding of the floristic diversity;
- Assess the potential presence of Red List flora species according to information obtained from SANBI;
- Incorporate existing knowledge of the region into the assessment;
- Describe broad habitat variations present in the study area in terms of biophysical attributes and phytosociological characteristics;
- Compile a floristic sensitivity analysis;
- Incorporate results into the Biodiversity Impact Evaluation;
- Map all relevant aspects;
- Provide pertinent recommendations; and
- Present all results in a suitable format.

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

- Obtain available faunal distribution records and Red Data faunal information
- Survey the site to obtain a broad overview of available faunal habitat types;
- Assess the potential presence of Red Data fauna species;
- Incorporate existing knowledge of the region;
- Describe the status of available habitat in terms of faunal attributes, preferences and conservation potential;
- Compile a faunal sensitivity analysis;
- Incorporate results into the Biodiversity Impact Evaluation;
- Map all relevant aspects; and
- Present all results in a suitable format.

3 INTRODUCTION

Why is biodiversity conservation important? Biodiversity sustains life on earth. An estimated 40 % of the global economy is based on biological products and processes (www.unep.org). Biodiversity has allowed massive increases in the production of food and other natural materials, which in turn have fed the (uncontrolled) growth and development of human societies. Biodiversity is also the basis of innumerable environmental services that keep humans and the natural environment alive, from the provision of clean water and watershed services to the recycling of nutrients and pollination (ICMM, 2004). Conservation of biodiversity has taken many different forms throughout history, including setting aside land for such reasons as their rare ecology (endemic or Red Listed species) or exceptionally high species diversity; their critical environmental services, such as watershed protection or evolutionary functions; or their continued use by indigenous peoples who are still pursuing 'traditional' lifestyles based on 'wild' resources.

South Africa is recognized as one of the world's few 'megadiverse' countries. In addition to having an entire floral kingdom, it also includes two globally significant biodiversity 'hot spots' (the Cape and succulent Karoo regions), six Centres of Plant Diversity, two Endemic Bird Areas and the richest temperate flora in the world (Cowling, 2000). Recent increases in human demand for space and life-supporting resources are however resulting in rapid losses of natural open space in South Africa. When natural open space systems are rezoned for development, indigenous fauna and flora are replaced by exotic species and converted to sterile landscapes with no dynamic propensity or ecological value (Wood *et. al.,* 1994). The conservation of critical biodiversity resources and the use of natural resources therefore appear to be two conflicting ideologies.

In 1992, the Convention of Biological Diversity (CBD), a landmark convention, was signed by more than 90 % of all members of the United Nations. The subsequent enactment of the National Environmental Management Biodiversity Act in 2004 (Act No. 10 of 2004), focused on the preservation of biological diversity in its totality, including genetic variability, natural populations, communities, ecosystems up to the scale of landscapes. The CBD not only considers the protection of threatened species and ecosystems, but also recognizes the importance of using resources sustainably, of ensuring equity in the exploitation of such resources, and of the need for sustainable development in developing countries. This concept seeks to ensure that social and economic development follows a path that enhances the quality of life of humans whilst ensuring the long-term viability of the natural systems (resources) on which that development depends (United Nations Conference on Environment and Development, in Rio de Janeiro, Brazil 1992). In southern Africa, acceptance of the concept of sustainable development has been marked by the ratification of international conventions by most countries, particularly the Convention on Biological Diversity, Ramsar Convention and CITES, as well as the development of SADC-based protocols on environmental issues. However, severe capacity constraints in most countries have made it difficult to translate these policies and concepts into practice.

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

4 PROJECT SYNOPSIS

Ash generated by Tutuka Power Station is currently being disposed by means of 'dry ashing' (20 % moisture content) within the premises of the Tutuka Power Station, on Eskom owned land. The existing ashing facility, which is situated approximately 4.5 kilometre (km) east of the station terrace, was initially designed for the planned life of operation of the Tutuka Power Station and utilises a conveyor, spreader and stacker system from the station terrace to the ash disposal site. Although the station has not reached the end of its life and the ashing

operations have not used all the design land, additional ashing facilities are required to be able to continuously ash to 2055 (based on an ash production rate of 4,624 million tonnes per annum). Based on estimations, the complete ash disposal site would eventually cover an area of 2,500 hectares (ha).

With the promulgation of the National Environmental Waste Management Act, Act 59 of 2008 (NEMWA), Eskom aims to align its continued ashing activities with the requirements of the waste licensing processes. In sourcing approval of the ashing plans, Eskom requires the licensing of the ash disposal facilities for its continuous operation in terms of the NEMWA. Eskom has appointed Lidwala Consulting Engineers as the Environmental Assessment Practitioner (EAP) for the project. BEC was appointed as independent ecologists to conduct an ecological EIA of the study area.

A technically suitable area was initially identified to the south and east of the existing ashing facility; this land was purchased before the commencement of Environmental laws; the Environment Conservation Act, in particular. However, in order to allow for a robust environmental process, all land within a radius of 8 km was assessed during a desktop assessment and three (3) potential alternatives were identified. Suitable biodiversity surveys were conducted on these portions of land during the EIA phase in order to assess and compare the biodiversity attributes that persist on each of these options. This report will indicate the suitability and sensitivity of each of these areas in terms of the planned activities.

5 BIOPHYSICAL ATTRIBUTES OF THE AFFECTED ENVIRONMENT

5.1 LOCATION

Tutuka Power Station is located approximately 25 km north-northeast of Standerton in the Mpumalanga Province. The power station falls within the Lekwa Local Municipality (LLM), which falls within the Gert Sibande District Municipality. The three site alternatives are situated around the existing ash disposal facility of Tutuka Power Station. The proposed sites are located on portions of the following farms:

- Dwars-in-die-weg 350;
- Mooimeisjesfontein 376;
- Pretoriusvley 374;
- Recesbult 352;
- Rouxland 358; and
- Uitkyk 377.

The regional location of the study area is illustrated in **Figure 1**. A composite Google Earth image is presented in **Figure 2**, reflecting a relatively high habitat fragmentation of the general region because of an intensive road and railway infrastructure.

5.2 LAND COVER & LAND USE OF THE REGION

Land cover categories are presented in **Figure 3**. The study areas are situated within the LLM, which comprises approximately 458,519 ha; 63.8 % of this (292,598 ha) is regarded untransformed. Transformation effects of commercial agriculture (maize production) are particularly evident from the mosaical appearance of land cover of the landscape, which is a major reason for the 'Endangered' conservation status ascribed to the regional ecological type. Road infrastructure in the region caused a moderate level of habitat fragmentation and isolation. Commercial agriculture (dry land maize production) and cattle grazing represents the major land use categories of the region.

For the purpose of this assessment, land cover is loosely categorised into classes that represent natural habitat and other categories that are characterised by degraded and transformed habitat. In terms of the importance for biodiversity, the assumption is that landscapes exhibiting high transformation levels are normally occupied by plant communities and faunal assemblages that are unlikely to reflect the original or pristine status. This is particularly important in the case of conservation important taxa as these plants and animals generally exhibit extremely low tolerances levels towards disturbances. This is one of the main reasons for the threatened status of these species; changes in the natural environment that is available to these species are likely to result in severe impacts on these species and, subsequently, their conservation status.

Three important aspects are associated with habitat changes that accompany certain land uses. Habitat transformation that follows activities such as agriculture, mining and urbanisation, results in permanent decimation of natural habitat; these areas will not recover to the original pristine status. A second aspect of habitat transformation or degradation is that it affects species directly, namely changes in species presence, absence and community composition. This result from the exodus of species for which habitat conditions have become unfavourable, the decrease in abundance of certain species because of decreased habitat size, or an influx of species that are better adapted to the altered environment. While some, or most, of the new species that occupy an area might be indigenous, they are not necessarily endemic to the affected area. Lastly, a larger threat to the natural biodiversity of a region is represented by the influx of invasive and/ or exotic species that can effectively sterilise large tracts of remaining natural habitat.

In most cases, as with the ENPAT database, the depiction of grassland represents an overestimation of the true extent of remaining natural (pristine) grassland habitat in the region. This statement is based on the following:

- The current land cover, as presented in ENPAT does not accurately reflect the current land cover status in all instances; in particular, recent agricultural activities and localised stands of exotics are not accurately captured within the existing data (*pers. obs*.); and
- The status of much of the remaining portions of 'natural grassland' is not accurately summarized in the assessment. These 'natural grasslands' frequently comprehend poor quality grassland or even pastures that exhibit severely altered species compositions and depleted diversity that does not reflect the natural grassland of the region (*pers. obs*.).

By inclusion of portions of other land cover categories, sub-climax grassland types in particular, within the category of 'Natural Grassland' a fallacious view is created of the extent of remaining natural (pristine) grassland habitat in the region. It is therefore extremely likely that remaining untransformed grassland habitat within the LLM is much lower than initially anticipated. Ultimately, the greater region is characterised by high levels of habitat transformation, isolation and habitat fragmentation, resulting from persistent increases in agricultural activities, urban developments, linear infrastructure and mining related activities.

5.3 DECLARED AREAS OF CONSERVATION

Although no formally declared area of conservation is present within the immediate vicinity, two areas of conservation are present in the surrounding region, including:

- Bloukop (23km east); and
- Reitvaal (37km east).

These areas are unlikely to be affected directly by the proposed development.

Figure 1: Regional setting of the study areas

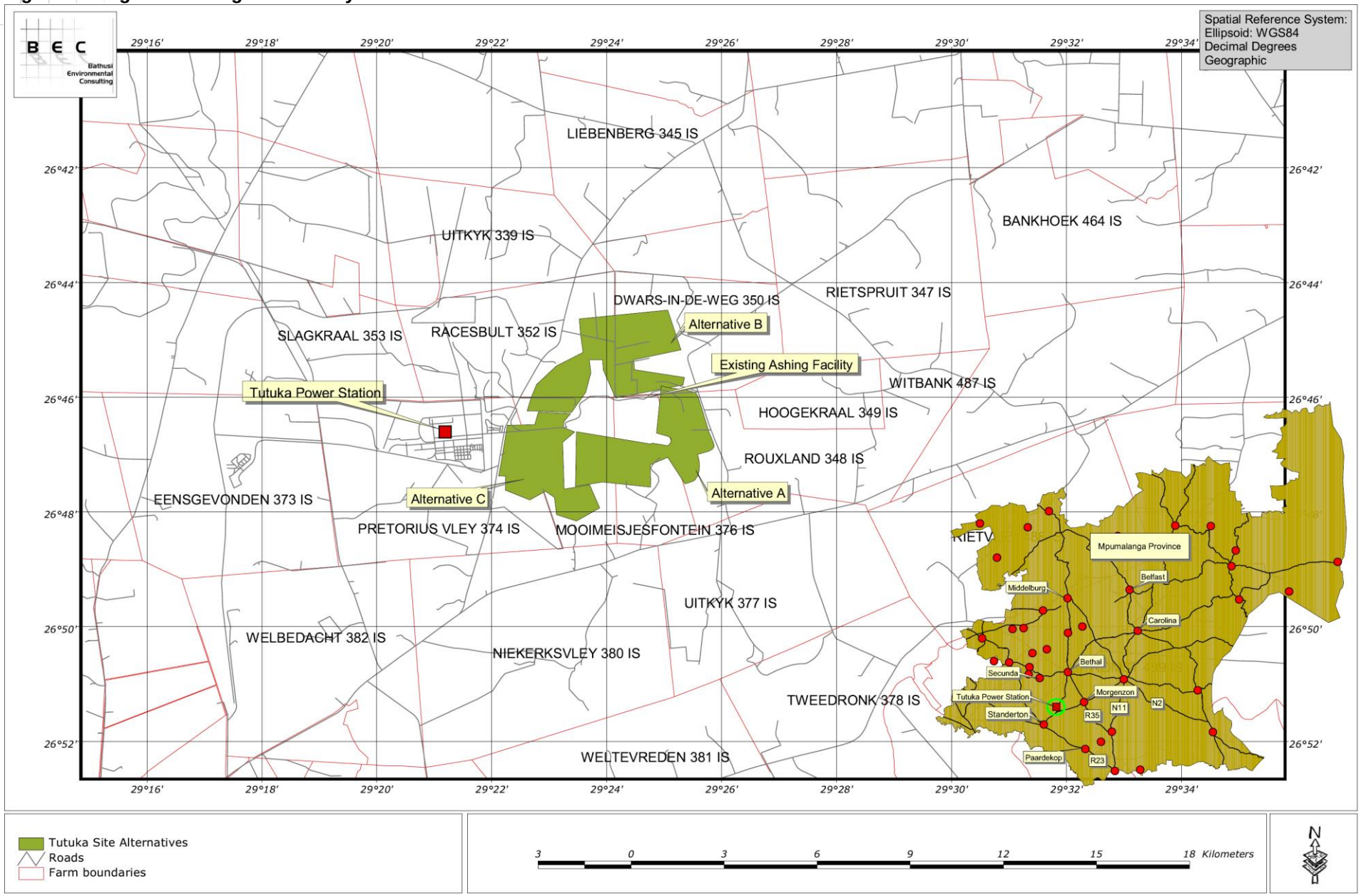
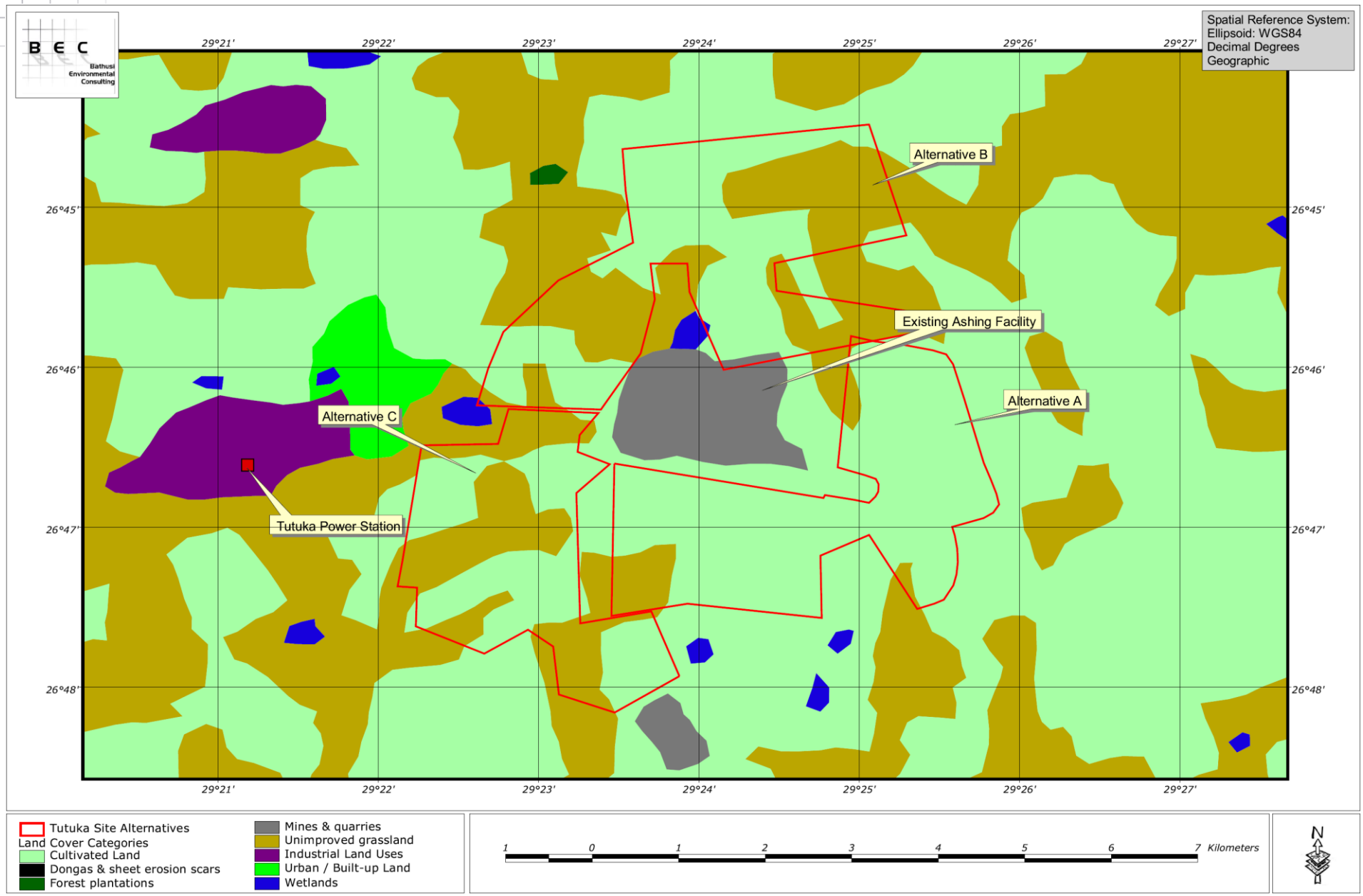


Figure 2: Composite aerial image of the study areas

(images courtesy of www.googleearth.com)

Figure 3: Land cover categories of the region


Spatial Reference System:
Ellipsoid: WGS84
Decimal Degrees
Geographic
29°21'
29°22'
29°23'
29°24'
29°25'
29°26'
29°27'
26°45'
26°46'
26°47'
26°48'
Alternative B
Existing Ashing Facility
Alternative A
Alternative C
Tutuka Power Station
Tutuka Site Alternatives
Land Cover Categories
Cultivated Land
Dongas & sheet erosion scars
Forest plantations
Mines & quarries
Unimproved grassland
Industrial Land Uses
Urban / Built-up Land
Wetlands
1 0 1 2 3 4 5 6 7 Kilometers
N

5.4 SURFACE WATER[1]

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

Areas of surface water and wetland related habitat types contribute significantly towards the local and regional biodiversity due to atypical habitat that is present within ecotonal areas. Ecotones (areas or zones of transition between different habitat types) are occupied by species occurring in both the bordering habitats, and are generally rich in species due to the confluence of habitats. In addition to daily visitors that utilise the water sources on a frequent basis, some flora and fauna species are specifically adapted to exploit the temporal or seasonal fluctuation in moisture levels in these areas, exhibiting extremely low tolerance levels towards habitat variation. Ecotonal interface areas form narrow bands around areas of surface water and they constitute extremely small portions when calculated on a purely mathematical basis. However, considering the high species richness, these areas are extremely important on a local and regional scale. Rivers also represent important linear migration routes for a number of fauna species as well as a distribution method for plant seeds.

The LLM, in which the study area is situated, comprises approximately 20,950 ha of wetlands. No RAMSAR sites are present in the LLM. Areas of surface water are present in the study area in the form of rivers, perennial and non-perennial steams, artificial and natural impoundments and, in particular, endorheic pans, moist grassland/ seepages and ephemeral grasslands. Larger rivers and streams include the Leeuspruit in the east and the Wolwespruit in the southeast. The study area is situated within the Vaal Primary Catchment area (refer **Figure 4**). Most of the smaller drainage lines, artificial impoundments and the large endorheic pan were found to be in a deteriorated state due to surrounding land uses. Trampling by cattle, chemical alteration through leaching and effluents and changed species composition is a common effect noted at most wetland habitat types of the study area.

5.5 TOPOGRAPHY, RELIEF & SLOPES

The ENPAT (2001) database revealed no topographical heterogeneous areas being present (slopes exceeding 8 %) in the study area. Although the ENPAT database slope classes is based on a high contour interval (probably 100m), smaller areas are unlikely to be identified during a routine assessment. However, no such areas were observed during the brief site investigation, as well as from Google Earth images. The topography of the study site is categorised as 'Slightly undulating plains' (ENPAT, 2001). Altitude of the study area varies around 1,600 m above sea level.

Varied topography is recognised as a powerful influence contributing to the high biodiversity of southern Africa. Landscapes composed of spatially heterogeneous abiotic conditions provide a greater diversity of potential niches

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

for plants and animals than do homogeneous landscapes. The species richness and biodiversity has been found to be significantly higher in areas of geomorphological heterogeneity.

Ridges and rocky outcrops are characterised by high spatial variability due to the range of differing aspects, slopes and altitudes all resulting in differing soil (e.g. depth, moisture, temperature, drainage, nutrient content), light and hydrological conditions. Temperature and humidity regimes of microsites vary on both a seasonal and daily basis. Moist cool aspects are more conducive to leaching of nutrients than warmer drier slopes. Variation in aspect, soil drainage and elevation/altitude has been found to be especially important predictors of biodiversity. It follows that ridges will be characterized by a particularly high biodiversity.

Many conservation important plants and animals occupy ridges. Due to their threatened status, Red Data species require priority conservation efforts in order to ensure their future survival. Ridges may have a direct effect on temperature/radiation, surface airflow/wind, humidity and soil types. Ridges also influence fire in the landscape, offering protection for those species that can be described as "fire-avoiders". Because of the influence of topography on rainfall, many streams originate on ridges and control water inputs into wetlands. The protection of the ridges in their natural state is therefore a first step in ensuring the normal functioning of ecosystem processes on a larger scale. In contrast, transformation of ridges will alter these major landscape processes. For example, water runoff into streams and wetlands will increase, causing erosion.

5.6 GEOLOGY

The major geological formations of the region are illustrated in **Figure 5**. The following geological formations are represented in the study area:

- Vryheid Arenites - sedimentary rock composed of sand-sized fragments irrespective of composition, thick beds of yellowish to white cross-bedded sandstone and grit, which alternate with beds of soft, dark-grey, sandy shale and a few seams of coal; and
- Karoo Dolerite – a dark coloured crystalline igneous rock that abundantly intrudes the Karoo Sequence, giving rise to many characteristic flat-topped hills, therefore typically present in steep hills, mountains and escarpment landforms. Sills and dykes often exert structural control in the landscape, and may be seen as present on flat-topped hills, or as the crest of waterfalls.

5.7 LAND TYPES & SOILS

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

The preferred site is situated within the Ea17 land type unit. E land type units indicate land with a high base status, dark coloured and/ or red soils, usually clayey, associated with basic parent materials. A land type more than half of which is covered by soil forms with vertic, melanic and red structured diagnostic horizons qualifies for inclusion in unit Ea, provided that it does not qualify for inclusion in units A, B or C. Land types in which these soils cover less than half of the area may also qualify for inclusion (i) where duplex soils occur in the non-rock land but where unit Ea soils cover a larger area than the duplex soils, or (ii) where exposed rock cores more than half the land type.

Figure 4: Areas of surface water in the region of the study areas

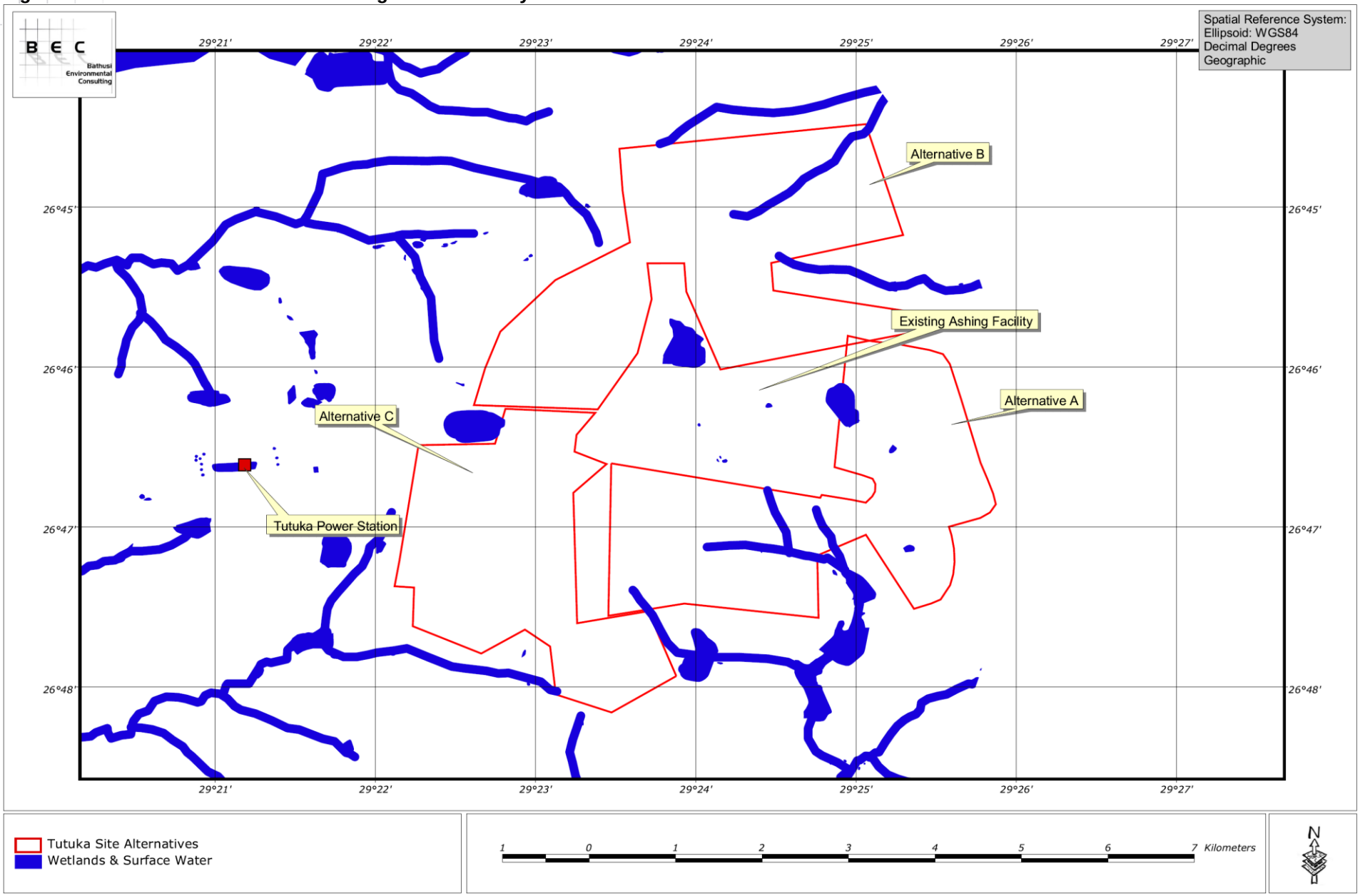
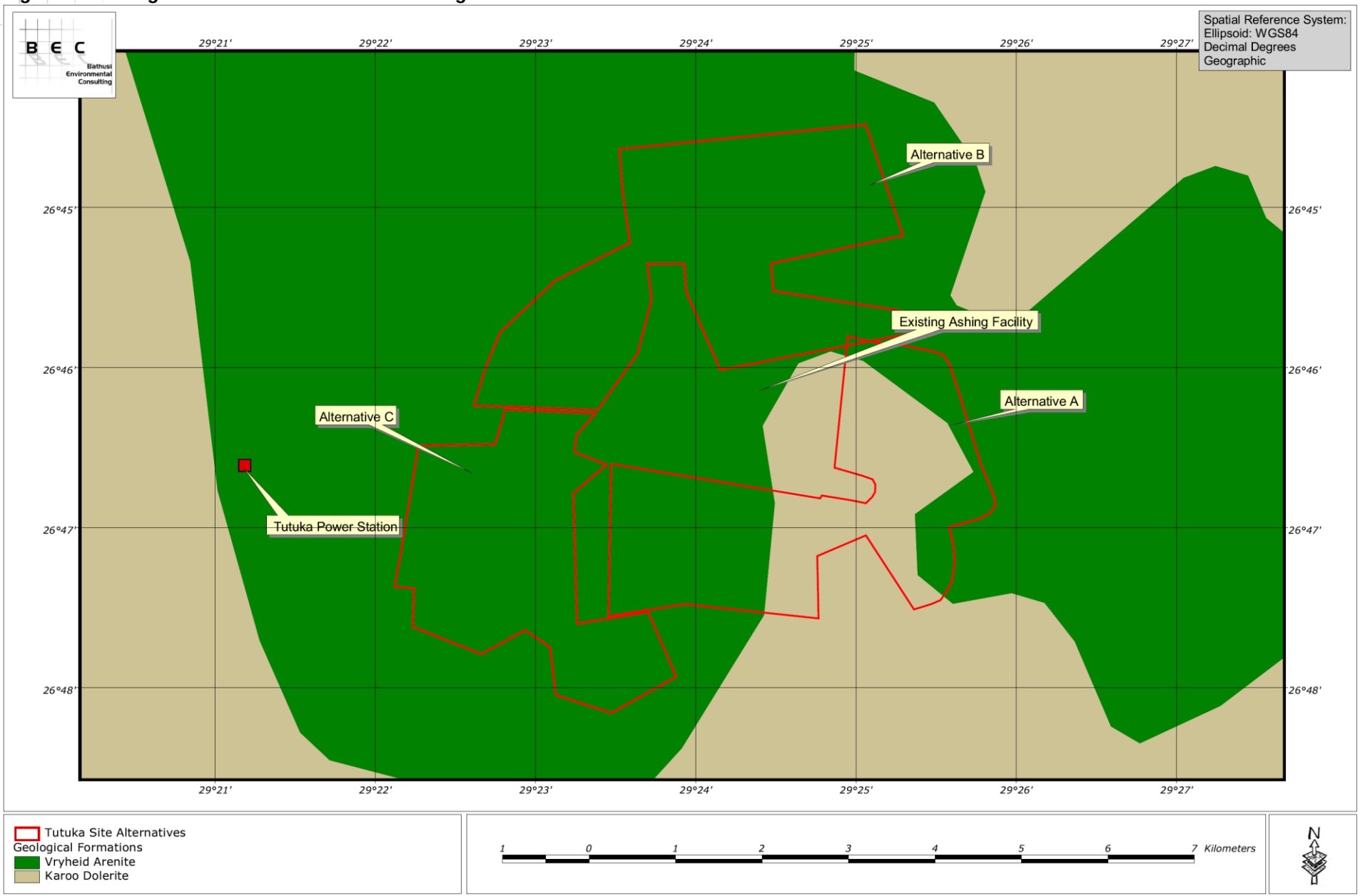


Figure 5: Geological variation of the immediate region



6 MPUMALANGA BIODIVERSITY CONSERVATION PLAN

6.1 TERRESTRIAL BIODIVERSITY SENSITIVITIES ON A LOCAL SCALE

6.1.1 Category Designation

The local and regional designation of Mpumalanga Terrestrial Biodiversity Conservation Categories (MBCP) is illustrated in **Figure 6**.

The mandate for conserving biodiversity lies with state agencies at national, provincial and local levels of government, forming part of a wider responsibility for the environment and the sustainable use of natural resources. Constitutional and national laws require these environmental issues to be dealt with in cooperative, participatory, transparent and integrated ways. The MBCP is the first spatial biodiversity plan for Mpumalanga that is based on scientifically determined and quantified biodiversity objectives. The purpose of the MBCP is to contribute to sustainable development in Mpumalanga.

The MBCP maps the distribution of Mpumalanga Province's known biodiversity into six categories (Lötter & Ferrar, 2006). These are ranked according to ecological and biodiversity importance and their contribution to meeting the quantitative targets set for each biodiversity feature. The categories are:

1 Protected areas - already protected and managed for conservation;
2 Irreplaceable areas - no other options available to meet targets—protection crucial;
3 Highly Significant areas - protection needed, very limited choice for meeting targets;
4 Important and Necessary areas - protection needed, greater choice in meeting targets;
5 Ecological Corridors – mixed natural and transformed areas, identified for long term connectivity and biological movement;
6 Areas of Least Concern – natural areas with most choices, including for development;
7 Areas with No Natural Habitat Remaining – transformed areas that do not contribute to meeting targets.

The study area comprises three of these categories (refer **Figure 7**), namely:

- Important & Necessary;
- No Natural Habitat Remaining; and
- Least Concern.

The category of '**Important & Necessary**' is significantly important areas of natural vegetation that play an important role in meeting biodiversity targets. Their designation as IMPORTANT AND NECESSARY seeks to minimise conflict with competing land uses and represents the most efficient selection of areas to meet biodiversity targets. No significant increase in the occurrence of Land-Use Types 5 – 9, should be permitted (refer Footnote 3). Every opportunity to revert to economic options using natural land cover should be taken. Some agricultural land uses may be permitted but with best-practice guidelines made conditional and aimed at benefiting the biodiversity assets and reducing the vulnerability of each site.

Biodiversity assets in landscapes categorized as **'Least Concern'** contributes to natural ecosystem functioning, ensuring the maintenance of viable species populations and providing essential ecological and environmental goods and services across the landscape. This category comprises approximately 25.5 % of the Mpumalanga Province and although these areas contribute the least to the achievement of biodiversity targets, they have significant environmental, aesthetic and social values and should not be viewed as wastelands or carte-blanche development zones. Development options are widest in these areas. At the broad scale, these areas and those where natural habitat has been lost serve as preferred sites for all forms of development. It is still required to consider other environmental factors such as socioeconomic efficiency, aesthetics and the sense-of-place in

making decisions about development. Prime agricultural land should also be avoided for all non-agricultural land uses. Land-use and administrative options for positive biodiversity outcomes include:

- Where this category of land occurs close to areas of high biodiversity value, it may provide useful ecological connectivity or ecosystem services functions, e.g. ecological buffer zones and corridors or water production. Encouragement needs to be given to biodiversity-friendly forms of management and even restoration options where appropriate;
- Develop incentives to reverse lost biodiversity for selected parcels of land where buffer zones and connectivity are potentially important;
- Standard application of EIA and other planning procedures are required; and
- These areas might serve as preferred sites for all forms of urban and industrial development (Land-Use Types 10 – 15).

Areas of '**No Natural Habitat Remaining**' comprise approximately 35.8 % of the Province. This category has already lost most of its biodiversity and ecological functioning. In the remnants of natural habitat that occur between cultivated lands and along river lines and ridges, residual biodiversity features and ecological processes do survive, but these disconnected remnants are biologically impoverished, highly vulnerable to damage and have limited likelihood of being able to persist. The more transformed a landscape becomes; the more value is placed on these remnants of natural habitat. Areas with no natural habitat remaining are preferred sites for developments, taking the potential presence of lands with high agricultural potential into consideration.

6.1.2 Development Restrictions in Terms of the MBCP

The MBCP suggests that 'Irreplaceable' and 'Highly Significant' categories should remain unaltered and be managed for biodiversity by various means. Categories of lower sensitivity incorporate increasing options for different types of land use that should be decided by the application of EIA procedures and negotiation between stakeholders. The MBCP also identifies that 35.8 % of the Province is included in the category of 'No natural habitat remaining', which has very little biodiversity value.

The proposed development relates to 'Major Development Projects' (Land Use Type 15 – Surface Mining[2], Dumping & Dredging) and is included in the category 'Urban Industrial Land Uses' with the other development types of Urban & Business Development, Major Development Projects, Linear Engineering Structures and Water Projects & Transfers. These six land uses cause the greatest environmental impact and are almost completely destructive of natural vegetation and natural biodiversity. Where biodiversity persists, it is artificially maintained, generally supporting only opportunistic assemblages of plants and animals. Ecosystem processes are completely disrupted, heavily impacted or artificially maintained at high cost. These land uses not only produce the highest local impacts but also dominate the dispersed and cumulative impacts. They are the most destructive and wide-ranging, often spreading hundreds of kilometres from their source, especially along river systems. These land-use types also require special provision in land-use planning, impact assessment and mitigation.

Restrictions in terms of major developments according to the Mpumalanga Biodiversity Conservation Plan (MBCP) are illustrated in **Figure 7**. Limitations in terms of the proposed surface mining development comprise the 'Permitted' and 'Restricted' categories.

Extensive parts of the study area are situated within areas where major developments are not permitted according to the Mpumalanga Biodiversity Conservation Plan (MBCP). This does not necessarily imply that any development will be denied, but rather that specialists studies clearly need to indicate that the proposed

[2]Includes all strip and opencast mining excavations or quarrying, plus the visual, physical and chemical impacts of these activities, particularly on ground water reserves as well as all mine waste

development will not adversely affect any sensitive floristic or faunal attributes that occur, or potentially could occur, within the study area or on a local and regional scale (refer **Footnote 3**). Specialist studies are furthermore required to show that the proposed development will not add to existing cumulative impacts, regional degradation and habitat transformation and the loss of biodiversity on a local or regional scale.

Figure 6: Terrestrial and Biodiversity Conservation (MBCP) categories of the study area

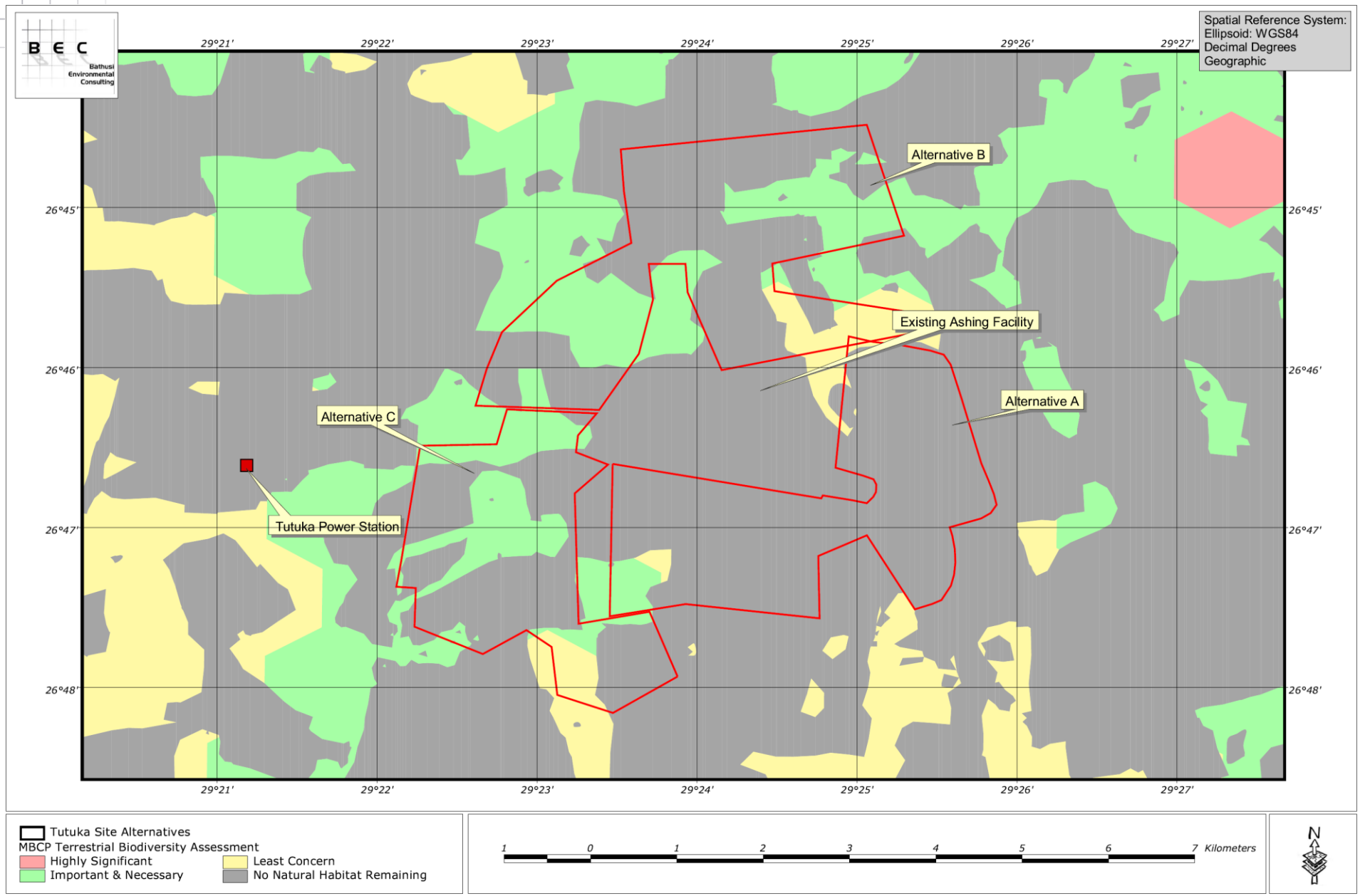
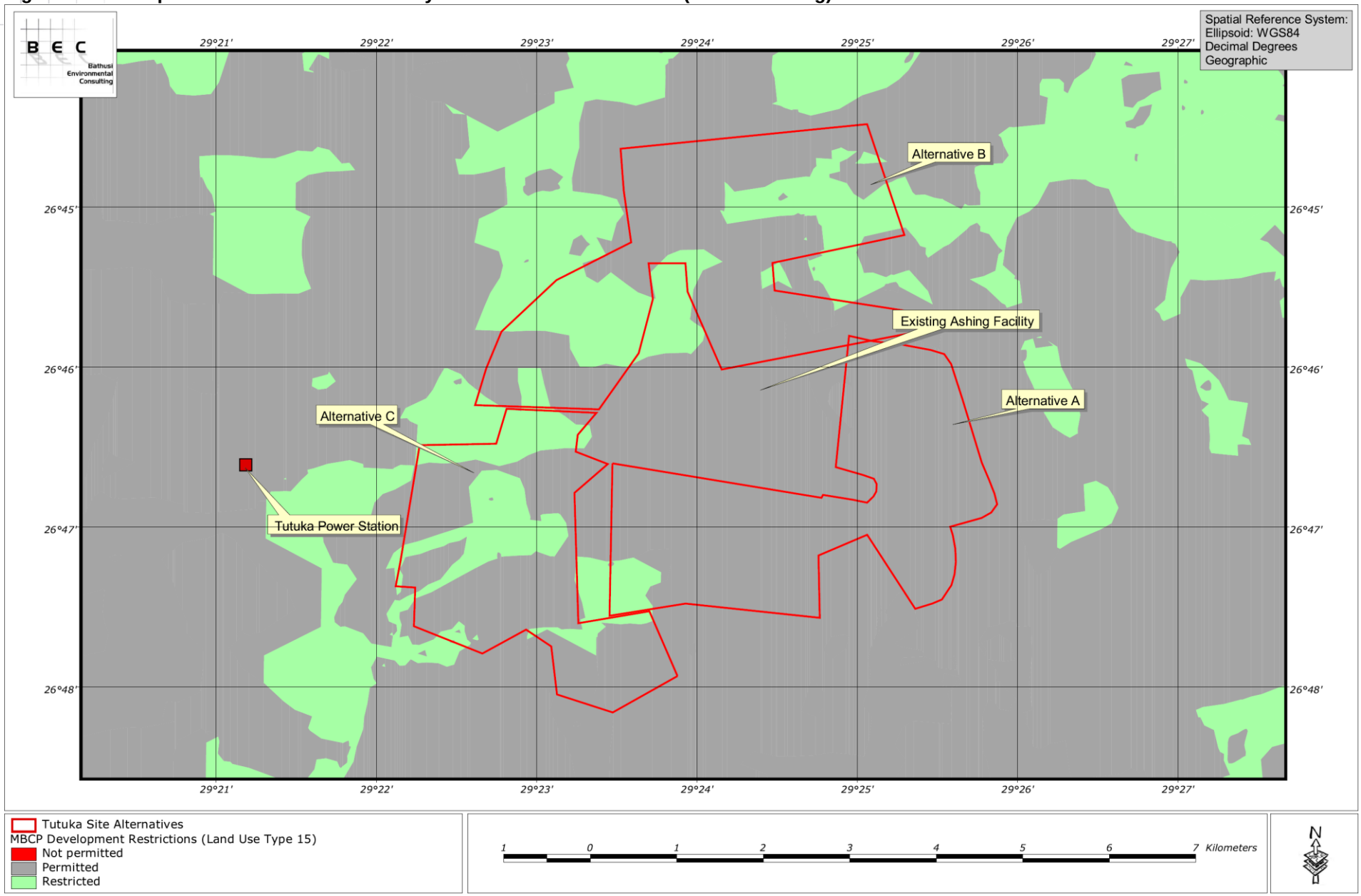

Bathusi Environmental Consulting
Spatial Reference System:
Ellipsoid: WGS84
Decimal Degrees
Geographic
29°21'
29°22'
29°23'
29°24'
29°25'
29°26'
29°27'
26°45'
26°46'
26°47'
26°48'
Alternative B
Existing Ashing Facility
Alternative A
Alternative C
Tutuka Power Station
Tutuka Site Alternatives
MBCP Terrestrial Biodiversity Assessment
Highly Significant
Important & Necessary
Least Concern
No Natural Habitat Remaining
1 0 1 2 3 4 5 6 7 Kilometers
N

Figure 7: Development limitations for the study area in terms of the MBCP (Surface Mining)



7 BACKGROUND TO THE REGIONAL ECOLOGY

From: Mpumalanga Biodiversity Conservation Plan Handbook (2007).

Grassland defines itself: landscapes dominated by grass. Although grasses are the most visible plants, grasslands have a higher diversity than other herbaceous species, especially those with belowground storage organs such as bulbs or tubers. These plants produce many of our spectacular wild flowers and contribute to biodiversity that is second only to the Cape Fynbos in species richness. Grassland species are particularly well adapted to being defoliated, whether by grazing, fire or frost. Repeated defoliation, within reason, does no real harm to such plants nor does it reduce productivity.

African grasslands are particularly old, stable and resilient ecosystems. Most plants are perennials and surprisingly long lived, with very few annual species, which are the pioneer plants needed to repair disturbance. This makes our grasslands vulnerable to destruction by cultivation; once ploughed they are invaded by weedy pioneer plants that are mostly alien. Although many grassland plants do produce seed, very little germinates, most being used as vital food for their rich rodent and insect fauna. Mpumalanga grasslands are mainly found in the highveld above 1000m. These are cool, dry open landscapes, with rainfall of mare than 500mm/year. Frost, hailstorms and lightning strikes are common. The natural occurrence of fire and other defoliating events favours grassland plants over woody species and help maintain the open treeless character of grasslands.

Grasslands have shallow-rooted vegetation with a growing season limited to about six months of the year. The non-growing seasons are characterised by cool and dry conditions, during which time most foliage is removed or killed by frost, and dies back to ground level. Large parts of our grasslands occur on deep fertile soils of high agricultural value. Much of this landscape has already been converted to crops, timber or intensive animal production. The unproductive winter and spring seasons in grassland require agricultural strategies for livestock and cultivation that bridge this gap in economic productivity. Crop rotation, cultivated pastures and fallow intervals, as well as supplementary feeding of livestock, including the use of crop residues, are all part of good farming practice in these regions. Grasslands originally covered 61 % of Mpumalanga, but 44 % of this has been transformed by agriculture and other development. This substantial and irreversible reduction of the biome is due mainly to cultivation, especially industrial scale agriculture and timber growing. These land uses destroy biodiversity but extensive livestock grazing can be reasonably biodiversity-friendly, provided good management and safe stocking rates are applied.

The palatability of grass and its value as food for livestock increases with decreasing rainfall, which is also correlated with altitude. In grazing terms, this corresponds to Sourveld in the moist highveld and sweetveld in the dryer lowveld. This grass palatability gradient extends from grassland into savannas. Although sweetveld grasses produce less biomass than sourveld grasses, they have higher food value and lower fibre. This means the plant nutrients are more available in lower rainfall areas due to less leaching of the soil by high rainfall. The 650mm rainfall isoline approximately separates these two livestock zones. Fire is a characteristic feature of grassland (and savannas) and is a necessary component of good land management. Grassland plants depend on fire, they resprout annually from their root-stocks.

Without frequent fire, grasslands eventually become invaded with woody species and some herbaceous plants die. Regular burning to complement good grazing management helps to prevent the increase of species unpalatable to livestock, including woody species that form bush encroachment. Timber growing is mainly restricted to grasslands but its impact is not limited to the plantation “footprint”. It significantly reduces surface and underground water and causes the spread of some of the most damaging alien species. These effects, along with flammability of its tree species and the fire protection measures required, also substantially change the fire regime in grasslands. The large number of rare and endangered species in grasslands is a particular problem for

environmental impact assessment. They are mostly small, very localised and visible for only a few weeks in the year when they flower. Most surveys will not pick them up and special skills are required to locate and identify them reliably. Highest biodiversity is found in rocky grassland habitats and on sandy soils. Clay soils generally have the lowest biodiversity in grasslands.

The grassland biome contains some of the most threatened vegetation types in South Africa. It is estimated that 60 to 80 % of South African grasslands have already been irreversibly transformed by agriculture, forestry, urban and industrial development and mining. An alarmingly low 2 % of the remaining pockets of pristine grasslands – areas of surprisingly high plant and animal diversity – are formally under conservation in 142 publicly owned nature reserves. On the positive side, by correlation of the geographic distribution, the 3,378 plant species found in the grassland biome, and the distribution of these nature reserves, it is estimated that 78 % of these species are indeed represented in conservation areas.

A reason for concern is the extensive commercial forestation over large areas of land in the high rainfall eastern Escarpment area, a region of exceptionally high biodiversity, which contains 30 % of the endemic and rare plant species of the former Transvaal Province. While it is too late to bring back the large migratory herds of grassland herbivores, it is imperative that the existing reserve network be maintained and expanded to conserve viable populations of South Africa's unique grassland species. The first step is to alert the South African public to the fact that a hitherto disregard heritage is slipping away. Warwick Tarboton, an eminent South African ornithologist, expressed it succinctly:

'If ever a biome needed a champion, it is the grassland'

8 BOTANICAL ASSESSMENT OF THE AFFECTED ENVIRONMENT

8.1 REGIONAL FLORISTIC TRAITS

The study site corresponds to the Grassland Biome as defined by Mucina & Rutherford (Vegmap, 2006). This ecological type is found in the eastern, precipitation-rich regions of the Highveld. Grasslands of these parts are regarded 'sour grasslands'. The three site alternatives are spatially represented in the Soweto Highveld Grassland ecological type. This vegetation type comprises a gently to moderately undulating landscape on the Highveld plateau supporting short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* and accompanied by a variety of other grasses such as *Elionurus muticus, Eragrostis racemosa, Heteropogon contortus* and *Tristachya leucothrix*. In places to disturbed, only scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover.

This vegetation type is regarded Endangered with a target of 24 %. Only a handful of patches are statutorily conserved, including Wadrift, Krugersdorp, Leeuwkuil, Suikerboschrand and Rolfe's Pan Nature Reserve. A few areas are privately conserved, including Johanna Jacobs, Tweefontein, Gert Jacobs, Nikolaas and Avalon Nature Reserves and Heidelberg Natural Heritage Site. Almost half of the area already transformed by cultivation, urban sprawl, mining and building of road infrastructure. Some areas have been flooded by dams (Grootdraai, Leeukuil, Trichardtsfontein, Vaal, Willem Brummer).

- **Graminoids**

Andropogon appendiculatus, *Brachiaria serrata*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *Elionurus muticus*, *Eragrostis capensis*, *E. chloromelas*, *E. curvula*, *E. plana*, *E. planiculmis*, *E. racemosa*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Setaria nigrirostris*, *S. sphacelata*, *Themeda triandra*, *Tristachya leucothrix*, *Andropogon schirensis, Aristida adscensionis, A. bipartita, A. congesta, A. junciformis* subsp. *galpinii, Cymbopogon caesius, Digitaria diagonalis, Diheteropogon amplectens, Eragrostis micrantha, E. superba, Harpochloa falx, Microchloa caffra* and *Paspalum dilatatum.*

- **Herbs**

Hermannia depressa, *Acalypha angustata, Berkheya setifera, Dicoma anomala, Euryops gilfillanii, Geigeria aspera* var. *aspera, Graderia subintegra, Haplocarpha scaposa, Helichrysum miconiifolium, H. nudifolium* var. *nudifolium, H. rugulosum, Hibiscus pusillus, Justicia anagalloides, Lippia scaberrima, Rhynchosia effusa, Schistostephium crataegifolium, Selago densiflora, Senecio coronatus, Vernonia oligocephala* and *Wahlenbergia undulata.*

- **Geophytic Herbs**

Haemanthus humilis subsp. *hirsutus* and *H. montanus.*

- **Herbaceous Climber**

Rhynchosia totta

- **Low Shrubs**

Anthospermum hispidulum, A. rigidum subsp. *pumilum, Berkheya annectens, Felicia muricata* and *Ziziphus zeyheriana.*

8.2 PHYTODIVERSITY

8.2.1 Regional Phytodiversity (POSA, 2012)

Information obtained from the SANBI database (POSA, 2012) indicates the known presence of approximately 390 plant species within the ¼-degree grids that are sympatric to the study area (2629CB & 2629CD)[3]. The high floristic diversity of the immediate region reflects the regional diversity context of the Grassland Biome. However, the paucity of accurate floristic species richness is indicated by the absence of some common plant taxa from the data records as well as the low species richness of certain ¼-degree grids.

An appraisal of the growth forms (refer **Table 1**) reflects the diverse grassland physiognomy with 142 herb species (52.8 %), 27 grass species, (10.0 %), 31 geophyte species (11.5 %) and 31 dwarf shrubs (11.5 %). The physiognomical dominance of the grassland biome is also illustrated by the absence of large trees and low diversity of shrubs (10 species, 3.7 %). This species richness also represents 70 plant families, typically dominated by Asteraceae (47 species, 17.5 %), Poaceae, (27 species, 10.0 %) and Fabaceae (16 species, 5.9 %).

Table 1: Growth forms of the region (POSA, 2012)

Growth Form	*Number*	*Percentage*
Climber	4	1.5 %
Cyperoid	7	2.6 %
Dwarf shrub	23	8.6 %
Geophyte	31	11.5 %
Graminoid	27	10.0 %
Helophyte	5	1.9 %
Herb	142	52.8 %
Hydrophyte	4	1.5 %
Lichen	1	0.4 %
Parasite	3	1.1 %
Shrub	10	3.7 %
Succulent	11	4.1 %
Tree	1	0.4 %
Total	**269**	

8.2.2 Recorded Phytodiversity (Species Richness)

Species richness is the number of different species represented in a set or collection of individuals. It is therefore simply a count of species, and it does not take into account the abundances of the species or their relative abundance distributions. In contrast, species diversity takes into account both species richness and species evenness.

Only 118 plant species were recorded during the survey period. Although relative low, the diversity is regarded representative of floristic diversity on a regional scale, but also reflects seasonal constraints of the survey. A list with the identified plant species, together with their growth forms, medicinal/ traditional uses and colloquial names are presented in Appendix 1.

A basic synopsis of the growth forms recorded in the study area reflects the major physiognomic variations that are present in the study area (refer **Table 2**). The grassland physiognomy is dominated by a species rich herb layer and grass sward. Typically, the herbaceous layer is prominent and is physiognomically dominated by the grass sward. A total of 33 grass species (28.0 %) were recorded. The herbaceous layer is rich in species, comprising 54 herbs and forbs (45.8 %). With the exception of human abodes where exotic and introduced tree

[3] This list is not included in the report due to the size, but can be presented separately on request.

species are present, woody species are absent from the study area or occur as scattered shrubs. The presence of wetland habitat is indicated by the presence of 7 sedges (5.9 %) and 5 hydrophilic species (4.2 %). The diversity of plants within the study area is represented by 38 plant families (refer **Table 3**), typically dominated by Poaceae (graminoids), comprising 34 species (28.8 %) and Asteraceae (Daisy family, 24 species, 20.3 %).

Table 2: Growth forms recorded in the study area

Growth Form	*Number*	*Percentage*
Creepers	2	1.7 %
Forbs	54	45.8 %
Geophytes	7	5.9 %
Grasses	33	28.0 %
Hydrophilics	5	4.2 %
Sedges	7	5.9 %
Shrubs	2	1.7 %
Succulents	1	0.8 %
Trees	7	5.9 %
Total	**118**	

Table 3: Plant families recorded in the study area

Growth Form	*Number*	*Percentage*
Acanthaceae	1	0.8 %
Amaranthaceae	1	0.8 %
Amaryllidaceae	2	1.7 %
Apiaceae	1	0.8 %
Apocynaceae	3	2.5 %
Asteraceae	24	20.3 %
Brassicaceae	1	0.8 %
Campanulaceae	1	0.8 %
Casuarinaceae	1	0.8 %
Chenopodiaceae	1	0.8 %
Commelinaceae	2	1.7 %
Convolvulaceae	2	1.7 %
Cyperaceae	7	5.9 %
Dipsacaceae	1	0.8 %
Fabaceae	5	4.2 %
Fagaceae	1	0.8 %
Geraniaceae	1	0.8 %
Hypoxidaceae	2	1.7 %
Lamiaceae	1	0.8 %
Liliaceae	1	0.8 %
Malvaceae	1	0.8 %
Meliaceae	1	0.8 %
Myrsinaceae	1	0.8 %
Onagraceae	2	1.7 %
Oxalidaceae	2	1.7 %
Plantaginaceae	1	0.8 %
Poaceae	34	28.8 %
Polygonaceae	1	0.8 %
Portulacaceae	1	0.8 %
Ranunculaceae	1	0.8 %
Rubiaceae	1	0.8 %
Salicaceae	2	1.7 %
Scrophulariaceae	2	1.7 %
Selaginaceae	1	0.8 %
Solanaceae	3	2.5 %

Table 3: Plant families recorded in the study area		
Growth Form	***Number***	***Percentage***
Sterculiaceae	3	2.5 %
Typhaceae	1	0.8 %
Verbenaceae	1	0.8 %

8.3 PLANT TAXA OF CONSERVATION IMPORTANCE

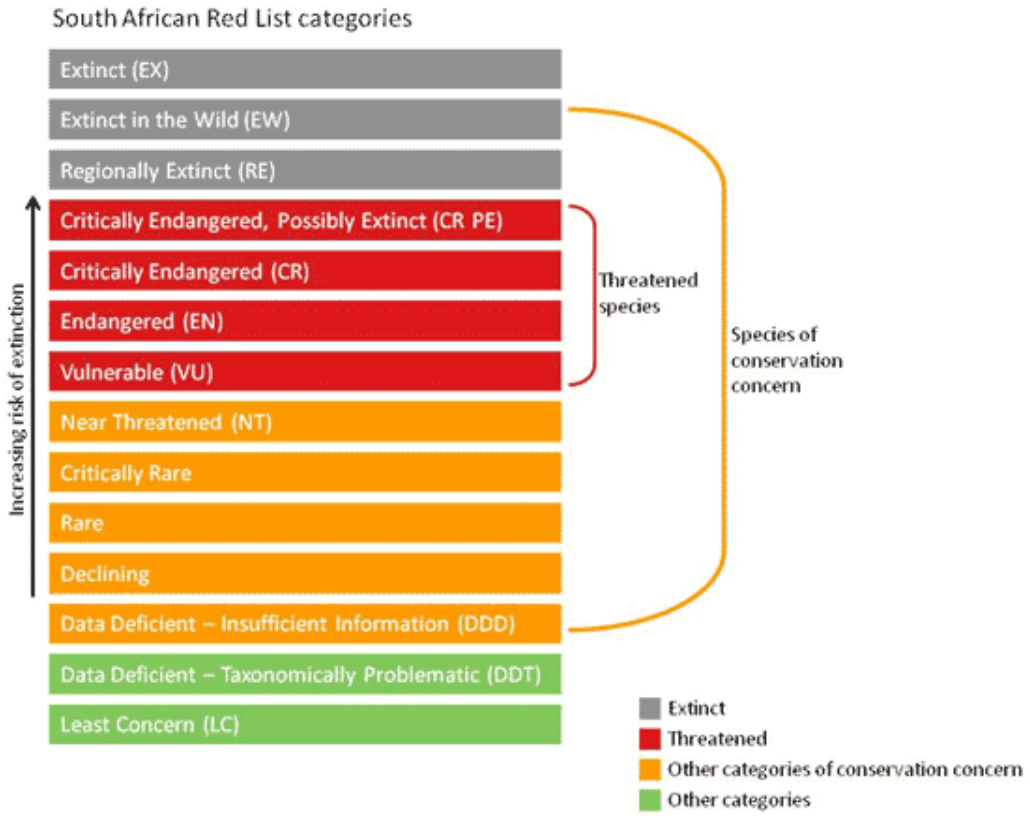
8.3.1 Available Information

South Africa uses the internationally endorsed IUCN Red List Categories and Criteria in the assessment of the conservation status of South African plants. This scientific system is designed to measure species' risk of extinction. The purpose of this system is to highlight those species that are most urgently in need of conservation action. Due to its strong focus on determining risk of extinction, the IUCN system does not highlight species that are at low risk of extinction, but may nonetheless be of high conservation importance. Because the Red List of South African plants is used widely in South African conservation practices such as systematic conservation planning or protected area expansion, an amended system of categories designed to highlight those species that are at low risk of extinction but of conservation concern are used.

Guidelines for the assessment of Red List species include (but are not necessarily limited to):

- A botanical specialist with local botanical and ecological knowledge and experience should undertake the survey;
- A suitable survey should be undertaken; in the summer-rainfall areas of the country, botanical surveys should take place between October and April while in the winter-rainfall areas they should take place between August and October;
- Prior to visiting the site, the specialist consultant should download a list of species that could potentially occur at the site from POSA;
- It is important that specimens are collected as part of the botanical survey, especially for taxonomic groups likely to be of conservation concern;
- Plants should be identified to species level wherever possible, not genus level;
- Species that may be dormant should also be reported;
- Once specimens are collected, they should be identified at a herbarium. Potential species of conservation concern sampled should be identified by a taxonomist specializing in the plant group in question;
- Specialist botanists should also include in their reports a list of species of conservation concern that may occur at a site but may be dormant as a result of unfavourable environmental conditions, for example species that were not seen because the vegetation at a site has not been burnt for many years.

Figure 8: South African Red List Categories (courtesy of SANBI)



Mpumalanga Province comprises 4,256 plant species of which 276 are included in the following conservation categories:

- 1 Extinct;
- 30 Endangered;
- 80 Vulnerable;
- 36 Near Threatened;
- 2 Critically Rare;
- 47 Rare;
- 25 Declining;
- 19 DDD; and
- 36 DDT.

Data records indicate the presence of only two plant species of conservation importance within the ¼-degree grids that are spatially represented in the study area, including.

- *Drimia elata* (Data Deficient); and
- *Cineraria austrotransvaalensis* (Near Threatened).

In addition to the species currently captured in the SANBI infobase (POSA, 2011), the following provincially protected plants are known to occur within the region of the study area (Mpumalanga Nature Conservation Act No.10 of 1998) (refer **Table 4**).

Table 4: Protected plant species within the region of the study area

Species Name	Family	Status
Eucomis autumnalis subsp. *clavata*	Hyacinthaceae	Provincially protected
Eulophia ovalis var. *ovalis*	Orchidaceae	Provincially protected
Gladiolus dalenii subsp. *dalenii*	Iridaceae	Provincially protected

Table 4: Protected plant species within the region of the study area		
Species Name	**Family**	**Status**
Gladiolus elliotii	Iridaceae	Provincially protected
Gladiolus longicollis subsp. *platypetalus*	Iridaceae	Provincially protected
Haemanthus humilis subsp. *hirsutus*	Amaryllidaceae	Provincially protected
Haemanthus montanus	Amaryllidaceae	Provincially protected

8.3.2 Survey Results

The following conservation important plant taxa were recorded during the survey period.

Table 5: Conservation important taxa recorded in the study area		
Species Name	***Family***	***Common Name***
Boophone disticha	Amaryllidaceae	Bushman Poison Bulb (e), Gifbol (a)
Crinum bulbispermum	Amaryllidaceae	Orange River Lily (e), Oranjerivierlelie (a)
Hypoxis hemerocallidea	Hypoxidaceae	African Potato (e), Afrika aartappel (a)

The relative low number of conservation important species that were recorded within the study area during the brief survey period, is a reflection of the moderately degraded status of the vegetation encountered in the study area. Considering the brief nature of the survey, the pristine nature of the vegetation and the number of conservation important species that are known to occur in the general region, it is likely that additional conservation important species could persist in the study area. However, it is regarded unlikely that any plant species of the higher conservation categories will persist within the proposed areas as a result of degradation patterns of the remaining areas of natural vegetation.

8.3.3 Weeds & Invasive Plants

The presence of numerous weeds and poor quality species strongly reflects the transformed and degraded nature of much of the study area, with particular reference to the agricultural fields. The following weeds and invasive plant taxa were recorded within the study area:

Table 6: Common weeds and invasive plant species recorded in the study area		
Taxon	***Colloquial Name***	***Status/ Uses***
Berkheya carlinopsis	Weed	--
Berkheya pinnatifida	Weed	--
Berkheya rhapontica	Weed	--
Berkheya setifera	Weed, widespread	Rasperdisseldoring (a)
Bidens pilosa	Naturalised exotic, edible parts	Black-jack (e), Knapsekêrel (a)
Bromus catharticus	Weed, average grazing potential, Naturalised exotic	Rescue Grass (e), Reddingsgras (a)
Chenopodium album	Naturalised exotic, weed, edible parts	Common pigweed (e), Bloubossie (a)
Ciclospermum leptophyllum	Exotic weed (S America)	--
Cirsium vulgare	Declared Invader - Category 1B, weed	Scottish thistle (e), Skotse dissel (a)
Conyza podocephala	Weed, indicator of disturbed areas	Bakbossie (a)
Cosmos bipinnatus	Weed, exotic (S. America), aesthetic uses	Cosmos (e), Kosmos (a)
Crepis hypochoeridea	Weed, indicator of disturbed areas, Naturalised exotic	--
Cyperus esculentus	Weed, edible parts (tuber)	Yellow nutsedge (e), Geeluintjie (a)
Datura stramonium	Declared Invader - Category 1B, weed	Common thorn apple (e)
Eucalyptus species	Declared Invader - Category 2, essential oils	Eucalyptus gum tree (e), Bloekomboom (a)
Flaveria bidentis	Declared Invader - Category 1B	Smelter's bush, Smelterbossie (a)
Gleditsia triacanthos	Naturalised exotic, Category 1B	Honey locust (e), Driedoring Gleditsia (a)

Table 6: Common weeds and invasive plant species recorded in the study area		
Taxon	***Colloquial Name***	***Status/ Uses***
Gomphrena celosioides	Weed, South America	Bachelor's button (e), Mierbossie (a)
Melia azedarach	Declared Invader - Category 1B	Seringa (e), Gewone sering (a)
Oenothera rosea	Weed (S. America), moist & degraded places	Rose evening primrose (e), Pienkaandblom (a)
Oenothera tetraptera	Weed (Mexico)	White evening primrose (e), Witaandblom (a)
Pennisetum clandestinum	Invader (E. Africa), palatable grazing	Kikuyu Grass (e), Kikoejoegras (a)
Populus canescens	Declared Invader - Category 2 - America, timber	Grey poplar (e), Gryspopulier (a)
Pseudognaphalium luteo-album	Weed (Europe)	Jersey Cudweed (e), Roerkruid (a)
Quercus ruber	Naturalised exotic	Acorn Tree (e), Akkerboom (a)
Salix babylonica	Declared Invader - Category 2	Weeping willow (e), Treurwilger (a)
Schkuhria pinnata	Medicinal uses, weed (S. America)	Dwarf Marigold (e), Bitterbossie (a)
Solanum panduriforme	Weed, traditional medicine, poisonous	Poison Apple (e), Gifappel (a)
Typha capensis	Cosmopolitan weed, edible parts, medicinal uses	Bulrush (e), Papkuil (a)
Verbena bonariensis	Declared Invader - Category 1B, Weed (S. America)	Purple Top (e), Blouwaterbossie (a)

The high number of weeds and invasive species provide some indication of the moderately degraded nature of the grasslands of the study area. The presence of these weeds is a reaction of severe grazing pressure in the grasslands. Similarly, increased abundance of many locally endemic species, as well as decreasing cover abundance values of normally abundant climax species, also indicate persistent high grazing pressure.

8.4 VEGETATION DEVELOPMENT DRIVERS

Development of the regional (natural) grassland vegetation is generally the result of complex interacting driving forces that include climatic-, geological (soil), topographical- and moisture gradients typical of the grassland regions of southern Africa. The study area and the general surrounds is characterised by extensive transformation of the original grasslands through agriculture and industrial land uses. Additionally, degradation of remaining natural grassland is evident, resulting from intensive livestock farming and suboptimal management strategies (e.g. fire management and camps systems) that tend to result in irreversible changes to the herbaceous layer (*also refer to **Section 5.2** for comments pertaining to the capturing and representation of natural grasslands in available infobases*). These changes are reflected in compositional and structural changes of the grass sward. A moderate divergence from the 'normal' or pristine composition of the primary grassland habitat (Soweto Highveld Grassland, **Section 8.1**) is noted in the study area. The use of camp systems for livestock farming results in the varying utilisation and management across any given area and compositional and structural variances result in a mosaical appearance of the grasslands. Thus, the status of grassland vary significantly across the region, but also on a much smaller scale in reaction to grazing pressure and management applications. Remaining natural grassland of the study area is moderately representative of the regional grassland vegetation, representing a primary climax status.

Wetland and ephemeral grassland habitat, reflecting regional vegetation patterns (primary grassland), comprises some portions of the study area; moderate to severe degradation is caused by livestock grazing. Development of wetland communities and variations are driven by the interplay of local and regional substrate-, moisture- and topographical gradients. Regionally the development of these habitat types are placed on topographical and geological gradients that are also likely to affect the persistence of moisture in the soils, resulting in the variation between ephemeral and permanent wetland types. Locally, the development of vegetation patterns are likely to be driven by topographical placement, slopes, local soil characteristics and moisture content and inundation of the soils, resulting in a gradient between wetland and terrestrial grasslands, characterised by the absence/ presence and abundance of specific species (flora and fauna).

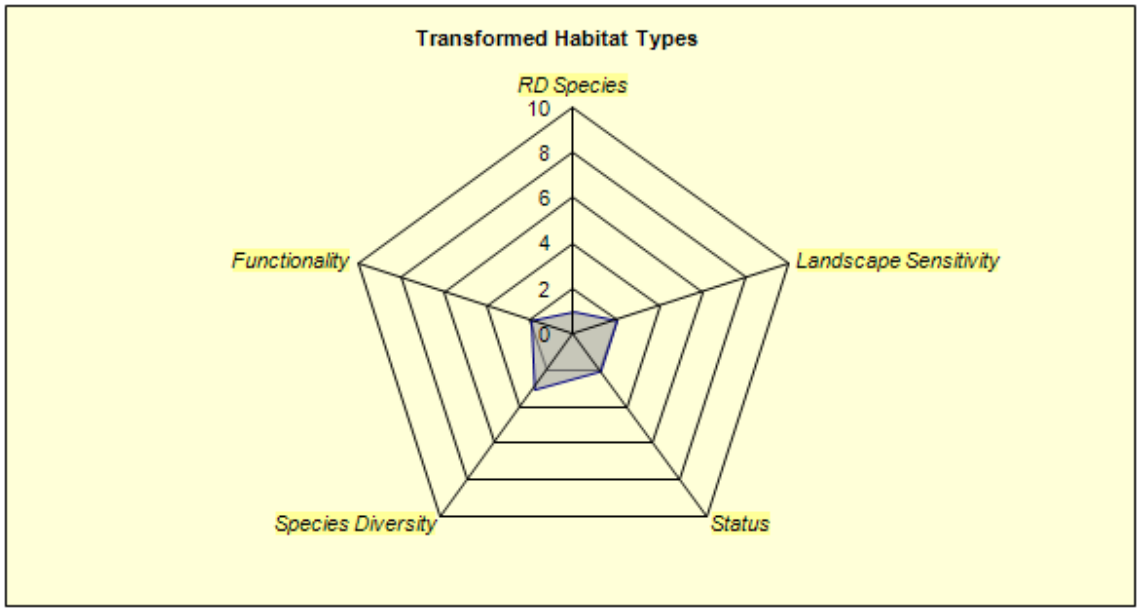
8.5 MACRO HABITAT TYPES & VARIATIONS

Remaining natural (untransformed) vegetation of the study area is regarded moderately representative of the regional vegetation type (Soweto Highveld Grassland, refer **Section 8.1**). While limited to severe divergence from the original species composition, diversity and vegetation structure (described by Mucina and Rutherford, Vegmap, 2006) is recorded, most of the original elements of the original grassland remain across the study area as a whole, albeit at much lower abundance levels. Zonality of natural grassland habitat is represented by the interplay of terrestrial and wetland related grassland habitat types. Deterioration of terrestrial grassland types is frequently observed, resulting mainly because of severe pressure from livestock farming practices. Results of the photo analysis and site observations revealed the presence of the following macro habitat types, communities and variations (refer **Figure 10**):

- Transformed Habitat Types, including;
  - Agricultural Fields;
  - Infrastructure/ Transformed Areas;
  - Stands of Exotic Trees;
- Wetland Habitat, including:
  - Ephemeral Grasslands;
  - Valley Bottoms & Drainage Lines;
- Terrestrial Grassland Habitat Types, including
  - Degraded Grassland;
  - Natural Grassland; and
  - Poor Status Grasslands.

8.5.1 Transformed Habitat Types

Areas included in this category are characterised by the atypical and degraded nature of the vegetation. Typically, a high degree of transformation of the natural vegetation is noted due to anthropogenic influences. In most cases, the original vegetation is entirely transformed and replaced by either agricultural fields, infrastructure, stands of exotic trees, or has been degraded beyond any recognition and is devoid of any natural vegetation. These areas were mostly excluded from the surveys as no natural vegetation remains.



Graph 1: Floristic Sensitivity Rose for Transformed Habitat Types

- **Agricultural Fields**

Commercial cultivation (*Zea mays*) represents the major land transformation activity in the region resulting in a mosaical pattern of agricultural fields within a natural grassland environment, of which extremely little remains, hence the 'Endangered' conservation status ascribed to the regional vegetation type. Vegetation altered by agricultural practices is unlikely to recover to a state that approximates the natural regional vegetation, even with the application of rehabilitation and management programmes.

Fringes of agricultural areas are furthermore frequently occupied by an admixture of weeds and invasive and pioneer species, including *Berkheya* species, *Bromus catharticus, Chenopodium album, Cirsium vulgare, Cosmos bipinnatus, Cyperus esculentus, Flaveria bidentis, Lepidium africanum, Physalis viscosa, Talinum caffrum* and *Verbena bonariensis.* Red Data plant species are unlikely to persist within these areas and a low floristic status and sensitivity is ascribed to these parts. It is however important to note that this habitat type frequently borders sensitive (wetland) habitat of the study area and while the floristic importance of these areas might be labelled as low, their utilisation for industrial purposes might not necessarily be as straightforward. The proximity to sensitive habitat implies that the status quo of sensitive habitat should (at least) be preserved or improved and that a carte blanche on development of low sensitivity areas is not necessarily a fait accompli.

- **Infrastructure/ Transformed Areas**

This habitat type represents areas where historical or recent human activities led to transformation of the natural vegetation. No natural vegetation remains in these areas and the floristic status of these areas is therefore regarded low because of the secondary vegetation that characterises these parts. The fringes of these areas are frequently occupied by species similar in nature and composition than the agricultural fields. The likelihood of encountering Red Data species within these areas are regarded low and a low floristic status is ascribed to these parts.

- **Exotic Stands**

Small, isolated stands of exotic trees occur in a scattered fashion in the study area. This habitat type comprises all areas where natural vegetation has been replaced by stands of exotic trees. Exotic tree species recorded in the study area include *Casuarina* species, *Eucalyptus* species, *Gleditsia triacanthos, Melia azedarach, Populus canescens, Quercus robur* and *Salix babylonica*. A low floristic status is ascribed to these areas and it is regarded highly unlikely that these areas will be inhabited by flora species of conservation importance. However, in spite of a low floristic status, the floristic sensitivity of respective portions varies due to the proximity to sensitive environs.

8.5.2 Wetland Habitat Types

This community is characterised by permanently or temporary inundated vegetation types, comprising of valley bottoms (streams/ drainage lines), and Ephemeral Grasslands (Hillslope Seepage Wetlands). A schematic diagram of how these systems are frequently positioned in the landscape and the general topography is presented in **Figure 9**.

This concomitance of habitat types is characterised by waterlogged soil conditions that may be permanent or persist for shorter periods subsequent to raining bouts. The loss of some terrestrial grassland habitat in the areas immediately surrounding most of the natural habitat types in the study area, effectively implies that the ecological character and the interrelationships between the terrestrial and aquatic environments are somewhat compromised, but ultimately renders the ecological and biodiversity importance of these habitat types on a local and regional scale extremely high. Similarly (and more directly), a utilisation gradient (livestock grazing) is noted throughout the study area, this is particularly prevalent in these units as animals congregate on a daily basis to

utilise these areas. Trampling, importation of weeds and invasive species, increased erosion, chemical depositions, high grazing pressure, etc. represent some of the direct impacts. In spite of several impacts noted in this habitat type, a diverse species composition was recorded (refer **Table 7**).

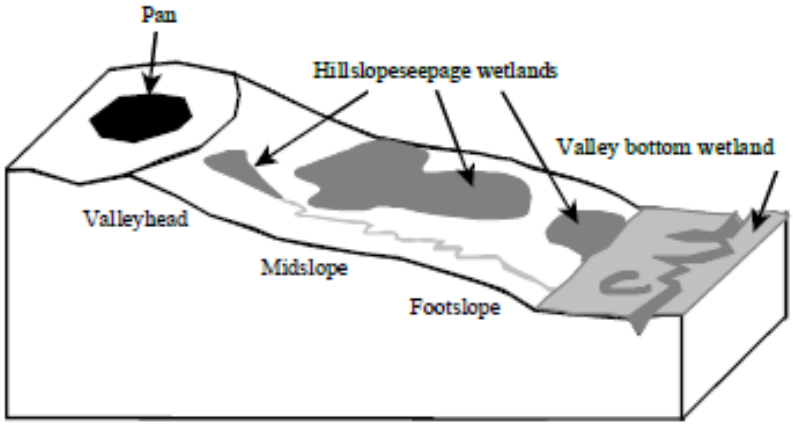


Figure 9: Schematic illustration of the topographical settings of typical wetland types

Table 7: Plant taxa recorded in the wetland habitat types

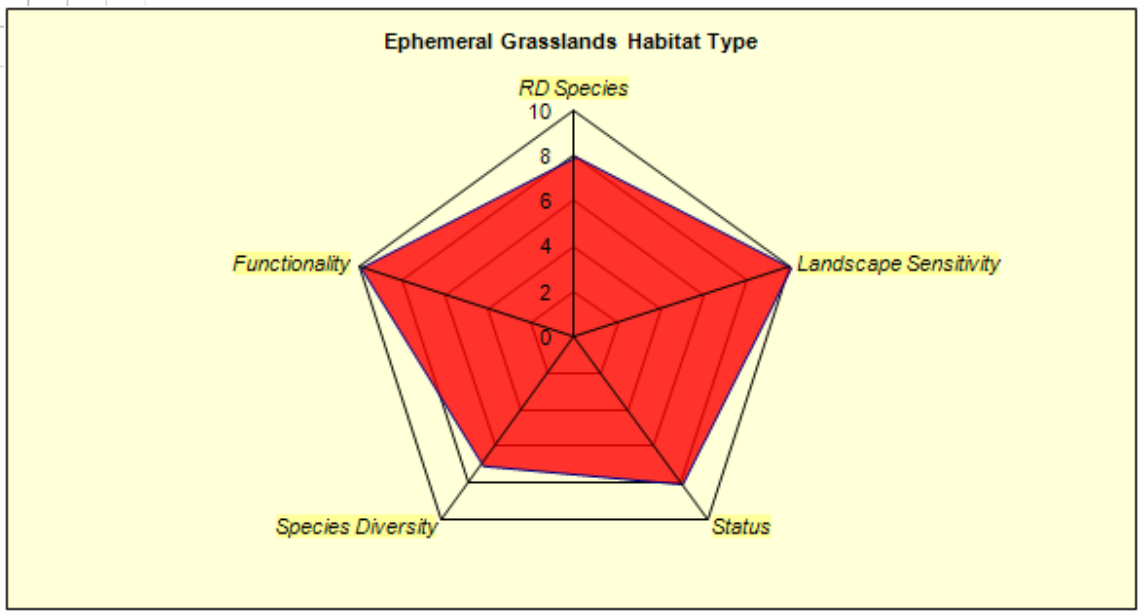
Family	*Species Name*	*Growth Form*
Amaryllidaceae	***Crinum bulbispermum***	**Geophyte**
Apiaceae	*Ciclospermum leptophyllum*	Hydrophilic
Apocynaceae	*Asclepias eminens*	Forb
	Gomphocarpus fruticosus	Shrub
	Xysmalobium undulatum	Succulent
Asteraceae	*Berkheya pinnatifida*	Forb
	Berkheya setifera	Forb
	Bidens pilosa	Forb
	Cirsium vulgare	Forb
	Cosmos bipinnatus	Forb
	Crepis hypochoeridea	Forb
	Flaveria bidentis	Forb
	Gerbera piloselloides	Forb
	Helichrysum aureonitens	Forb
	Lactuca inermis	Forb
	Pseudognaphalium luteo-album	Forb
	Senecio achilleifolius	Forb
	Senecio erubescens	Forb
	Senecio inornatus	Forb
Brassicaceae	*Lepidium africanum*	Forb
Campanulaceae	*Wahlenbergia undulata*	Forb
Cyperaceae	*Abildgaardia ovata*	Sedge
	Bulbostylis burchellii	Sedge
	Cyperus compressus	Sedge
	Cyperus esculentus	Sedge
	Eleocharis dregeana	Sedge
	Kyllinga alba	Sedge
	Schoenoplectus corymbosus	Sedge
Fabaceae	*Indigofera species*	Forb
	Erythrina zeyheri	Shrub
Hypoxidaceae	*Hypoxis rigidula*	Geophyte
Myrsinaceae	*Eucalyptus species*	Tree
Onagraceae	*Oenothera rosea*	Forb

	Oenothera tetraptera	Forb
Oxalidaceae	*Oxalis semiloba*	Geophyte
	Oxalis species	Geophyte
Plantaginaceae	*Plantago lanceolata*	Forb
Poaceae	*Agrostis lachnantha*	Grass
	Aristida bipartita	Grass
	Brachiaria eruciformis	Grass
	Brachiaria glomerata	Grass
	Bromus catharticus	Grass
	Chloris virgata	Grass
	Eragrostis chloromelas	Grass
	Eragrostis curvula	Grass
	Eragrostis plana	Grass
	Helictotrichon turgidulum	Grass
	Imperata cylindrica	Grass
	Leersia hexandra	Grass
	Paspalum dilatatum	Grass
	Paspalum notatum	Grass
	Paspalum species	Grass
	Phragmites australis	Hydrophilic
Polygonaceae	*Rumex crispus*	Hydrophilic
Ranunculaceae	*Ranunculus multifidus*	Forb
Salicaceae	*Salix babylonica*	Tree
Scrophulariaceae	*Jamesbrittanea aurantiaca*	Forb
	Diclis species	Hydrophilic
Selaginaceae	*Selago densiflora*	Forb
Sterculiaceae	*Hermannia lancifolia*	Forb
Typhaceae	*Typha capensis*	Hydrophilic
Verbenaceae	*Verbena bonariensis*	Forb

- **Ephemeral Grasslands**

The vegetation of this variation comprehends mesic grasslands in the form of marshy/ moist grassland seepages. Surface water is present for prolonged periods of the year and the vegetation manifests as dense, moribund grasses and cyperoid species, some of which are obligate wetland taxa. This variation is situated on the flatter footslopes that are characterised by local soils with relative high clay content. Soils that characterise this habitat type are characteristic, comprising a humic A-horizon, frequently an E-horizon and typically a clayey B-horizon of which the clay content is normally high, varying between 35 and 45 %. The clayey B-horizon facilitates retention of water in the top part of the soils, which may seep throughout the year within the humic A-horizon or could desiccate during the winter season. This wetland variation is also situated on the valley bottom floor (Terrain Unit 4) where the topography is mostly flat, causing slow seepage towards the perennial drainage line. The floristic status of these areas varies greatly; grazing by livestock is recognised as the driving force behind habitat status of these areas. Intensive grazing results in disappearance of many species; the vegetation is dominated by hardy and resilient species, mostly grasses such as *Eragrostis curvula* and *E. plana*.

A dominant (frequently moribund) grass sward and diverse herbaceous component is typical of the vegetation. Because of the association with the nearby sensitive channelled valley bottoms, a high floristic sensitivity is estimated, specifically because many plant taxa of conservation importance have strong affinity with this type of vegetation (refer **Graph 2**). The moderate high diversity recorded in this habitat type is ascribed to the ecotonal interface between the valley bottoms and the adjacent terrestrial grasslands. While a relative high percentage of the species composition comprises obligate wetland taxa, a portion of the composition is also strongly associated with the drier upland environs. The grass sward of this unit is characteristically dominant, but a high geophyte component is noted.



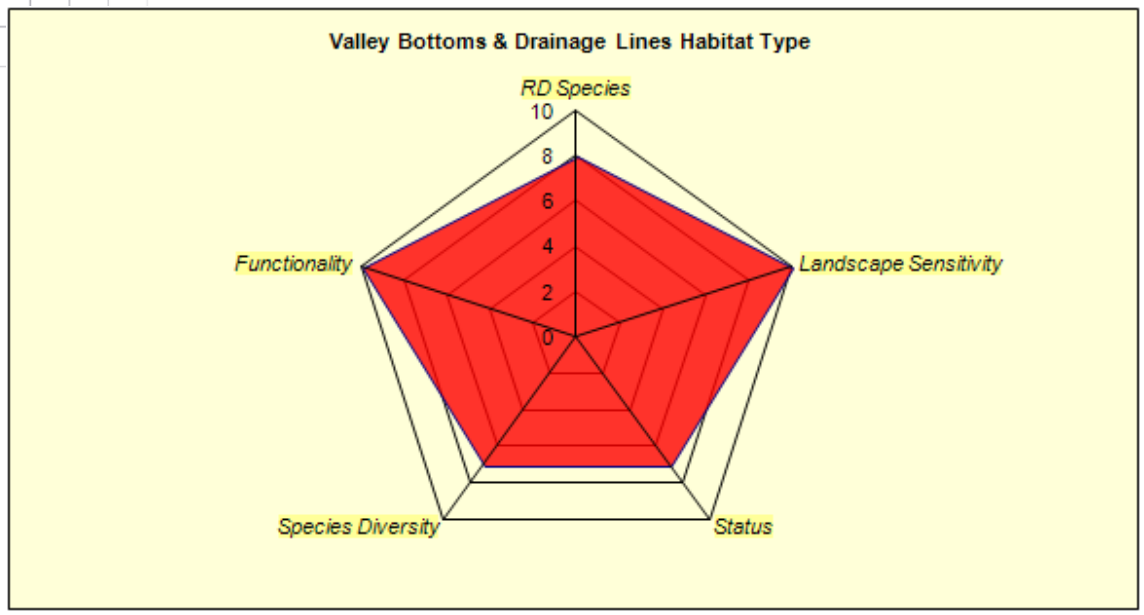
Graph 2: Floristic Sensitivity Rose of the Ephemeral Grasslands Unit

- **Valley Bottoms & Drainage Lines**

Perennial and non-perennial drainage lines in the study area is characterised by soils types with high clay content (35 – 60 %). This terrain unit typically comprises approximately 5 % of the landscape. Channelled valley bottoms of the study area comprise drainage lines and perennial streams with both clearly and ill-defined banks and streambeds. These features are closely associated with valley bottom seepages as well as upland terrestrial grasslands, differentiated by the variation in soil conditions and slopes that results in a varied nature. Grazing and trampling by livestock, infestation by exotic trees and the proximity to mining areas are recognised as the driving forces behind habitat status in these areas. All of these factors cause severe habitat deterioration. Trampling of soils, localised erosion and bank destabilisation are characteristic impacts in areas subjected to high stocking rates.

The vegetation of the Valley Bottoms is diverse, comprehending dominant grasses and forbs embedded as localised stands. This diversity is the result of the widely varying habitat conditions within this habitat type, ranging from clearly defined streams with banks and a well-defined bed, to ill-defined drainage areas where there are little visual differences in the appearance of the actual drainage line and surrounding grassland habitat. Wetland areas characterised by defined boundaries are also characterised by clearly defined floristic variations with (similarly) defined boundaries. These wetland types are frequently characterised by a higher percentage of obligate wetland taxa. Conversely, wetland types with ill-defined drainage lines, where there are no clear boundaries and stream banks and streambeds are mostly absent, comprise floristic variations that gradually changes with the slopes and proximity to the stream/ drainage line. These variations are particularly difficult to distinguish visually and are sometimes treated as a conglomerate of variations, rather than distinct units. The floristic composition of these areas is frequently similar to the surrounding grasslands and a lower percentage of obligate wetland taxa are recorded in these areas.

Various geophytes and obligate wetland species occur in this unit and the habitat is furthermore regarded suitable for a number of conservation important plant taxa. Generally, the floristic status of this habitat unit is regarded moderately pristine and only localised areas of severe deterioration and degradation is noted. A high conservation status and sensitivity is therefore ascribed to this unit (refer **Graph 3**).



Graph 3: Floristic Sensitivity Rose for the Valley Bottoms & Drainage Line Unit

8.5.3 Terrestrial Grassland Habitat

Terrestrial grasslands comprise natural grasslands situated in upland positions (topographical unit 3), characterized by a short, low cover of herbaceous species, physiognomically dominated by grasses, but with a high diversity of forbs. The floristic status of these areas is determined by the intensity of livestock grazing and by insowing and harvesting practices. The phytosociological characteristics are determined by the interplay between moisture levels, topographical placement and status.

This community comprehends the natural terrestrial grassland habitat of the study area. Significant variations are however noted in the status, composition and physiognomy because of anthropogenic impacts caused by intensive livestock utilisation. High stocking rates and overutilization are the most important reason for grassland degradation, leading to the prominence of secondary grasses such as *Eragrostis plana, Cynodon dactylon* and the disappearance of some of the forbs and geophyte species. Areas subjected to lower grazing pressure exhibit vegetation with a higher floristic status, which can also be noted from a higher species richness of the herbaceous stratum. The insowing of *Eragrostis curvula* in natural grasslands, for harvesting purposes, represents a severe impact on the status of natural grasslands. Changes in the dominance of certain species lead to the disappearance of numerous forbs and grasses that are strongly associated with pristine grassland habitat.

The conservation status of these grasslands, on a regional scale, is regarded 'Endangered'. Natural grassland habitats within the study area where the species composition and floristic character approximates that of the regional vegetation type is therefore regarded sensitive. In addition to the conservation importance that is ascribed to these remaining portions of grassland, the ecological importance in terms of their contribution to the functionality of associated wetland habitat types cannot be overemphasised.

Based on the occurrence of surface outcrops, the severity of slopes and the observed status, the grasslands of the study areas are divided into the following variations:

- Degraded Grassland;
- Natural Grassland; and
- Poor Status Grassland.

The distinction between Degraded and Natural Grasslands represents a continuum of varying species presence/ absence and dominance factors that (mostly) results from varying grazing intensities. The status of grasslands therefore frequently varies over short distances.

Table 8: Plant taxa recorded in the grassland habitat of the study area

Family	*Species Name*	*Growth Form*
Acanthaceae	*Chaetacanthus costatus*	Forb
Amaranthaceae	*Gomphrena celosioides*	Forb
Apocynaceae	*Asclepias eminens*	Forb
	Gomphocarpus fruticosus	Shrub
	Xysmalobium undulatum	Succulent
Asteraceae	*Berkheya carlinopsis*	Forb
	Berkheya pinnatifida	Forb
	Berkheya setifera	Forb
	Bidens pilosa	Forb
	Cirsium vulgare	Forb
	Conyza podocephala	Forb
	Crepis hypochoeridea	Forb
	Felicia muricata	Forb
	Gerbera piloselloides	Forb
	Helichrysum pilosellum	Forb
	Helichrysum rugulosum	Forb
	Hilliardiella oligocephala	Forb
	Pseudognaphalium luteo-album	Forb
	Schkuhria pinnata	Forb
	Senecio erubescens	Forb
	Senecio inaequidens	Forb
	Tagetes minuta	Forb
Campanulaceae	*Wahlenbergia undulata*	Forb
Commelinaceae	*Commelina africana*	Forb
	Cyanotis speciosa	Forb
Convolvulaceae	*Ipomoea crassipes*	Creeper
	Ipomoea oblongata	Creeper
Cyperaceae	*Abildgaardia ovata*	Sedge
Dipsacaceae	*Scabiosa columbaria*	Forb
Fabaceae	*Indigofera hedyantha*	Forb
	Indigofera species	Forb
	Sphenostylis angustifolia	Forb
Geraniaceae	*Monsonia angustifolia*	Forb
Hypoxidaceae	*Hypoxis hemerocallidea*	Geophyte
	Hypoxis rigidula	Geophyte
Lamiaceae	*Stachys* species	Forb
Liliaceae	*Chlorophytum cooperi*	Geophyte
Malvaceae	*Hibiscus trionum*	Forb
Onagraceae	*Oenothera rosea*	Forb
Oxalidaceae	*Oxalis* species	Geophyte
Plantaginaceae	*Plantago lanceolata*	Forb
Poaceae	*Aristida aequiglumis*	Grass
	Aristida congesta subsp. *barbicollis*	Grass
	Aristida species	Grass
	Cymbopogon pospischilii	Grass
	Cynodon dactylon	Grass
	Digitaria eriantha	Grass
	Eragrostis capensis	Grass
	Eragrostis chloromelas	Grass
	Eragrostis curvula	Grass

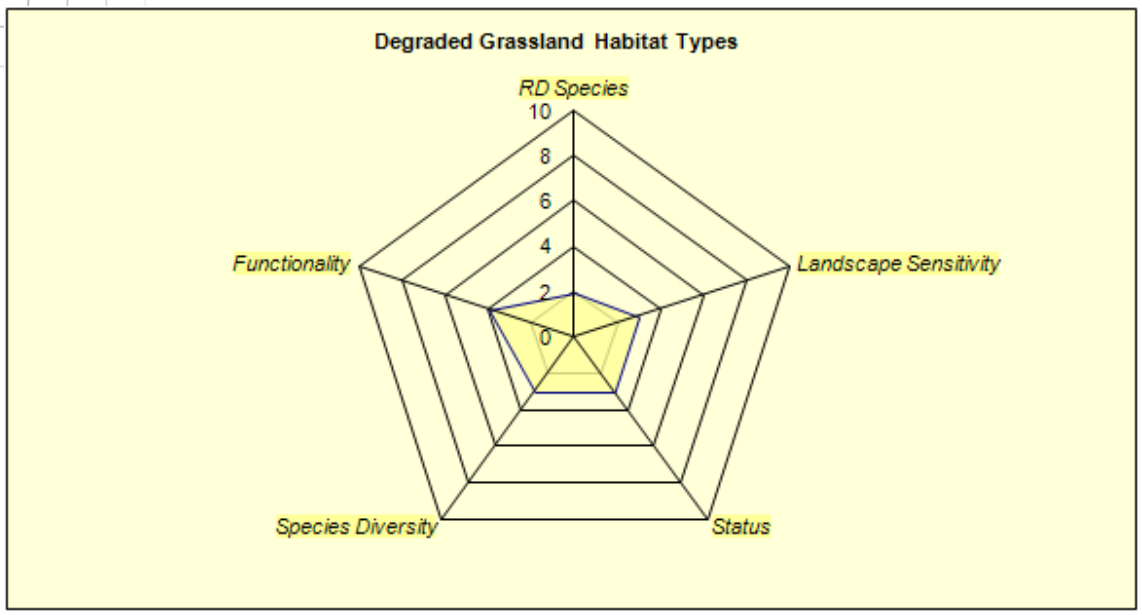
	Eragrostis plana	Grass
	Eragrostis species	Grass
	Eragrostis superba	Grass
	Heteropogon contortus	Grass
	Hyparrhenia filipendula	Grass
	Hyparrhenia hirta	Grass
	Setaria sphacelata	Grass
	Themeda triandra	Grass
	Urochloa brachyura	Grass
Polygonaceae	*Rumex crispus*	Hydrophilic
Rubiaceae	*Anthospermum rigidum*	Forb
Scrophulariaceae	*Jamesbrittanea aurantiaca*	Forb
Solanaceae	*Datura stramonium*	Forb
Sterculiaceae	*Hermannia coccocarpa*	Forb
	Hermannia depressa	Forb
	Hermannia lancifolia	Forb
Verbenaceae	*Verbena bonariensis*	Forb

- **Degraded Grassland**

The physiognomy of this unit does not always vary significantly from the isolated portions of pristine grasslands of the region, but a marked difference in the floristic composition is usually recorded. The degraded status of selected instances is determined by surface disturbances resulting from nearby anthropogenic activities. The severity of livestock utilisation determines the incidence of this unit, which is indicated by a distinct disappearance of palatable grasses and some forbs and geophytes, and the dominance of poor quality grasses and the appearance of weeds that frequently indicate habitat degradation. The relative high species richness is mostly a result of the presence of various weeds and poor quality species that are not normally associated with terrestrial grasslands in the area. Also of note is the interspecific dominance values; degraded grassland is frequently dominated by a low number of species, *i.e.* two or three species tend to dominate in certain areas, occurring in abundance.

This is in contrast with pristine grasslands where there is normally a higher number of co-dominant species recorded, *i.e.* more species occurring together at lower abundance values. In particular, the grasses *Eragrostis plana, Hyparrhenia hirta, E. chloromelas* and *E. curvula* tend to become dominant with increasing degradation. The presence of the forbs *Acanthospermum australe, Crepis hypochoeridea, Ipomoea ommanneyi, Plantago lanceolata, Richardia brasiliensis, Verbena* species and *Hypoxis rigidula* is noted within these areas and is frequently associated with poor status grassland habitat.

A medium-low floristic status and sensitivity (refer **Graph 4**) is ascribed to these parts, as these areas could potentially recover to a pristine condition under correct management principles.



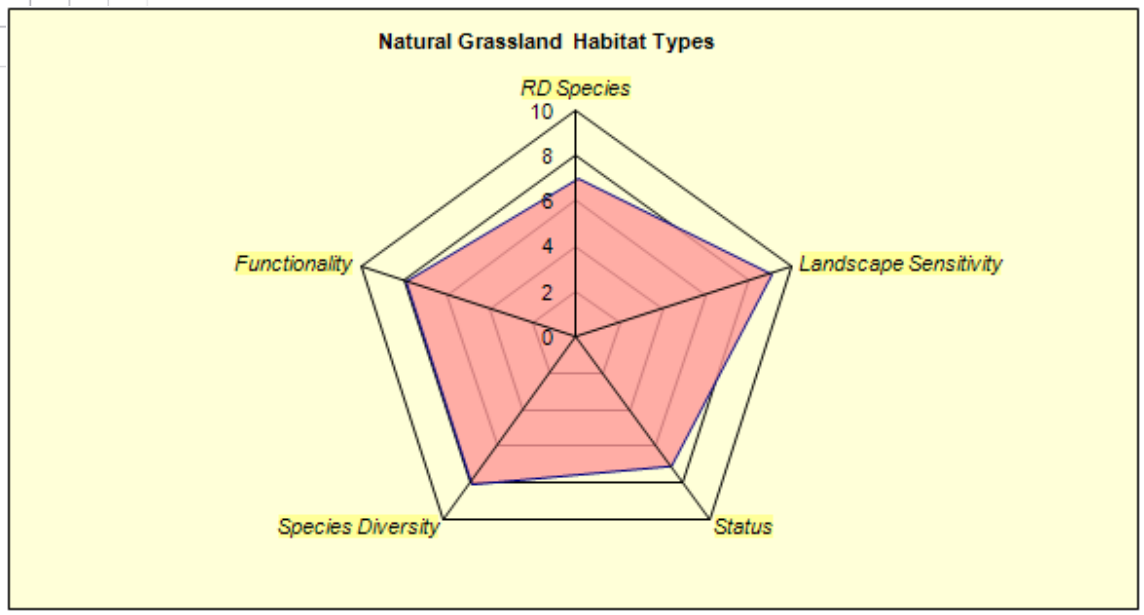
Graph 4: Floristic Sensitivity Rose of the Degraded Grasslands Unit (refer Table 9)

- **Natural Grassland**

Natural grasslands comprise grassland habitat situated in upland positions (topographical unit 3) and is characterised by the dominance of the grass sward, with a varying and diverse herbaceous layer. Due to the 'Endangered' status of the regional ecological type, a high floristic sensitivity is frequently ascribed to portions that are regarded to be in a pristine status. However, severe pressure from livestock utilisation has caused some degradation and representative portions of grassland are not entirely representative of the regional ecological type. The species richness of natural grasslands is high and is typically comprised of a high number of forbs while the physiognomy is dominated by the grass sward, including prominent co-dominant species, such as. In particular, the prominence of the grass species *Themeda triandra* is a characteristic feature of these grasslands. This species is a highly palatable grass and is therefore frequently targeted by grazing cattle.

Consistently high stocking rates and grazing pressure within these grasslands tend to lead to a disappearance of *Themeda triandra*, which gradually becomes replaced with secondary climax grasses and forbs with a weedy disposition.

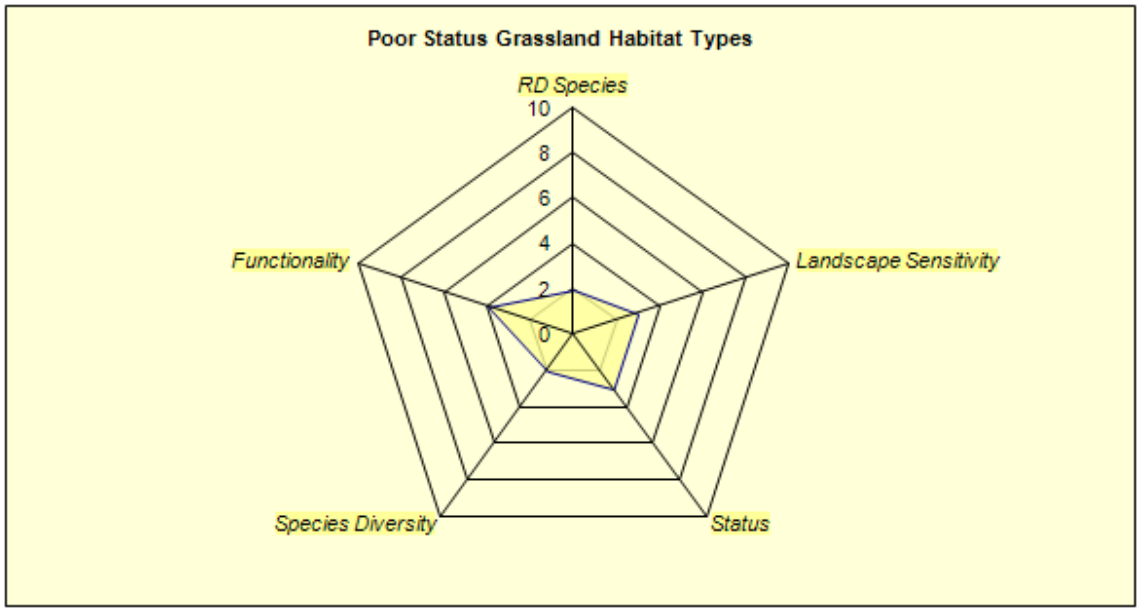
Because of the species changes that accompany consistent and high grazing pressure and the moderate level of degradation that is noted across most grassland, a medium-high conservation status and floristic sensitivity is ascribed to this unit (refer **Graph 5**). Since this unit comprises the largest geographical extent of the (original) grassland community, it is reasonable to assume that the highest proportion of ecological services will be performed by this unit and the importance and contribution of terrestrial grasslands in terms of moisture retention and release and other aquatic services to the catchment cannot be over emphasised.



Graph 5: Floristic Sensitivity Rose of the Natural Grasslands Unit (refer Table 9)

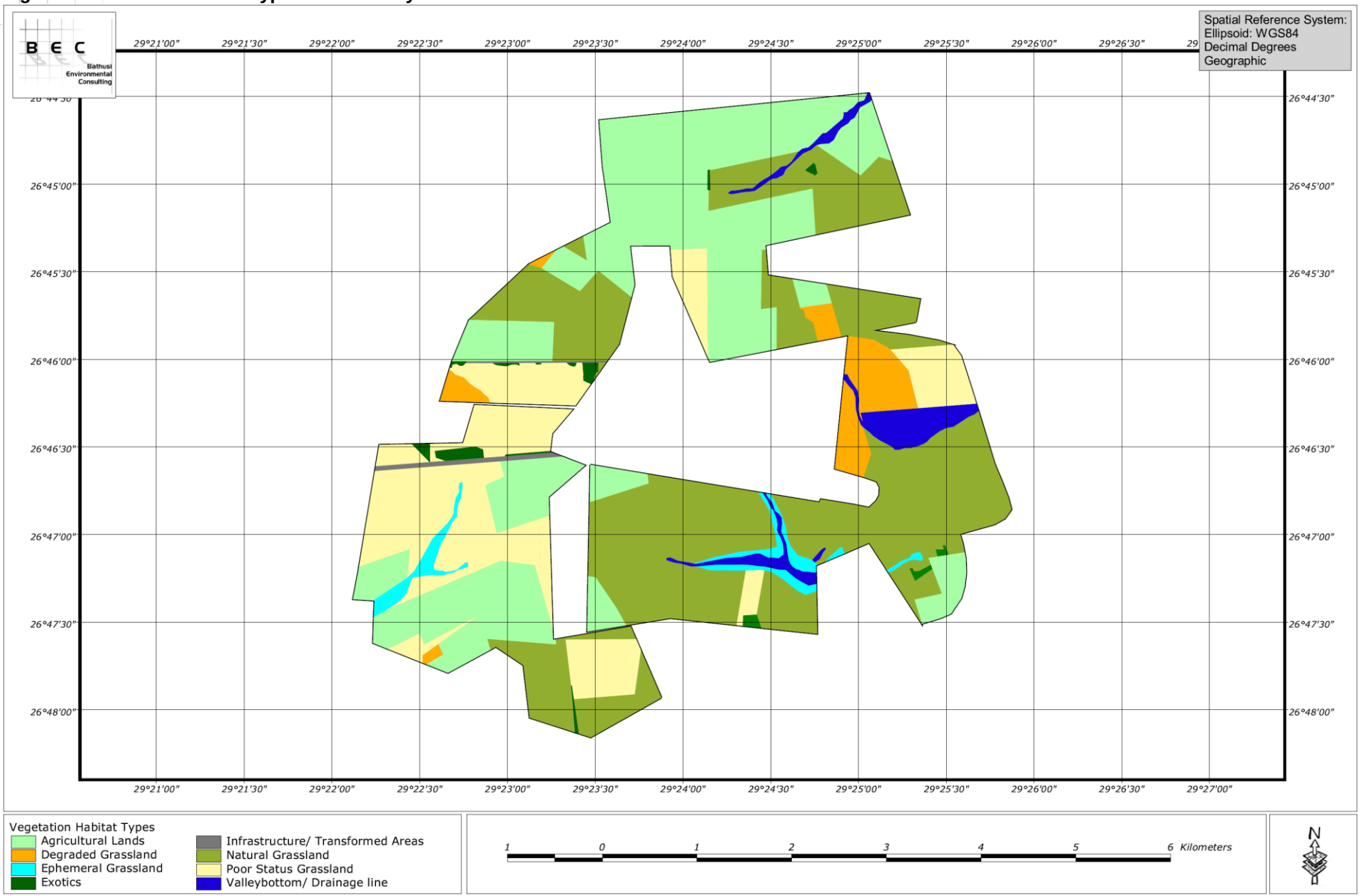
- **Poor Status Grasslands**

Several grassland areas were identified that are currently managed as pastures. Insowing of *Eragrostis curvula,* which is a popular fodder for cattle, results in the establishment of a grass sward dominated exclusively by this species, creating a mono-specific composition. Seasonal harvesting (mowing) normally takes place at the end of the growing season. Visually, particularly from aerial imagery, these areas appear similar to natural grasslands, but significant structural and compositional changes are severe. In ecological terms, these areas are similar to agricultural fields, with the distinction that only part of the vegetative cover is removed on an annual basis (as opposed to agricultural fields where the removal of vegetation is entire and topsoils are disturbed through ploughing). Being dominated by *E. curvula*, other species only occur as infrequent individuals, comprising weedy, opportunistic and pioneer species. Climax species, such as *Themeda triandra,* that characterise pristine grassland, and numerous forb and geophyte species, are largely absent from these parts. The potential presence of conservation important species in these areas is regarded negligent and a medium-low floristic status is ascribed (refer **Graph 6**).



Graph 6: Floristic Sensitivity Rose of the Poor Status Grasslands Unit (refer Table 9)

Figure 10: Floristic Habitat types of the study area



8.6 FLORISTIC SENSITIVITY OF THE STUDY AREA

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

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

Botanical sensitivity values are presented in **Table 9**. These estimations are used to ascribe a sensitivity index value to units of the respective variations, illustrated in **Figure 11**. Habitat sensitivity is categorised as follows:

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

Medium – low All areas where the natural habitat has been degraded, with the important distinction that the vegetation has not been decimated and a measure of the original vegetation remain, albeit dominated by secondary climax species. The likelihood of plant species of conservation

importance occurring in these areas is regarded low. These areas also occur as highly fragmented and isolated patches, typical to cultivated fields, areas that have been subjected to clearing activities and areas subjected to severe grazing pressure. The species composition of these areas is typically low and is frequently dominated by a low number of species, or invasive plants.

Medium

Indigenous natural habitat that comprehend habitat with a high diversity, but characterised by moderate to high levels of degradation, fragmentation and habitat isolation;

Also include areas where flora species of conservation importance could potentially occur, but habitat is regarded marginal;

Medium – high

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

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

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

High

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

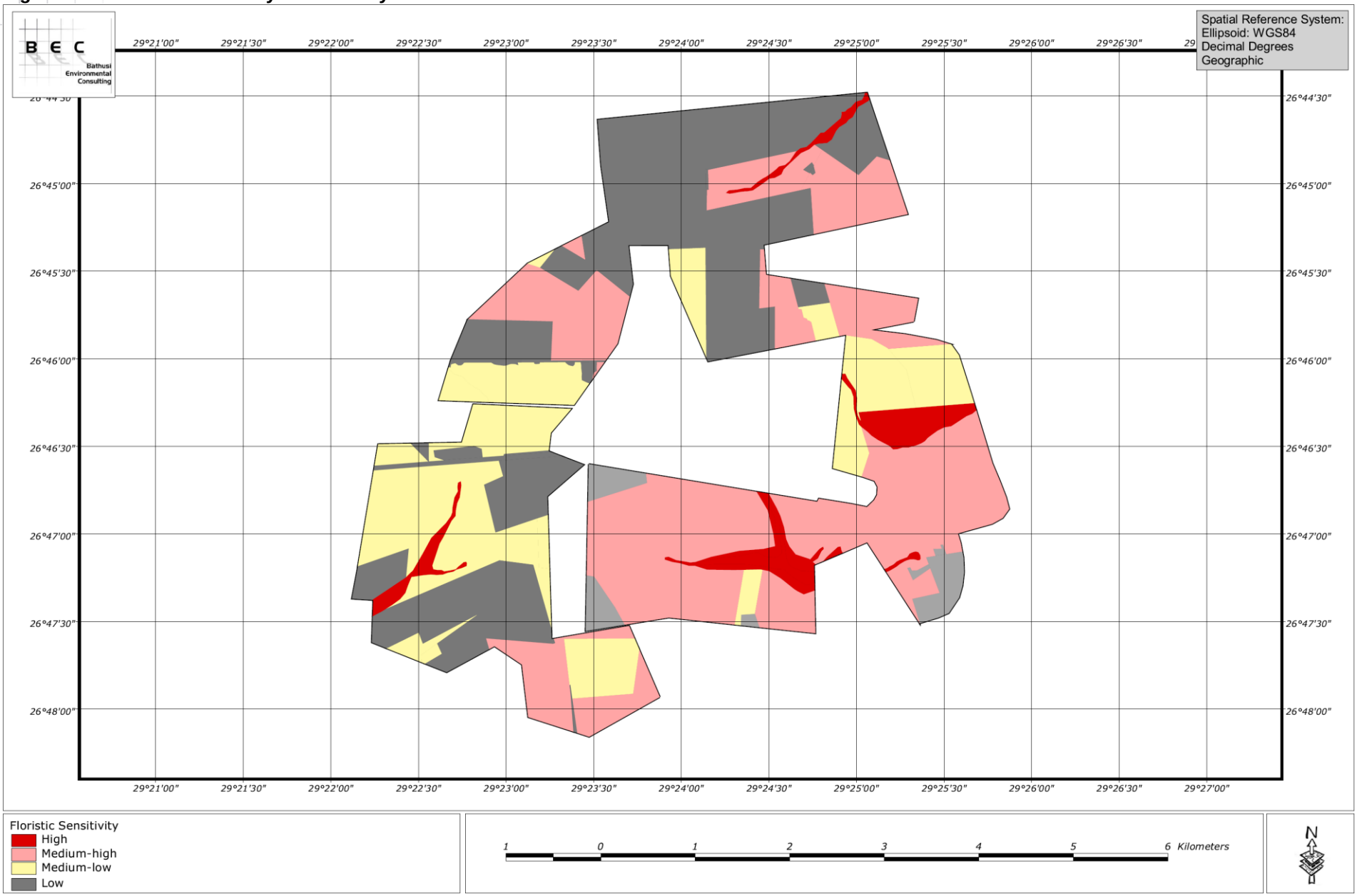
- The presence of plant species of conservation importance, particularly threatened categories (Critically Endangered, Endangered, Vulnerable);
- Areas where 'threatened' plants are known to occur, or habitat that is highly suitable for the presence of these species;
- Regional vegetation types that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

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

Table 9: Floristic sensitivity estimations for the respective habitat types								
Community/ Variation	**RD species**	**Landscape sensitivity**	**Status**	**Species diversity**	**Functionality/ fragmentation**	**TOTAL**	**SENSITIVITY INDEX**	**SENSITIVITY CLASS**
Agricultural Fields	1	3	2	2	2	62	19 %	low
Infrastructure/ Transformed Areas	1	2	2	3	2	59	18 %	low
Stands of Exotic Trees	2	2	2	2	1	61	19 %	low
Ephemeral Grasslands	8	10	8	7	10	273	85 %	high
Valley Bottoms & Drainage Lines	8	10	7	7	10	267	83 %	high
Degraded Grassland	2	3	3	3	4	89	28 %	medium-low
Natural Grassland	7	9	7	8	8	248	78 %	medium-high
Poor Status Grassland	2	3	3	2	4	84	26 %	medium-low

A map illustrating the floristic sensitivity of the study area is presented in **Figure 11**.

Figure 11: Floristic sensitivity of the study area



8.7 DISCUSSION

The regional and national importance of the Soweto Highveld Grassland is reflected in the 'Endangered' conservation status that is ascribed to this regional ecological type. This high conservation status is not only emphasised by the relative high phytodiversity and endemic richness that is reflected in the study area, but also by the presence of some plant taxa of conservation importance. The floristic nature of the proposed alternatives, and immediate surrounds, is typical of the grassland biome; open grassland plains and undulating hills with frequent wetlands, marshes and streams in the lowlands. The regularity with which these widely varying habitat types occur provides for a rich flora.

Most of the remaining natural grassland habitat within the immediate region is however only regarded moderately pristine. The effects of anthropogenic activities are severe in the grasslands of the region. Cultivation and industrial land uses have caused severe habitat transformation, fragmentation and isolation, rendering the ecological functionality of remaining land parcels sub-optimal. Impacts within the remaining areas of natural grassland caused by consistently high livestock stocking rates resulted in deterioration of the grasslands, manifesting in altered species composition, the disappearance of climax species, proliferating poor quality species and weeds as well as altered physiognomy and structure. The cumulative effects of these impacts contribute significantly to the Endangered status of this grassland ecological type on a regional scale.

8.7.1 Alternative A

Table 10: Habitat extent & Sensitivity of Alternative A

Habitat	***Coverage (ha)***	***Percentage***
Agricultural Lands	47.7 ha	7.1 %
Degraded Grassland	59.3 ha	8.8 %
Ephemeral Grassland	22.7 ha	3.4 %
Exotics	4.2 ha	0.6 %
Natural Grassland	446.9 ha	66.3 %
Poor Status Grassland	44.3 ha	6.6 %
Valleybottom/ Drainage line	48.8 ha	7.2 %
Total	**673.9 ha**	
Sensitivity	***Coverage (ha)***	***Percentage***
High	71.5 ha	10.6 %
Medium-high	446.9 ha	66.3 %
Medium-low	103.5 ha	15.4 %
Low	51.9 ha	7.7 %

This alternative comprises 673.9ha, of which 10.6 % is deemed highly sensitive. Significantly, 66.3 % of the site exhibit attributes of medium-high floristic sensitivity (natural terrestrial grasslands). This large extent of high and medium-high sensitivity is not only the result of relative pristine grasslands on this portion, but also due to the presence of highly sensitive habitat near to the site; specifically the pan system situated directly to the south of the site. Impacts from the existing ashing facility have already resulted in severe effects on the status and functionality of the wetland system. Further development of habitat closer to the wetland will inevitably result in increased cumulative adverse impacts and further deterioration of this system. In order to preserve the integrity of this ecological type, it is strongly recommended that water drainage originating from the existing impacts be contained and evacuated to a designated treatment area and not released into the wetland systems.

Persistently high stocking rates are having adverse effects on the status of the terrestrial grasslands, but the status is nonetheless regarded moderately representative of the regional ecological type. The protected species

Hypoxis hemerocallidea and *Boophone disticha* were recorded in this area. This alternative is therefore regarded the least preferred option for the proposed development.

8.7.2 Alternative B

Table 11: Habitat extent & Sensitivity of Alternative B		
Habitat	***Coverage (ha)***	***Percentage***
Agricultural Lands	422.0 ha	55.1 %
Degraded Grassland	19.4 ha	2.5 %
Exotics	5.5 ha	0.7 %
Infrastructure/ Transformed Areas	2.8 ha	0.4 %
Natural Grassland	237.7 ha	31.0 %
Poor Status Grassland	69.3 ha	9.0 %
Valleybottom/ Drainage line	9.6 ha	1.3 %
Total	**766.3 ha**	
Sensitivity	***Coverage (ha)***	***Percentage***
High	9.6	1.3 %
Medium-high	237.7	31.0 %
Medium-low	69.3	11.6 %
Low	430.3	56.2 %

Alternative B comprises 766.3 ha, with 1.3 % and 31.0 % included in the high and medium-high floristic sensitivity categories, respectively, which are situated in the eastern and western parts of the site. In particular, the Natural Grassland habitat portions situated in the eastern part of the study area is regarded the most representative and pristine portions of grassland encountered in the entire study area and should preferably not be included in development plans. Significantly, 56.2 % of this site comprises habitat of low floristic sensitivity. However, much of this low sensitivity habitat is situated around and in close proximity to high and medium-high sensitivity areas; development of these portions is therefore highly likely to affect sensitive areas significantly. The only habitat of particular importance that was identified in the immediate vicinity of this alternative is represented by the non-perennial drainage line that leads to the northeast. Although development of this option is likely to affect these wetland features, this option is nonetheless recommended as the second preferred alternative. Severe mitigation measures will need to be implemented in order to prevent significant impacts, the most important being the exclusion of high and medium-high sensitivity areas and the inclusion of lower sensitivity areas from nearby options.

8.7.3 Alternative C

Table 12: Habitat extent & Sensitivity of Alternative C		
Habitat	***Coverage (ha)***	***Percentage***
Agricultural Lands	173.8 ha	32.5 %
Degraded Grassland	2.2 ha	0.4 %
Ephemeral Grassland	16.3 ha	3.0 %
Exotics	8.8 ha	1.6 %
Infrastructure/ Transformed Areas	8.8 ha	1.6 %
Natural Grassland	73.0 ha	13.6 %
Poor Status Grassland	252.5 ha	47.2 %
Total	**535.3 ha**	
Sensitivity	***Coverage (ha)***	***Percentage***
High	16.3 ha	3.0 %
Medium-high	73.0 ha	13.6 %
Medium-low	254.6 ha	47.6 %
Low	191.4 ha	35.8 %

Alternative C comprises the least high and medium-high sensitivity areas; 3.0 % and 13.6 % respectively. However, the ephemeral grassland of this area is regarded to be of moderate quality, with relative severe impacts resulting from insowing of the adjacent terrestrial grassland as well as from the surrounding agricultural fields. Medium-high sensitivity grasslands situated in the southeastern section of this land parcel is, similar to Alternative A, situated in relative close proximity to the wetland system to the east and impacts resulting from the potential use of these areas are likely to affect this wetland system adversely.

This alternative is recommended as the preferred option, in terms of floristic sensitivity, however, it is strongly recommended that medium-high sensitivity grasslands in the southeastern section be excluded from the development and additional areas be sourced from Alternative B located to the north of this alternative.

9 FAUNAL ASSESSMENT

9.1 REGIONAL FAUNAL DIVERSITY

Biological diversity everywhere is at great risk as a direct result of an ever-expanding human population and its associated needs for energy, water, food and minerals. Landscape transformation that is needed to accommodate these activities inevitably leads to habitat loss and habitat fragmentation, resulting in the mosaical appearance of undisturbed habitat within a matrix of transformed areas. Remaining areas of natural habitat are frequently too small to support the biodiversity that previously occupied, consequently the area and the region is constantly losing its ecological integrity and diversity (Kamffer, 2004). Grasslands of Mpumalanga are no exception and the presence of minerals such as coal has led to significant transformation, degradation and fragmentation of the region's grasslands. Agriculture and pastoral activities have similarly had a significant impact on the biodiversity of the region, in fact, farming is believed by some to be the most damaging sector of human activity affecting wild nature (Balmford *et. al.,* 2012).

The study area is situated within the regional vegetation community of Soweto Highveld Grassland (Mesic Highveld Grassland Bioregion: Grassland Biome – Vegmap 2006). This ecological type is listed as Endangered (only 56 % remains untransformed). The Grassland Biome (or eco-region) of South Africa is spatially represented in all nine provinces of the country. South African grasslands cover 26 % of the country and include six major regions comprising 14 vegetation types.

Grasslands are the habitat of large herds of antelope, as well as many smaller animals, but are currently one of the most threatened in South Africa; forestry, mining and development industries have irreversibly transformed 60-80 % of grasslands in South Africa – with only 2 % formally conserved. Grasslands are characterised by high levels of species richness and endemism:

- Mammals: 89 species (18 endemic, 9 threatened);
- Reptiles: 84 species (17 endemic, 4 threatened);
- Amphibians: 36 species (18 endemic, 2 threatened); and
- Invertebrates: unknown (? endemic, 16 threatened).

It is important to view the study area on an ecologically relevant scale; consequently, all sensitive animal species (specific faunal groups) known from the Mpumalanga Province are included in this assessment. Detailed regional and scientific data on all faunal groups are lacking (notably for most of the invertebrate groups) and as a result only data sets on specific faunal groups allow for habitat sensitivity analyses based on the presence/ absence of sensitive faunal species (Red Data species) and their specific habitat requirements. The following faunal groups were included in these analyses:

- Butterflies (Invertebrata: Insecta: Lepidoptera – Nymphalidae, Lycaenidae, Hesperiidae, Pieridae and Papilionidae). References used include the IUCN Red List (2011) – http://www.iucnredlist.org and the South African Butterfly Conservation Assessment (SABCA, 2011) – http://sabca.adu.org.za.
- Frogs (Amphibia: Anura). References used include the Atlas and Red Data Book of the South Africa, Lesotho and Swaziland, the Giant Bullfrog Conservation Group (2011) – http://www.up.ac.za/bullfrog and a Complete Guide to the Frogs of Southern Africa (du Preez & Carruthers, 2009).
- Reptiles (Reptilia: Testudines and Squamata). References used include the IUCN Red List (2011) and the South African Reptile Conservation Assessment (SARCA, 2011) – http://sarca.adu.org.za.
- Birds: All bird groups (Roberts VII Multimedia: Birds of Southern Africa, PC Edition).
- Terrestrial Mammals (Mammalia: Insectivora, Chiroptera, Primates, Lagomorpha, Pholidota, Rodentia, Carnivora, Tubulidentata, Proboscidea, Hyracoidea, Perissodactyla and Artiodactyla). References used

include the Red Data Book of the Mammals of South Africa: A Conservation Assessment (Endangered Wildlife Trust, 2004).

As more data become available, additional faunal groups are likely to be added to these assessments. Dragonflies and Damselflies (Invertebrata: Insecta: Odonata) are some examples of future inclusions.

Animals known to be present in the ¼-degree grids 2630CD and 2730AB were considered potential inhabitants of the study area (all species known from Mpumalanga were included in the assessment to limit the known effects of sampling bias, except for birds which have been sampled extensively and the data for the Q-grid is accepted as accurate).

9.2 FAUNAL DIVERSITY OF THE SITE

9.2.1 General Diversity

The presence of 86 animal taxa was confirmed during the 2013 summer investigation (refer **Table 13**) by means of visual sightings, tracks, scats, burrows and species-specific calls as well as camera and small mammal trapping. The following results were recorded:

- 9 invertebrate species;
- 2 reptile species;
- 63 bird species; and
- 12 mammals.

The diversity of animals recorded in the study area included four Red Data species, namely:

- Greater Flamingo (*Phoenicopterus roseus*);
- Grey Crowned Crane (*Balearica regulorum*);
- Black-winged Pratincole (*Glareola nordmanni*); and
- Serval (*Leptailurus serval*).

The diversity of animals recorded in the study area included one Provincially Protected species, namely:

- Serval (*Leptailurus serval*);

The diversity of animals recorded in the study area included one Alien and Invasive species, namely:

- Spotted Maize Beetle (*Astylus atromaculatus*);

Table 13: Animal species recorded in the study area

Class	*Order*	*Family*	*Biological Name*	*Colloquial Name*
Insecta	Odonata	Aeshnidae	*Anax imperator*	Blue Emperor
	Coleoptera	**Melyridae**	***Astylus atromaculatus***	**Spotted Maize Beetle**
	Hymenoptera	Apidae	*Apis mellifera*	Honey Bee
	Lepidoptera	Nymphalidae	*Danaus chryssipus orientis*	African Monarch
			Junonia hierta cebrene	Yellow Pansy
			Junonia oenone oenone	Blue Pansy
			Vanessa cardui	Painted Lady
		Pieridae	*Eurema brigitta brigitta*	Broad-bordered Grass Yellow
			Catopsilla florella	African Migrant
Reptilia	Squamata	Colubridae	*Psammophylax tritaeniatus*	Striped Skaapsteker
		Elapidae	*Hemachatus haemachatus*	Rinkhals
Aves	Struthioniformes	Struthionidae	*Struthio camelus*	Common Ostrich
	Galliformes	Numididae	*Numida meleagris*	Helmeted Guineafowl

Table 13: Animal species recorded in the study area

Class	*Order*	*Family*	*Biological Name*	*Colloquial Name*
		Phasianidae	*Pternistis swainsonii*	Swainson's Spurfowl
			Coturnix coturnix	Common Quail
	Anseriformes	Anatidae	*Plectropterus gambensis*	Spur-winged Goose
			Alopochen aegyptiaca	Egyptian Goose
			Anas erythrorhyncha	Red-billed Teal
			Tadorna cana	South African Shelduck
			Anas undulata	Yellow-billed Duck
			Anas smithii	Cape Shoveler
			Anas capensis	Cape Teal
	Ciconiiformes	Podicipedidae	*Tachybaptus ruficollis*	Little Grebe
		Phoenicopteridae	**Phoenicopterus roseus**	**Greater Flamingo**
		Threskiornithidae	*Threskiornis aethiopicus*	African Sacred Ibis
			Bostrychia hagedash	Hadeda Ibis
			Plegadis falcinellus	Glossy Ibis
		Ardeidae	*Ardea melanocephala*	Black-headed Heron
		Phalacrocoracidae	*Microcarbo africanus*	Reed Cormorant
		Anhingidae	*Anhinga rufa*	African Darter
	Falconiformes	Accipitridae	*Elanus caeruleus*	Black-winged Kite
			Buteo buteo	Common Buzzard
			Buteo rufofuscus	Jackal Buzzard
		Falconidae	*Falco amurensis*	Amur Falcon
	Gruiformes	Otididae	*Afrotis afraoides*	Northern Black Korhaan
		Rallidae	*Fulica cristata*	Red-knobbed Coot
		Gruidae	***Balearica regulorum***	**Grey Crowned Crane**
	Charadriiformes	Burhinidae	*Burhinus capensis*	Spotted Thick-knee
		Charadriidae	*Vanellus armatus*	Blacksmith Lapwing
			Charadrius pecuarius	Kittlitz's Plover
		Scolopacidae	*Gallinago nigripennis*	African Snipe
			Tringa nebularia	Common Greenshank
		Glareolidae	***Glareola nordmanni***	**Black-winged Pratincole**
	Columbiformes	Columbidae	*Columba guinea*	Speckled Pigeon
			Streptopelia semitorquata	Red-eyed Dove
			Streptopelia capicola	Ring-necked Dove
			Spilopelia senegalensis	Laughing Dove
	Strigiformes	Strigidae	*Asio capensis*	Marsh Owl
	Apodiformes	Apodidae	*Apus apus*	Common Swift
			Apus affinis	Little Swift
			Apus caffer	White-rumped Swift
	Coraciiformes	Meropidae	*Merops apiaster*	European Bee-eater
	Passeriformes	Laniidae	*Lanius collaris*	Common Fiscal
		Corvidae	*Corvus capensis*	Cape Crow
		Alaudidae	*Mirafra africana*	Rufous-naped Lark
		Pycnonotidae	*Pycnonotus tricolor*	Dark-capped Bulbul
		Hirundinidae	*Riparia cincta*	Banded Martin
			Hirundo rustica	Barn Swallow
			Hirundo albigularis	White-throated Swallow
			Ptyonoprogne fuligula	Rock Martin
			Cecropis cucullata	Greater Striped Swallow
		Cisticolidae	*Cisticola tinniens*	Levaillant's Cisticola
			Cisticola juncidis	Zitting Cisticola
			Cisticola textrix	Cloud Cisticola
			Cisticola ayresii	Wing-snapping Cisticola
			Prinia flavicans	Black-chested Prinia
		Ploceidae	*Ploceus velatus*	Southern Masked Weaver

Table 13: Animal species recorded in the study area				
Class	***Order***	***Family***	***Biological Name***	***Colloquial Name***
			Quelea quelea	Red-billed Quelea
			Euplectes progne	Long-tailed Widowbird
		Estrildidae	*Estrilda astrild*	Common Waxbill
		Motacillidae	*Motacilla capensis*	Cape Wagtail
			Macronyx capensis	Cape Longclaw
			Anthus cinnamomeus	African Pipit
		Fringillidae	*Crithagra atrogularis*	Black-throated Canary
Mammalia	Lagomorpha	Leporidae	*Lepus saxatilis*	Scrub Hare
	Rodentia	Bathyergidae	*Cryptomys hottentotus*	Common Mole-rat
		Hystricidae	*Hystrix africaeaustralis*	Porcupine
		Muridae	*Tatera brantsii*	Highveld Gerbil
	Carnivora	**Felidae**	***Leptailurus serval***	**Serval**
		Herpestidae	*Atilax paludinosus*	Marsh Mongoose
		Canidae	*Canis mesomelas*	Black-backed Jackal
	Perissodactyla	Equidae	*Equus quagga*	Plains Sebra
	Artiodactyla	Bovidae	*Antidorcas marsupialis*	Cape Springbok
			Damaliscus phillipsi	Blesbok
			Connachaetus gnou	Black Wildebeest
			Sylvicapra grimmia	Bush Duiker

9.3 RED DATA FAUNA ASSESSMENT

A total of 119 Red Data animals are known to occur in Mpumalanga (dragonflies, damselflies, butterflies, frogs, reptiles and mammals) and in the ¼-degree grids 2629CB and 2629CD (birds), indicated in **Table 14** The following conservation categories area included:

- 23 species are listed as Data Deficient (DD);
- 42 species are listed as Near Threatened (NT);
- 36 species are listed as Vulnerable (VU);
- 13species are listed as Endangered (EN); and
- 5 species are listed as Critically Endangered (CR).

Estimated Probability of Occurrence (PoC) of the Red Data fauna assessment is based on:

- the size of the study area;
- the location of the study area;
- the diversity and status of each faunal habitat within the study area; and
- the connectivity of the study area to other untransformed faunal habitats.

An assessment of the PoC for these animals yielded the following probabilities (refer **Table 14**):

- 48 species have a low PoC;
- 17 species have a moderate-low PoC;
- 26 species have a moderate PoC;
- 15 species have a moderate-high PoC;
- 9 species have a high PoC and;
- 4 conservation important species were recorded in the study area (refer **Table 14**, indicated in **red**).

Table 14: Red Data fauna assessment for the study area			
Species Details			**Probability Assessment**
Biological Name	***Colloquial Name***	***RD Status***	
Dragonflies and Damselflies			
Pseudagrion inopinatum	Balinsky's Sprite	EN	low
Pseudagrion newtoni	Newton's Sprite	VU	low
Butterflies			
Aloeides barbarae	Barbara's Copper	EN	low
Aloeides merces	Wakkerstroom Copper	VU	low
Aloeides nubilus	Cloud Copper	EN	low
Aloeides rossouwi	Rossouw's Copper	EN	low
Chrysoritis aureus	Heidelberg Opal	VU	low
Chrysoritis phosphor borealis	Scarce Scarlet	DD	low
Lepidochrysops irvingi	Irving's Blue	VU	low
Lepidochrysops jefferyi	Jeffrey's Blue	EN	low
Lepidochrysops swanepoeli	Swanepoel's Blue	VU	low
Metisella meninx	Marsh Sylph	VU	high
Frogs			
Breviceps sopranus	Whistling Rain Frog	DD	low
Hemisus guttatus	Spotted Shovel-nosed Frog	VU	moderate-high
Pyxicephalus adspersus	Giant Bullfrog	NT	moderate
Strongylopus wageri	Plain Stream Frog	NT	moderate
Reptiles			
Acontias breviceps	Short-headed Legless Skink	NT	moderate-high
Afroedura major	Swazi Flat Gecko	NT	moderate-low
Chamaesaura aenea	Coppery Grass Lizard	NT	moderate-high
Chamaesaura macrolepis	Large-scaled Grass Lizard	NT	moderate-high
Homoroselaps dorsalis	Striped Harlequin Snake	NT	moderate
Kininyx natalensis	Natal Hinged Tortoise	NT	moderate
Lamprophis fuscus	Yellow-bellied House Snake	NT	moderate
Smaug giganteus	Giant Girdled Lizard	VU	low
Tetradactylus breyeri	Breyer's Long-tailed Seps	VU	moderate-low
Birds			
Phoenicopterus roseus	**Greater Flamingo**	**NT**	**confirmed**
Phoenicopterus minor	Lesser Flamingo	NT	moderate-low
Mycteria ibis	Yellow-billed Stork	NT	moderate
Ciconia nigra	Black Stork	NT	moderate
Leptoptilos crumeniferus	Marabou Stork	NT	moderate
Geronticus calvus	Southern Bald Ibis	VU	high
Botaurus stellaris	Eurasian Bittern	CR	moderate
Sagittarius serpentarius	Secretarybird	NT	high
Gyps coprotheres	Cape Vulture	VU	moderate-low
Circus ranivorus	African Marsh Harrier	VU	high
Circus maurus	Black Harrier	VU	moderate-high
Circus macrourus	Pallid Harrier	NT	high
Polemaetus bellicosus	Martial Eagle	VU	moderate-high
Stephanoaetus coronatus	Crowned Eagle	NT	low
Falco naumanni	Lesser Kestrel	VU	high
Falco biarmicus	Lanner Falcon	NT	high
Neotis denhami	Denham's Bustard	VU	moderate-high
Eupodotis caerulescens	Blue Korhaan	NT	moderate-high
Eupodotis senegalensis	White-bellied Korhaan	VU	moderate
Lissotis melanogaster	Black-bellied Bustard	NT	moderate-low
Sarothrura affinis	Striped Flufftail	VU	moderate-low
Crex crex	Corn Crake	VU	moderate

Table 14: Red Data fauna assessment for the study area			
Species Details			**Probability Assessment**
Biological Name	***Colloquial Name***	***RD Status***	
Balearica regulorum	**Grey Crowned Crane**	**VU**	**confirmed**
Anthropoides paradisea	Blue Crane	VU	moderate-high
Bugeranus carunculatus	Wattled Crane	CR	moderate
Turnix nanus	Black-rumped Buttonquail	EN	moderate
Vanellus melanopterus	Black-winged Lapwing	NT	moderate
Rostratula benghalensis	Greater Painted-snipe	NT	moderate
Glareola nordmanni	**Black-winged Pratincole**	**NT**	**confirmed**
Tyto capensis	African Grass-owl	VU	moderate
Alcedo semitorquata	Half-collared Kingfisher	NT	moderate-low
Heteromirafra ruddi	Rudd's Lark	CR	low
Spizocorys fringillaris	Botha's Lark	EN	moderate-low
Lioptilus nigricapillus	Bush Blackcap	NT	low
Zoothera gurneyi	Orange Ground Thrush	NT	low
Anthus brachyurus	Short-tailed Pipit	VU	moderate-low
Anthus chloris	Yellow-breasted Pipit	VU	low
Mammals			
Chrysospalax villosus	Rough-haired Golden Mole	CR	moderate-low
Amblysomus hottentotus	Hottentot's Golden Mole	DD	moderate-low
Amblysomus robustus	Robust Golden Mole	EN	low
Amblysomus septentrionalis	Highveld Golden Mole	NT	moderate-high
Neamblysomus julianae	Juliana's Golden Mole	VU	low
Atelerix frontalis	South African Hedgehog	NT	moderate-low
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	DD	low
Myosorex cafer	Dark-footed Forest Shrew	DD	low
Myosorex varius	Forest Shrew	DD	high
Crocidura cyanea	Reddish-grey Musk Shrew	DD	high
Crocidura flavescens	Greater Musk Shrew	DD	moderate-high
Crocidura fuscomurina	Tiny Musk Shrew	DD	moderate
Crocidura hirta	Lesser Red Musk Shrew	DD	moderate
Crocidura maquassiensis	Maquassie Musk Shrew	VU	low
Crocidura mariquensis	Swamp Musk Shrew	DD	moderate-high
Crocidura silacea	Lesser Grey-brown Musk Shrew	DD	moderate-high
Suncus infinitesimus	Least Dwarf Shrew	DD	moderate
Suncus lixus	Greater Dwarf Shrew	DD	low
Suncus varilla	Lesser Dwarf Shrew	DD	moderate
Cloeotis percivali	Percival's Short-eared Trident Bat	VU	moderate-low
Rhinolophus blasii	Blasius's Horseshoe Bat	NT	moderate
Rhinolophus swinnyi	Swinny's Horseshoe Bat	NT	moderate-low
Miniopterus natalensis	Natal Long-fingered Bat	NT	moderate-high
Scotophilus nigrita	Giant Yellow House Bat	NT	low
Cercopithecus mitis	Samango Monkey	VU	low
Cercopithecus mitis labiatus	Samango Monkey	EN	low
Manis temminckii	Ground Pangolin	VU	moderate-low
Graphiurus platyops	Rock Dormouse	DD	low
Mystromys albicaudatus	White-tailed Rat	EN	moderate
Tatera leucogaster	Bushveld Gerbil	DD	low
Lemniscomys rosalia	Single-striped Mouse	DD	moderate
Dasymys incomtus	Water Rat	NT	moderate
Grammomys dolichurus	Woodland Mouse	DD	low
Otomys slogetti	Sloggett's Rat	DD	low
Panthera pardus	Leopard	NT	moderate-low
Panthera leo	Lion	VU	low
Leptailurus serval	**Serval**	**NT**	**confirmed**

Table 14: Red Data fauna assessment for the study area			
Species Details			**Probability Assessment**
Biological Name	***Colloquial Name***	***RD Status***	
Acinonyx jubatus	Cheetah	VU	low
Felis nigripes	Black-footed Cat	VU	low
Crocuta crocuta	Spotted Hyaena	NT	low
Parahyaena brunnea	Brown Hyaena	NT	moderate
Paracynictis selousi	Selous's Mongoose	DD	low
Rhynchogale melleri	Meller's Mongoose	DD	low
Canis adustus	Side-striped Jackal	NT	low
Lycaon pictus	African Wild Dog	EN	low
Mellivora capensis	Honey Badger	NT	moderate-high
Poecilogale albinucha	African Striped Weasel	DD	moderate
Hydrictis maculicollis	Spotted-necked Otter	NT	moderate-low
Loxodonta africana	African Savanna Elephant	VU	low
Diceros bicornis	Black Rhinoceros	CR	low
Ceratotherium simum	White Rhinoceros	NT	low
Hippopotamus amphibius	Common Hippopotamus	VU	low
Raphicerus sharpei	Sharpe's Grysbok	NT	low
Ourebia ourebi	Southern Oribi	EN	low
Hippotragus equinus	Roan Antelope	VU	low
Hippotragus niger	Southern Sable Antelope	VU	low
Damaliscus lunatus	Western Tsessebe	EN	low

9.4 PROVINCIALLY PROTECTED TAXA

In addition to the above-mentioned Red Data species of Mpumalanga, 31 animal taxa (some overlap does occur) have protected status (NEMBA) within Mpumalanga (www.speciesstatus.sanbi.org). PoC for these species was estimated as follows (refer **Table 15**):

- 8 species have a low PoC;
- 18 species have a moderate-low PoC;
- 1 species has a moderate PoC;
- 1 species has a moderate-high PoC;
- 2 species have a high PoC and;
- 1 species has been confirmed in the study area (**refer Table 15**, indicated in **red**).

Table 15: Protected fauna species of Mpumalanga

Species Details			Probability Assessment
Biological Name	***Colloquial Name***	***NEMBA status***	
Aonyx capensis	African Clawless Otter	protected	high
Atelerix frontalis	South African Hedgehog	protected	moderate-low
Bucorvus leadbeateri	Southern Ground-Hornbill	protected	low
Ceratogyrus bechuanicus	Starbust Horned Baboon Spider	protected	moderate-low
Ceratotherium simum	White Rhinoceros	protected	low
Circus ranivorus	African Marsh Harrier	protected	high
Connachaetus gnou	Black Wildebeest	protected	low
Crocuta crocuta	Spotted Hyaena	protected	low
Dromica species	Flightless Tiger Beetle species	protected	moderate-low
Felis nigripes	Black-footed Cat	protected	low
Graphipterus assimilis	Velvet Ground Beetle	protected	moderate-low
Harpactira gigas	Transvaal Banded Baboon Spider	protected	moderate-low
Hydrictis maculicollis	Spotted-necked Otter	protected	moderate-low
Leptailurus serval	**Serval**	**protected**	**confirmed**
Loxodonta africana	African Savanna Elephant	protected	low
Manticora species	Monster Tiger Beetle species	protected	moderate-low
Megacephala asperata	Tiger Beetle	protected	moderate-low
Megacephala regalis	Tiger Beetle	protected	moderate-low
Neotis denhami	Denham's Bustard	protected	moderate-high
Nigidius auriculatus	Stag Beetle	protected	moderate-low
Oonotus adspersus	Stag Beetle	protected	moderate-low
Oonotus interioris	Stag Beetle	protected	moderate-low
Oonotus rex	Stag Beetle	protected	moderate-low
Oonotus sericeus	Stag Beetle	protected	moderate-low
Parahyaena brunnea	Brown Hyaena	protected	moderate
Prosopocoilus petitclerci	Stag Beetle	protected	moderate-low
Prothyma guttipennis	Tiger Beetle	protected	moderate-low
Pterinochilus breyeri	Malelane Golden-brown Baboon Spider	protected	moderate-low
Pterinochilus nigrofulvus	Transvaal Golden Baboon Spider	protected	moderate-low
Raphicerus sharpei	Sharpe's Grysbok	protected	low
Redunca arundinum	Southern Reedbuck	protected	low

9.5 ANNOTATIONS ON CONFIRMED RED DATA ANIMALS OF THE STUDY AREA

9.5.1 Greater Flamingo (Phoenicopterus roseus)

The Greater Flamingo (*Phoenicopterus roseus,* Ciconiiformes: Phoenicopteridae - NT), is one of two flamingos found in Southern Africa. Although the species is considered a locally common resident, it is highly nomadic and partially migratory (usually in large flocks). The species favours saline or brackish shallow water bodies such as saltpans, large dams and coastal mudflats. They feed on aquatic invertebrates such as brine shrimps and brine fly (larvae) as well as algae. The species is not considered globally threatened, but is listed as Near Threatened in South Africa and Vulnerable in Namibia (Hockey *et al* 2005). Threats to the Greater Flamingo include mining, collisions with fences and overhead power lines and lowered water tables.

9.5.2 Grey Crowned Crane (Balearica regulorum)

The Grey Crowned Crane (*Balearica regulorum*) occurs in eastern and Southern Africa. This species is found from Mozambique south through Zimbabwe to South Africa and west in small numbers to Namibia and Angola. The species is not migratory although it may make variable local and seasonal movements depending on the abundance and distribution of food, nest-sites and rainfall. The species inhabits wetlands such as marshes, pans and dams with tall emergent vegetation, riverbanks, open riverine woodland, shallowly flooded plains and temporary pools with adjacent grasslands, open savannas, croplands, pastures, fallow fields and irrigated areas. The loss and degradation of wetland breeding areas through drought-related changes in land-use, drainage and overgrazing, as well as the heavy use of agricultural pesticides, high sedimentation rates, uncontrolled grass and deep litter fires threaten the species in the breeding season, dam construction and groundwater extraction. The species has been uplisted to Endangered because of such threats. It is also listed in CITES Appendix II.

9.5.3 Black-winged Pratincole (Glareola nordmanni)

The Black-winged Pratincole (*Glareola nordmanni*) has a very large range, breeding in Russia, Ukraine, and Kazakhstan. It migrates to southern Africa, mainly to Botswana, Zimbabwe, South Africa and Namibia. The species reach their wintering grounds in southern Africa in October-November; migratory flocks of several thousand individuals have been recorded. During the non-breeding season, the species is constantly nomadic and highly congregatory, occurring regularly in flocks of thousands. Non-breeding birds frequent open high-altitude grassland and mudflats – during the non-breeding season it occupies seasonally wet grasslands, savannas and sandbanks along large rivers; it is also found at the edge of salt pans. Threats to the species are poorly understood. In the wintering grounds, agricultural practises and grassland degradation may have reduced the area of available habitat, and locust control measures may have negative impacts both in terms of loss of a food source and the impact of pesticides. Evidence of declines in Europe, West Africa and Central Asia indicate that this species has experienced moderately rapid overall declines, and thus warrants Near Threatened status.

9.5.4 Serval (Leptailurus serval)

The Serval (*Leptailurus serval,* Carnivora: Felidae – NT) is found in almost all types of grasslands and savannas in Africa. Their distribution is closely tied to water and associated vegetation, reed beds and marshes. The species utilises medium and tall grasslands and reedbeds as rest sites, although in areas with greater disturbance from people and livestock frequently retreat to patches of woody vegetation during the day. The species is listed on CITES (Appendix II) and on the IUCN Red List as a species of Least Concern. Locally, Serval is listed as Near Threatened (EWT 2004). Serval is widely distributed in grasslands south of the Sahara but numbers are declining in the west and extreme south of Africa.

9.6 FAUNAL HABITAT TYPES

Animals of terrestrial as well as aquatic ecosystems are closely linked to, and significantly influenced by, plant community structures and species diversities. Many aquatic macro invertebrates find refuge in extensive reedbeds that are frequently found within lowland wetland ecosystems (Sychra *et. al.,* 2010). Furthermore, the structure and age of the vegetal formations of ponds and impounds play a significant role in selecting species traits related to the population dynamics and feeding habits of invertebrates (Céréghinoa *et. al.,* 2008). Similarly, terrestrial animals' ecological reactions depend on plant community structure; studies on arthropod species richness have indicated that for spiders local processes are important, with assemblages in a particular patch being constrained by habitat structure (Borgesa & Browna, 2004). Likewise, plant community structure is often influenced by primary consumers; herbivores are known key drivers of ecosystem function and nutrient dynamics within grazed plant communities (Duncan, 2005).

As a result, faunal community structure and ecological diversity cannot be viewed in isolation without considering vegetation habitat diversity; therefore, the plant communities or macro habitat types described in this document (refer **Section 8.5**) are considered the main faunal habitats within the study area for the purposes of this EIA assessment. The reader is referred to **Figure 10** for an illustration of the vegetal communities of the respective study sites.

9.6.1 Transformed Faunal Habitats

Atypical faunal habitats are areas of transformed nature; areas where the natural vegetation has been removed and replaced by various substitutes of either a sterile or an artificial nature. These substitutes include agricultural lands, stands of exotic trees and human structures such as buildings, roads, mining areas, etc. Atypical faunal habitats that were recorded in the study area include:

- Infrastructure and associated transformed habitat;
- Agricultural fields; and
- Stands of exotic trees.

Transformed faunal habitats have lost the ability to function ecologically and bear no biological resemblance to the original faunal habitat associated with the Mesic Highveld Grassland Bioregion's (Mucina and Rutherford 2004) grasslands and associated wetlands. These areas have little or no conservation value and it is highly unlikely that any threatened faunal taxa would persist in these areas (other than potentially passing through). Further transformation and degradation of the transformed faunal habitats is unlikely to lead to an accelerated loss of biodiversity or a significant negative impact on the faunal assemblages currently persisting in these areas.

9.6.2 Wetland Faunal Habitats

Wetland faunal habitats of the study area are characterised by areas of permanent or temporary surface water and vegetation associated with such areas. The wetland faunal habitats of the study area include:

- Valley bottoms and drainage lines; and
- Ephemeral grasslands.

Within the landscape of the study area, wetland habitat is fairly unique and uncommon (compared to terrestrial grassland). Because of the unique and scarce nature of wetland habitat, these areas of temporary and permanent surface water are at risk when changes in land use are considered. Wetlands often host a variety of sensitive and threatened faunal taxa; faunal wetland species are often particularly sensitive because of the pressures on the freshwater ecological systems of South Africa and especially the Mesic Highveld Grassland

Bioregion of the country. Sensitive faunal wetland species considered likely to persist in the study area (but not necessarily recorded during the field investigation) include:

- Grey Crowned Crane (*Balearica regulorum* – Endangered);
- The Forest Shrew (*Myosorex varius* – Data Deficient);
- Pallid Harrier (*Circus macrourus* – Near Threatened);
- Marsh Sylph (*Metisella meninx* – Vulnerable);
- African Grass-owl (*Tyto capensis* – Vulnerable);
- Black Harrier (*Circus maurus* – Vulnerable);
- Serval (*Leptailurus serval* – Near Threatened); and
- African Marsh Harrier (*Circus ranivorus* – Vulnerable).

The wetlands of the study area therefore exhibit high conservation characteristics; the ecological functionality and biodiversity value of these wetlands are moderate-high and in dire need of formal protection.

9.6.3 Natural Faunal Grassland Habitats

The natural faunal grassland habitats of the study area comprises those parts that still exhibit (to varying degrees) a significant proportion of the functional ecological characteristics of the original (currently Endangered) Soweto Highveld Grassland (Mucina and Rutherford 2004). In other words, these areas currently constitute untransformed, functioning faunal grassland habitat characteristic of the Mesic Highveld Grassland Bioregion of South Africa. The natural (terrestrial) faunal grassland habitats of the study area include:

- Degraded grassland;
- Poor status grassland; and
- Natural grassland.

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

Sensitive faunal terrestrial faunal species likely to persist in the study area (but not necessarily recorded during the field investigation) include:

- Black-winged Pratincole (*Glareola nordmanni* – Near Threatened);
- Reddish-grey Musk Shrew (*Crocidura cyanea* – Data Deficient);
- Secretarybird (*Sagittarius serpentarius* – Near Threatened);
- Lanner Falcon (*Falco biarmicus* – Near Threatened);
- Lesser Kestrel (*Falco naumanni* – Vulnerable);
- Blue Crane (*Anthropoides paradisea* – Vulnerable);
- Blue Korhaan (*Eupodotis caerulescens* – Near Threatened);
- Highveld Golden Mole (*Amblysomus septentrionalis* – Near Threatened);
- Brown Hyaena (*Parahyaena brunnea* – Near Threatened);
- Honey Badger (*Mellivora capensis* – Near Threatened);

- Natal Long-fingered Bat (*Miniopterus natalensis* – Near Threatened);
- Martial Eagle (*Polemaetus bellicosus* – Vulnerable);and
- Denham's Bustard (*Neotis denhami* – Vulnerable).

The natural terrestrial faunal habitats of the study area therefore exhibit moderate-high conservation characteristics; ecological functionality and biodiversity value of these grasslands are high and changes in the land use are likely to influence a significant number of sensitive and threatened faunal taxa.

9.7 FAUNAL HABITAT SENSITIVITY ASSESSMENT

The study area was investigated and the faunal sensitivity of respective habitat types assessed in terms of the following biodiversity attributes (refer **Table 16**):

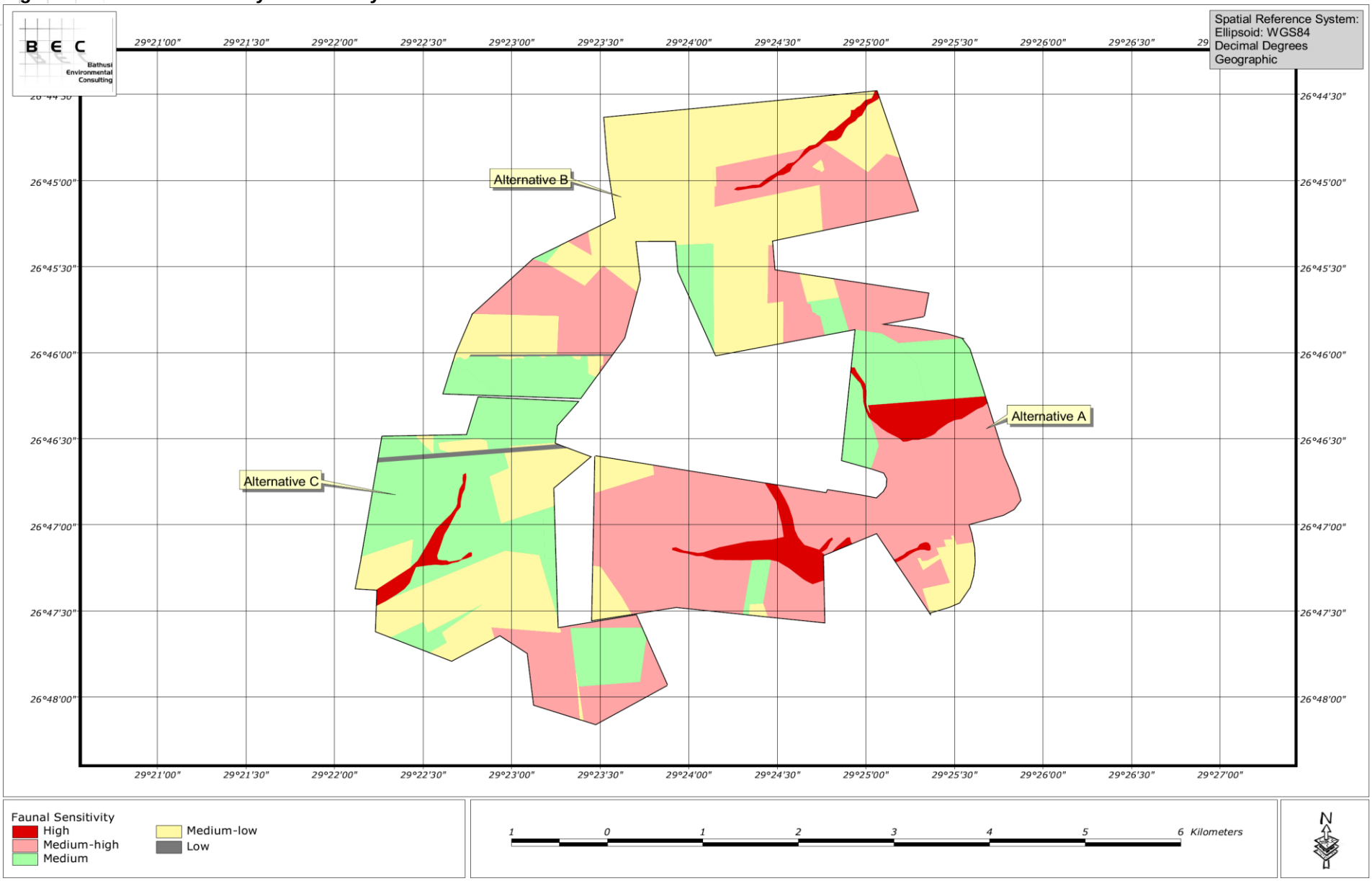
- Habitat status (ST): level of habitat transformation and degradation vs. pristine faunal habitat;
- Habitat diversity (DV): the number of different faunal habitat types (both on micro- and macro-scale) found within the proposed site and bordering areas;
- Habitat linkage (LN): the degree to which the faunal habitat of the proposed site is linked to other natural areas enabling movement of animals to and from the habitat found on site;
- Red Data species (RD): the degree to which suitable habitat for the red data species likely to be found in the study area (larger study area) is located on each site; and
- Sensitive faunal habitat (SE): the relative presence of faunal sensitive habitat type elements such as surface rock associated with outcrops and hills as well as wetland elements.

Table 16: Faunal Habitat Sensitivities for the study area

Unit	*Habitat Type*	*ST*	*DV*	*LN*	*RD*	*SE*	*Ave*	*Sensitivity Class*
Transformed	Infrastructure	1	1	1	1	1	10 %	low
	Agricultural fields	2	2	3	3	2	24 %	medium-low
	Stands of exotic trees	2	2	3	6	1	28 %	medium-low
Wetlands	Valley bottoms & drainage lines	7	8	8	9	8	80 %	high
	Ephemeral grasslands	7	8	8	9	8	80 %	high
Grasslands	Degraded grasslands	5	6	6	6	6	58 %	medium
	Poor status grasslands	4	5	6	5	5	50 %	medium
	Natural grasslands	7	7	8	7	8	74 %	medium-high

Faunal habitat sensitivities of the study areas are illustrated in Figure 12.

Figure 12: Faunal sensitivity of the study area



9.8 DISCUSSION

The area investigated includes significant fragments of natural Soweto Highveld Grassland and associated ephemeral grasslands and drainage lines. The ecological functionality of these grassland and wetland ecosystems were attested to by the presence of many grassland and wetland specialist fauna species such as Rinkhals, Common Quail, Spur-winged Goose, South African Shelduck, Cape Shoveler, Little Grebe, Glossy Ibis, African Darter, Kittlitz's Plover, African Snipe, Common Greenshank, Marsh Owl, Rufous-naped Lark, Cloud Cisticola, Highveld Gerbil and Marsh Mongoose. The sensitivity of these natural faunal habitats of the study area were further emphasised by the presence of four Red Data species: the Greater Flamingo, Grey Crowned Crane, Black-winged Pratincole and Serval. It must be noted that the presence of Plains Sebra, Cape Springbok, Black Wildebeest and Blesbok is a direct result of relocation to the area and, although present, are not considered free roaming within the area.

Despite significant transformation pressures found in the region of the study area, the natural faunal habitats are still considered to have significant biodiversity value; not only as breeding and feeding habitat for many grassland and wetland animals (including sensitive species), but also as migration corridors and sink habitats between larger fragments of wetlands and grasslands in the immediate regions bordering the study area.

The three site alternatives are situated around the current ashing facility at Tutuka Power Station, but exhibit significant variation in terms of presence and status of faunal habitats, and consequently, sensitivity. Ultimately, based on these differences, a preference rating is assigned to each alternative in terms of faunal sensitivity.

9.8.1 Alternative A

Table 17: Habitat extent & Sensitivity of Alternative A

Sensitivity	*Coverage (ha)*	*Percentage*
High	71.5 ha	10.6 %
Medium-high	446.9 ha	66.3 %
Medium	103.5 ha	15.4 %
Medium-low	51.9 ha	7.7 %
Low	0.0 ha	0.0 %

66.3 % of the site exhibit attributes of medium-high faunal sensitivity (natural grassland habitat) and 10.6 % of high faunal sensitivity (wetland habitat). This large extent of high and medium-high sensitivity is not only the result of relative pristine grasslands on this portion, but also due to the presence of highly sensitive habitat near to the site; specifically the pan system situated directly to the south of the site. Four Red Data fauna species observed during the field investigation was recorded within the pan system south of Alternative A. Indications are that impacts from the existing ashing facility have already resulted in severe effects on the status and functionality of the wetland system. Alternative A is therefore considered the least preferred alternative (most sensitive alternative).

9.8.2 Alternative B

Table 18: Habitat extent & Sensitivity of Alternative B		
Sensitivity	***Coverage (ha)***	***Percentage***
High	9.6 ha	1.3 %
Medium-high	237.7 ha	31.0 %
Medium	88.7 ha	11.6 %
Medium-low	427.5 ha	55.8 %
Low	2.8 ha	0.4 %

Alternative B includes 1.3 % high and 31.0 % medium-high faunal sensitivity (less than Alternative A, but more than Alternative C). In particular, the Natural Grassland habitat portions situated in the eastern part of the study area is regarded the most representative and pristine portions of grassland encountered in the entire study area. Significantly, 67.8 % of this site comprises habitat of low and medium-low faunal sensitivity. Furthermore, Alternative B is situated the furthest from the sensitive pan system located south of the current ashing facility (host to at least four red data animal species). Based on this assessment, Alternative B is considered the least sensitive and therefore the most preferred alternative.

9.8.3 Alternative C

Table 19: Habitat extent & Sensitivity of Alternative C		
Sensitivity	***Coverage (ha)***	***Percentage***
High	16.3 ha	3.0 %
Medium-high	73.0 ha	13.6 %
Medium	254.6 ha	47.6 %
Medium-low	182.6 ha	34.1 %
Low	8.8 ha	1.6 %

Alternative C comprises the smallest extent of high and medium-high sensitivity areas, namely 3.0 % and 13.6 % respectively. However, Alternative C includes ephemeral grassland of moderate quality. This alternative is also situated reasonably close to the sensitive wetland system located south of Alternative A, which is host to at least four Red Data species. The proximity of this wetland system to Alternative C significantly affects the preference and sensitivity of this alternative in terms of faunal sensitivity. In spite of the lowest extent of high and medium-high faunal sensitivity habitat, this alternative is considered the second-least preferred alternative, in terms of faunal sensitivity (second-most sensitive alternative).

10 ECOLOGICAL IMPACT ASSESSMENT

The impact assessment is aimed at presenting a description of the nature, extent significance and potential mitigation of identified impacts on the ecological environment. These tabular assessments are presented in Section 10.3 in the form of an Impact Rating Matrix for expected impacts within the development area.

Direct or primary impacts from these types of development can result from any activity that involves land clearance (such as access road construction, topsoil stripping or tailings impoundment construction) or direct discharges to water bodies (riverine tailings disposal, for instance, or tailings impoundment releases) or the air (such as dusts or smelter emissions). Direct impacts are usually readily identifiable, while indirect or secondary impacts can result from social or environmental changes induced by mining operations and are often harder to identify and assess. Cumulative impacts occur where similar projects are developed in environments that are influenced by other projects; both mining and non-mining.

10.1 IDENTIFICATION OF IMPACTS

No impacts were identified that could lead to a beneficial impact on the ecological environment of the study area since the proposed development is largely destructive, involving the alteration of natural habitat or degradation of habitat that is currently in a climax status.

Impacts resulting from the proposed development on floristic and faunal attributes of the study area are largely restricted to the physical effects of habitat clearance the establishment of artificial habitat. Direct impacts include any effect on populations of individual species of conservation importance and on overall species richness. This includes impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of concern. In addition, impacts on sensitive or protected habitat are included in this category, but only on a local scale. These impacts are mostly measurable and easy to assess, as the effects thereof are immediately visible and can be determined to an acceptable level of certainty.

In contrast, indirect impacts are not immediately evident and can consequently not be measured at a moment in time. In addition, the extent of the effect is frequently at a scale that is larger than the actual site of impact. A measure of estimation is therefore necessary in order to evaluate the importance of these impacts. Lastly, impacts of a cumulative nature places direct and indirect impacts of this projects into a regional and national context, particularly in view of similar or resultant developments and activities. The following impacts were therefore identified as relevant to this proposed development:

- Impacts on flora species of conservation importance (including habitat suitable for these species);
- Impacts on fauna species of conservation importance (including habitat suitable for these species);
- Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation);
- Displacement of fauna species, human-animal conflicts & interactions;
- Impacts on ecological connectivity and ecosystem functioning;
- Indirect impacts on surrounding habitat;
- Cumulative impacts on conservation obligations & targets (including national and regional);
- Cumulative increase in local and regional fragmentation/ isolation of habitat; and
- Cumulative increase in environmental degradation, pollution.

10.2 NATURE OF IMPACTS

Impacts that are likely to result from the development activities are described briefly below. This list was compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of this type of development on the floristic environment.

10.2.1 Impacts on flora species of conservation importance (including suitable habitat)

Development activities frequently result in direct impacts or destruction of conservation important plant species, communities of these species, areas where these species are known to occur or areas that are considered particularly suitable for these species. Plant species of conservation importance, in most cases, do not contribute significantly to the biodiversity of an area in terms of sheer numbers, as there are generally few of them, but a high ecological value is placed on the presence of such species in an area as they represent an indication of pristine habitat conditions. Conversely, the presence of pristine habitat conditions can frequently be accepted as an indication of the potential presence of species of conservation importance, particularly in moist habitat conditions.

Red Data species are particularly sensitive to changes in their environment, being adapted to a narrow range of specific habitat requirements. Changes in habitat conditions resulting from human-related activities is one of the greatest reasons for these species being in danger of extinction. Surface transformation/ degradation activities within habitat types that are occupied by flora species of conservation importance will ultimately result in significant impacts on these species and their population dynamics. Effects of this type of impact are usually permanent and recovery or mitigation is generally not perceived as possible.

One of the greatest limitations in terms of mitigating or preventing this particular impact, is the paucity of species specific information that describe their presence, distribution patterns, population dynamics and habitat requirements. To allow for an accurate assessment, it is usually necessary to assess the presence/ distribution, habitats requirements, etc. associated with these species in detail and over prolonged periods; something that is generally not possible during EIA investigation such as this. However, by applying ecosystem conservation principles to this impact assessment and subsequent planning and development phases, potential impacts will be limited largely.

The presence of several plants of conservation importance was established during the brief survey period, while habitat within most of the proposed areas is considered suitable for a number of other taxa that were not recorded during the survey. This impact will therefore likely be severe. Exclusion of red data habitat is the only sensible manner in which this impact can be mitigated.

10.2.2 Impacts on fauna species of conservation importance (including suitable habitat)

Similarly, animal taxa of conservation importance generally do not contribute significantly to the species richness of a region, but do contribute significantly to the ecological diversity of a region as their presence usually provides an indication of a relatively pristine environment. Because animals are mostly mobile and are ultimately able to migrate away from impacts, developments rarely affect them directly. However, significant impacts result from losses and degradation of suitable habitat that is available to them. This represents a significant direct impact on these animals. Additional aspects that will be affected include migration patterns and suitable habitat for breeding and foraging purposes. Habitat requirements and preferences of conservation important species are much stricter than for common or generalist species and a higher conservation obligation is placed on these areas. Even slight changes to habitat in which these species persist are therefore likely to have significant effects on the presence and status of these taxa within the immediate region.

The presence of Red Data fauna species within as well as near to the proposed development areas was established during the survey period. Considering the brief period over which the survey was conducted, and taking cognisance of the habitat status and availability, the likelihood that other conservation important species would occur in the study area is regarded high. Exclusion of red data habitat is the only sensible manner in which this impact can be mitigated to some extent.

10.2.3 Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)

The loss or degradation of natural vegetation or habitat that are regarded sensitive as a result of restricted presence in the larger region, represents a potential loss of habitat and biodiversity on a local and regional scale. Sensitive habitat types might include mountains, ridges, koppies, wetlands, rivers, streams, pans and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is generally ascribed to floristic communities that occupy these areas as they contribute significantly to the biodiversity of a region.

Natural faunal habitat of the study area will be affected adversely by direct impacts resulting from construction and operational activities. Particular reference is made to the loss of habitat resulting from surface clearing activities, the construction of infrastructure and contamination of natural habitat through the leaching of chemicals into the groundwater and surface water and generation of huge amounts of dust and spillages. Also of importance is the loss of habitat that are not necessarily considered suitable for Red Data species, but where high endemic species richness is likely to be recorded.

All wetland related habitat within the proposed development areas are regarded sensitive, particularly in view of the presence of several conservation important plant and animal taxa that were recorded within these areas during the survey period. In addition, particularly sensitive habitat was identified in proximity to some of the development alternatives, which will ultimately affect the preference rating and impact significance ascribed to the site alternatives.

This impact also includes adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;
- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

Changes to the natural habitat may lead to a reduction in the resilience of ecological communities and ecosystems and changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of the wetland habitat types, is particularly important. A high conservation value is generally ascribed to faunal assemblages that persist in these areas as they contribute significantly to the biodiversity of a region.

10.2.4 Displacement of fauna species, human-animal conflicts & interactions

Activities that are known to transpire from human–animal conflicts are likely to affect animals that utilise surrounding areas. Unwanted activities might include poaching, snaring, killing by accidental contact, capturing, effects of domestic cats and dogs, escalation in numbers of exotic and non-endemic species, roadkills, etc. While the tolerance levels of common animal species is generally of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from the area of impact, some species would not able to relocate, such as ground living and small species. It should be noted that animals generally avoid contact with human structures, but do grow accustomed to structures after a period. An aspect that is of concern is the presence of vehicles on access roads, leading to accidental death of animals, particularly with regards to nocturnal animals.

The presence of personnel within the development area during construction and operational phases will inevitably result in some contact with animals. Therefore, encounters with dangerous animals (such as snakes) remain likely. In addition, the presence of domestic dogs and cats is generally associated with humans. These animals are frequently accountable for killing of natural fauna. It is also regarded moderately likely that the natural faunal component might be attracted to the artificial habitat that is created by the development. The establishment of human abodes generally result in the presence of foraging rodents, which is likely to attract smaller predators, raptors, owls, and snakes. The lack of understanding from personnel frequently results in the unnecessary killing of these animals.

10.2.5 Impacts on ecological connectivity & ecosystem functioning

The larger region is characterised by highly transformed and fragmented grassland habitat. This is also reflected in the study area and immediate surrounds. Therefore, the ecological connectivity that natural habitat provides within this regional setting of habitat fragmentation and isolation, is therefore particularly important in the effective functioning of the regional and local ecological processes. Evidence obtained during the investigation period revealed that the biodiversity aspects recorded within both the terrestrial grassland types and wetland related habitat is much higher than would be expected when looking at the study area in isolation, providing insight into the regional importance of these habitat types. It is therefore reasonable to assume that the animals that utilises these habitat types migrate extensively across the region for various reasons. Foraging, available water, food sources, breeding patterns and seasonal climate changes include some of the more obvious explanations for migration of animals. In order to ensure the persistence of animals within this system on a local and regional scale, it is critical that the basic characteristics of the system, such as a natural species composition, physiognomy, aquatic principles, contributions from surrounding habitat types, etc. are preserved. This is also particularly relevant for plant species of conservation consideration that could potentially occupy the area.

The ecological interconnectivity of terrestrial and wetland related habitat types is important for the functioning; without terrestrial grasslands, the reservoirs of water that feed wetland habitat types will disappear and the characteristics and features that makes these features suitable for a high biodiversity will disappear, effectively destroying the remaining biodiversity to a large extent.

While most of the larger mammal species (ungulates) are restricted in their movement by fences, small and medium sized animals, that include predators, burrowing species, small mammals, invertebrate species, reptiles, amphibians, etc. utilises all available natural habitat as either corridors, ‘stepping stones’ or habitat. Loss of current migration routes or connectivity areas (‘stepping stones’) within the study area will likely affect the migration pattern of some species on larger scale. Particular reference is made to the disruption of migration patterns of flightless animals.

10.2.6 Indirect impacts on surrounding habitat

Surrounding areas and species present in the direct vicinity of the study areas will likely be affected adversely by indirect impacts resulting from construction and operational activities. These indirect impacts also include adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;
- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

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

These impacts lead to a reduction in the resilience of peripheral ecological communities and ecosystems or loss or changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of drainage lines, is regarded important. It is well known that the status of a catchment is largely determined by the status of the upper reaches of the rivers. Small drainage lines might be insignificant on a regional scale, but the combined impact on numerous such small drainage lines will affect the quality of larger rivers further downstream adversely.

10.2.7 Cumulative impacts on conservation obligations & targets (including national and regional)

This impact is regarded a cumulative impact since it affects the status of conservation strategies and targets on a local as well as national level and is viewed in conjunction with other types of local and regional impacts that affects conservation areas or threatened areas. The importance of vegetation types is based on the conservation status ascribed to regional vegetation types (VEGMAP, 2006) and because impacts that result in irreversible transformation of natural habitat is regarded significant. The current conservation status is based on regional information relating to the status and availability of remaining natural habitat. This vegetation type is included in the ‘Endangered’ category.

It has been established that the available infobase inaccurately displays the status and availability of natural grasslands. Poor quality (degraded) grasslands, and cultivated pastures are frequently included in this category. Additionally, developments that have taken place subsequent to the compilation of the VEGMAP database have resulted in further decimation of natural grasslands, contributing to this cumulative impact. Ultimately, the current estimation of conservation level is therefore likely to be an underrepresentation of the conservation requirements that need to be applied to these vegetation types. The continued conservation of any area that is representative of these regional vegetation types should therefore be prioritised.

10.2.8 Cumulative increase in local and regional fragmentation/ isolation of habitat

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

The danger in this type of cumulative impact is that effects are not known or is not visible with immediate effect and normally when these effects become visible, they are usually beyond repair. Impacts on linear areas of natural habitat affect the migratory success of animals in particular.

The general region is characterised by high levels of transformation and habitat fragmentation.

10.3 CAUSATIVE ACTIVITIES

The following activities, related to the construction, operation and decommissioning phases of the proposed development, are expected to result in adverse impacts on the ecological environment:

- Clearing of land for construction purposes;
- Construction of required infrastructure (roads, offices, storage areas, laydown areas, etc.);
- Presence of construction and operational personnel within a natural environment (ablution, fires, damage to vegetation, etc.);
- Chemical contamination by construction vehicles and machinery;
- Hydrocarbon spillages;
- Generation & Handling of Waste;
- Operational activities, with specific reference to ashing operations;
- Removal and dismantling of infrastructure during decommissioning;
- Rehabilitation activities (introduction of species);

Impacts within the biodiversity environment will be assessed in each of the construction, operational and decommissioning phases.

10.4 ECOLOGICAL IMPACT RATING TABLES

10.4.1 Construction Phase

Ash Disposal Facility - Alternative A									
Potential Impact	**Mitigation**	**Extent**	**Duration**	**Magnitude**	**Probability**	**Significance**		**Status**	**Confidence**
		(E)	**(D)**	**(M)**	**(P)**	**(S=(E+D+M)*P)**		**(+ve or -ve)**	
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	10	4	**76**	**High**	-	High
	with	4	5	10	3	**57**	**Medium**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	10	4	**76**	**High**	-	High
	with	4	5	10	3	**57**	**Medium**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	3	5	10	4	**72**	**High**	-	High
	with	3	5	10	3	**54**	**Medium**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	5	**65**	**High**	-	High
	with	2	5	4	5	**55**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	5	4	5	**60**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	4	4	5	**55**	**Medium**	-	Medium

Ash Disposal Facility - Alternative B									
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	8	3	**51**	**Medium**	-	High
	with	4	5	6	3	**45**	**Medium**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	8	3	**51**	**Medium**	-	High
	with	4	5	6	3	**45**	**Medium**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	3	5	8	3	**48**	**Medium**	-	High
	with	3	5	6	3	**42**	**Medium**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	4	**52**	**Medium**	-	High
	with	2	5	4	3	**33**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	4	**56**	**Medium**	-	High
	with	3	5	4	3	**36**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	4	4	4	**44**	**Medium**	-	Medium

Ash Disposal Facility - Alternative C									
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	10	4	**76**	**High**	-	High
	with	4	5	8	3	**51**	**Medium**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	10	4	**76**	**High**	-	High
	with	4	5	8	3	**51**	**Medium**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	3	5	10	4	**72**	**High**	-	High
	with	3	5	8	3	**48**	**Medium**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	5	**65**	**High**	-	High
	with	2	5	4	4	**44**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	5	4	4	**48**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	4	4	4	**44**	**Medium**	-	Medium
Ash Disposal Facility - No-Go									
No impacts identified should the No-Go Option be exercised									

10.4.2 Operational Phase

Ash Disposal Facility - Alternative A									
Potential Impact	**Mitigation**	**Extent**	**Duration**	**Magnitude**	**Probability**	**Significance**		**Status**	**Confidence**
		(E)	**(D)**	**(M)**	**(P)**	**(S=(E+D+M)*P)**		**(+ve or -ve)**	
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	3	4	10	4	**68**	**High**	-	High
	with	3	4	10	3	**51**	**Medium**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	3	4	10	4	**68**	**High**	-	High
	with	3	4	10	3	**51**	**Medium**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	3	4	10	4	**68**	**High**	-	High
	with	3	4	8	3	**45**	**Medium**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	5	**65**	**High**	-	High
	with	2	5	4	5	**55**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	5	4	5	**60**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	3	5	8	5	**80**	**High**	-	High
	with	3	4	6	5	**65**	**High**	-	Medium

Ash Disposal Facility - Alternative B									
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	8	3	**51**	**Medium**	-	High
	with	4	5	6	3	**45**	**Medium**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	8	3	**51**	**Medium**	-	High
	with	4	5	6	3	**45**	**Medium**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	3	4	8	3	**45**	**Medium**	-	High
	with	3	4	6	3	**39**	**Medium**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	4	**52**	**Medium**	-	High
	with	2	5	4	3	**33**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	4	**56**	**Medium**	-	High
	with	3	5	4	3	**36**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	3	5	6	4	**56**	**Medium**	-	High
	with	3	4	4	3	**33**	**Medium**	-	Medium

Ash Disposal Facility - Alternative C									
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	10	4	**76**	**High**	-	High
	with	4	5	8	3	**51**	**Medium**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	4	5	10	4	**76**	**High**	-	High
	with	4	5	8	3	**51**	**Medium**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	3	5	8	3	**48**	**Medium**	-	High
	with	3	5	6	3	**42**	**Medium**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	5	**65**	**High**	-	High
	with	2	5	4	4	**44**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	5	4	4	**48**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	3	5	8	4	**64**	**High**	-	High
	with	3	4	6	4	**52**	**Medium**	-	Medium
Ash Disposal Facility - No-Go									
No impacts identified should the No-Go Option be exercised									

10.4.3 Decommissioning Phase

Ash Disposal Facility - Alternative A									
Potential Impact	**Mitigation**	**Extent**	**Duration**	**Magnitude**	**Probability**	**Significance**		**Status**	**Confidence**
		(E)	**(D)**	**(M)**	**(P)**	**(S=(E+D+M)*P)**		**(+ve or -ve)**	
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	2	5	10	3	**51**	**Medium**	-	High
	with	2	5	10	2	**34**	**Medium**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	2	5	10	3	**51**	**Medium**	-	High
	with	2	5	10	2	**34**	**Medium**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	2	4	10	3	**48**	**Medium**	-	High
	with	2	4	8	2	**28**	**Low**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	5	**65**	**High**	-	High
	with	2	5	4	5	**55**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	5	4	5	**60**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	2	4	6	3	**36**	**Medium**	-	High
	with	2	3	4	2	**18**	**Low**	-	Medium

Ash Disposal Facility - Alternative B									
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	3	5	8	2	**32**	**Medium**	-	High
	with	3	5	6	2	**28**	**Low**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	3	5	8	2	**32**	**Medium**	-	High
	with	3	5	6	2	**28**	**Low**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	3	4	8	2	**30**	**Low**	-	High
	with	3	4	6	2	**26**	**Low**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	4	**52**	**Medium**	-	High
	with	2	5	4	3	**33**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	4	**56**	**Medium**	-	High
	with	3	5	4	3	**36**	**Medium**	-	High
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	2	4	6	4	**48**	**Medium**	-	High
	with	2	4	4	3	**30**	**Low**	-	Medium

Ash Disposal Facility - Alternative C									
Impacts on flora species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on plants of conservation importance during construction and site preparation activities, such as soil disturbances and topsoil stripping. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	3	4	10	3	**51**	**Medium**	-	High
	with	3	4	8	2	**30**	**Low**	-	High
Impacts on fauna species of conservation importance (including habitat suitable for these species)	**Nature of impact:**	Includes direct impacts of development of the ashing facility on animals of conservation importance during construction and site preparation activities, such as accidental killing and, particularly, habitat destruction. Also include impacts in habitat that are associated with the presence of conservation important species, although not necessarily recorded on the site							
	without	3	4	10	3	**51**	**Medium**	-	High
	with	3	4	8	2	**30**	**Low**	-	High
Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation)	**Nature of impact:**	Destruction or degradation of important/ protected ecological types that are typically restricted in distribution and also typically high in biodiversity. Wetlands are important in regards to the study area							
	without	2	4	10	3	**48**	**Medium**	-	High
	with	2	4	8	2	**28**	**Low**	-	High
Displacement of fauna species, human-animal conflicts & interactions	**Nature of impact:**	Naturally occurring fauna species will be displaced into adjacent areas of natural habitat, the presence of construction personnel, vehicles and activities will likely result in conflict situations							
	without	2	5	6	5	**65**	**High**	-	High
	with	2	5	4	4	**44**	**Medium**	-	High
Impacts on ecological connectivity and ecosystem functioning	**Nature of impact:**	The transformed nature of the landscape places a high premium on remaining natural habitat to serve as migration corridors. Effective ecological functioning of the habitat is also dependent on a minimum availability of natural habitat. Transformation of natural habitat increases disruption of movement corridors and functionality							
	without	3	5	6	5	**70**	**High**	-	High
	with	3	5	4	4	**48**	**Medium**	-	Medium
Indirect impacts on surrounding habitat	**Nature of impact:**	Impacts on surrounding habitat can potentially include all of the above, as well as additional impacts such as habitat degradation and deterioration due to leaching, effluents, dust, etc							
	without	2	4	6	4	**48**	**Medium**	-	High
	with	2	3	4	3	**27**	**Low**	-	Medium
Ash Disposal Facility - No-Go									
No impacts identified should the No-Go Option be exercised									

10.4.4 Cumulative Impacts

Potential Impact	Mitigation	Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Ash Disposal Facility - Alternative A									
Cumulative impacts on conservation obligations & targets (including national and regional)	**Nature of impact:**	The Soweto Highveld Grassland is listed as Endangered and the continued loss of representative habitats will adversely impact on the conservation status of this unit							
	without	4	5	8	5	**85**	**High**	-	High
	with	4	5	8	5	**85**	**High**	-	High
Cumulative increase in local and regional fragmentation/ isolation of habitat	**Nature of impact:**	Current transformation and fragmentation levels of the landscape is regarded severe and the continued loss of natural habitat will result in augmentation of these levels							
	without	3	5	8	4	**64**	**High**		High
	with	3	5	6	4	**56**	**Medium**		High
Cumulative increase in environmental degradation, pollution	**Nature of impact:**	Evidence indicates existing moderately significant impacts on surrounding areas of natural habitat. Existing impacts will be augmented by extension of the present ashing facility, particularly in view of the proximity of sensitive habitat to some alternatives							
	without	3	5	8	4	**64**	**High**	-	High
	with	3	5	6	3	**42**	**Medium**	-	High
Ash Disposal Facility - Alternative B									
Cumulative impacts on conservation obligations & targets (including national and regional)	**Nature of impact:**	The Soweto Highveld Grassland is listed as Endangered and the continued loss of representative habitats will adversely impact on the conservation status of this unit							
	without	4	5	6	4	**60**	**Medium**	-	High
	with	4	5	6	4	**60**	**Medium**	-	High
Cumulative increase in local and regional fragmentation/ isolation of habitat	**Nature of impact:**	Current transformation and fragmentation levels of the landscape is regarded severe and the continued loss of natural habitat will result in augmentation of these levels							
	without	3	5	6	4	**56**	**Medium**		High
	with	3	5	4	3	**36**	**Medium**		High
Cumulative increase in environmental degradation, pollution	**Nature of impact:**	Evidence indicates existing moderately significant impacts on surrounding areas of natural habitat. Existing impacts will be augmented by extension of the present ashing facility, particularly in view of the proximity of sensitive habitat to some alternatives							
	without	3	5	6	4	**56**	**Medium**	-	High
	with	3	5	4	3	**36**	**Medium**	-	High
Ash Disposal Facility - Alternative C									
Cumulative impacts on conservation obligations & targets (including national and regional)	**Nature of impact:**	The Soweto Highveld Grassland is listed as Endangered and the continued loss of representative habitats will adversely impact on the conservation status of this unit							
	without	4	5	8	4	**68**	**High**	-	High
	with	4	5	8	4	**68**	**High**	-	High
Cumulative increase in local and regional fragmentation/ isolation	**Nature of impact:**	Current transformation and fragmentation levels of the landscape is regarded severe and the continued loss of natural habitat will result in augmentation of these levels							
	without	3	5	6	4	**56**	**Medium**	-	High

of habitat	**with**	3	5	4	4	**48**	**Medium**	-	High
Cumulative increase in environmental degradation, pollution	**Nature of impact:**	Evidence indicates existing moderately significant impacts on surrounding areas of natural habitat. Existing impacts will be augmented by extension of the present ashing facility, particularly in view of the proximity of sensitive habitat to some alternatives							
	without	3	5	6	4	**56**	**Medium**	-	High
	with	3	5	4	3	**36**	**Medium**	-	High
Ash Disposal Facility - No-Go									
Cumulative impacts on conservation obligations & targets (including national and regional)									

11 SITE PREFERENCE RANKING

In order to rank the site alternatives in terms of biodiversity sensitivity/ preference for the proposed project, a site preference rating system is applied, based on integrated results of the floristic and faunal assessments. The following protocol is applied:

1 = Not Suitable for development / No-Go (impact of very high significance - negative)
2 = Not Preferred (impact of high significance - negative)
3 = Acceptable (impact of moderate significance - negative)
4 = Preferred (impact of low or negligible significance - negative)

The following criteria are applied for the ranking protocol:

Table 20: Criteria for site preference ranking

Site preference Rating	***Criteria***
Preferred (4)	• No natural habitat remaining; or • Highly fragmented habitat in-between degraded habitat; and • Low intrinsic biodiversity and conservation value; and • Plants and animal species of conservation importance unlikely to occur; and • No significant direct and indirect impacts identified
Acceptable (3)	• Natural habitat largely degraded & transformed; and • A measure of original biodiversity still present, albeit mostly secondary climax status; and • High utilisation factors; and • Low probability for plants and animal species of conservation importance to occur; and • Impact significance of moderate significance, but could be mitigated successfully
Not Preferred (2)	• Habitat suitable for RD flora & fauna species; and • High/ moderate-high intrinsic biodiversity value; and • Moderate to low transformation & degradation levels; and • Impacts of high significance identified, moderate potential to successfully mitigate
No-Go (1)	• Presence of RD flora & fauna species; and • Protected habitat types; and • Intrinsic high biodiversity value; and • Low transformation & fragmentation levels; and • Pristine status and high ecological functionality; and • Highly significant impacts identified, impossible to mitigate against

Based on floristic and faunal attributes that persist within each of the alternatives, as well as taking cognisance of the potential importance of the site in the larger landscape (in terms of ecological contribution and intrinsic ecological value), the site alternatives are therefore ranked as follows:

Alternative A 2 (Not Preferred Option)
Alternative B 4 (Preferred Option)
Alternative C 3 (Acceptable Option)

However, based on the disparity of habitat types within each of the site alternatives, as well as the requirement of approximately 800 ha for the proposed development, it is strongly suggested that suitable portions (moderate to low floristic and faunal sensitivity) be used for development purposes. It is important to note that habitat of medium-high and high floristic and faunal sensitivity be excluded as well as placing the proposed ashing facility as far away from the sensitive wetland habitat type situated south of Alternative A.

12 RECOMMENDED MITIGATION MEASURES

12.1.1 Site Specific Mitigation Measures

Mitigation Measure 1 - Exclude all areas of high ecological sensitivity from the proposed development;
Mitigation Measure 2 - Prevent all and any effluent from the ashing facility into wetland habitat;
Mitigation Measure 3 - Prevent contamination of natural habitat, wetland and endorheic pans from any source of pollution;
Mitigation Measure 4 - Provide an adequate buffer between areas of development and surrounding natural habitat.

12.1.2 General Aspects

Mitigation Measure 5 - Appoint an Environmental Control Officer (ECO) prior to commencement of construction phase. Responsibilities should include, but not necessarily be limited to, ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;
Mitigation Measure 6 - Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Biodiversity monitoring should be conducted at least twice per year (Summer, Winter) in order to assess the status of natural habitat and effects of the development on the natural environment;

12.1.3 Environmental Control Officer

Mitigation Measure 7 - Have overall responsibility for the implementation of the EMP;
Mitigation Measure 8 - Ensure that the developer and contractors are aware of environmental specifications, legal constraints and general standards and procedures;
Mitigation Measure 9 - Ensure that all stipulations within the EMP are communicated and adhered to by the developer and contractors;
Mitigation Measure 10 - Monitor the implementation of the EMP throughout the project by means of site inspections and meetings. This will be documented as part of the site meeting minutes;
Mitigation Measure 11 - Be fully conversant with the Environmental Impact Assessment for the project, the conditions of the RoD, all relevant environmental legislation and with the EMP;
Mitigation Measure 12 - Ensure that periodic environmental performance audits are undertaken on the project implementation;
Mitigation Measure 13 - Convey the contents of the EMP to the site staff and discuss the contents in detail with the Project Manager and Contractors;
Mitigation Measure 14 - Take appropriate action if the specifications contained in the EMP are not followed;
Mitigation Measure 15 - Monitor and verify that environmental impacts are kept to a minimum, as far as possible;
Mitigation Measure 16 - Compile progress reports on a regular basis, with input from the Site Manager, for submission to the Project Manager, including a final post-construction audit carried out by an independent auditor/consultant.

12.1.4 Fences & Demarcation

Mitigation Measure 17 - Demarcate construction areas by semi-permanent means/ material, in order to control movement of personnel, vehicles, providing boundaries for construction and operational sites;

Mitigation Measure 18 - No painting or marking of rocks or vegetation to identify locality or other information shall be allowed, as it will disfigure the natural setting. Marking shall be done by steel stakes with tags, if required;

12.1.5 Fire

Mitigation Measure 19 - The Project team will compile a Fire Management Plan (FMP) and Contractors directed by the ECO will submit a FMP. The Project FMP shall be approved by local Fire Protection Association, and shall include *inter alia* aspects such as relevant training, equipment on site, prevention, response, rehabilitation and compliance to the National Veld and Forest Fire Act, Act No. 101 1998;

Mitigation Measure 20 - Prevent all open fires;

Mitigation Measure 21 - Provide demarcated fire-safe zones, facilities and suitable fire control measures;

Mitigation Measure 22 - Use of branches of trees, shrubs or any vegetation for fire making purposes is strictly prohibited;

12.1.6 Roads & Access

Mitigation Measure 23 - Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

Mitigation Measure 24 - A road management plan should be compiled prior to the commencement of construction activities;

Mitigation Measure 25 - Dust control on all roads should be prioritised;

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

12.1.7 Workers & Personnel

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

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

12.1.8 Vegetation Clearance & Operations

Mitigation Measure 29 - The landowner must immediately take steps to remove alien vegetation as per Conservation of Agricultural Resource Act. This should be done based on an alien invasive management strategy that should be compiled by a suitable ecologist. The plan must make reference to:

- Uprooting, felling or cutting;
- Treatment with a weed killer that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;
- The application of control measures regarding the utilisation and protection of veld in terms of regulation 9 of the Act;
- The application of control measures regarding livestock reduction or removal of animals in terms of regulations 10 and 11of the Act;
- Any other method or strategy that may be applicable and that is specified by the executive officer by means of a directive.

- According to the Conservation of Agricultural Resource Act (No. 43 of 1983) as amended, the person applying herbicide must be adequately qualified and certified as well as registered with the appropriate authority to apply herbicides.

Mitigation Measure 30 - The size of areas subjected to land clearance will be kept to a minimum;

Mitigation Measure 31 - Only areas as instructed by the Site Manager must be cleared and grubbed;

Mitigation Measure 32 - Cleared vegetation and debris that has not been utilised will be collected and disposed of to a suitable waste disposal site. It will not be burned on site;

Mitigation Measure 33 - All vegetation not required to be removed will be protected against damage;

Mitigation Measure 34 - Removal of vegetation/ plants shall be avoided until such time as soil stripping is required and similarly exposed surfaces must be re-vegetated or stabilised as soon as is practically possible;

Mitigation Measure 35 - Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and vice versa and protecting the agricultural resources and soil conservation works are regulated by the Conservation of Agricultural Resources Act (No 43 of 1983) and must be addressed on a continual basis, through an alien vegetation control and monitoring programme;

Mitigation Measure 36 - Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area. Removal of topsoil should be done to a depth of at least 1m;

Mitigation Measure 37 - Stored topsoil will be free of deleterious matter such as large roots, stones, refuse, stiff or heavy clay and noxious weeds, which would adversely affect its suitability for planting;

Mitigation Measure 38 - No spoil material will be dumped outside the defined site;

Mitigation Measure 39 - Disturbance of vegetation must be limited to areas of construction;

Mitigation Measure 40 - The removal or picking of any protected or unprotected plants shall not be permitted and no horticultural specimens (even within the demarcated working area) shall be removed, damaged or tampered with unless agreed to by the ECO;

Mitigation Measure 41 - Ensure proper surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;

Mitigation Measure 42 - Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation;

Mitigation Measure 43 - The grass mix should consist of indigenous grasses adapted to the local environmental conditions;

Mitigation Measure 44 - Revegetated areas should be fenced to prevent damage by grazing animals;

Mitigation Measure 45 - Re-vegetated areas showing inadequate surface coverage (less than 30 % within eight months after re-vegetation) should be prepared and re-vegetated from scratch;

Mitigation Measure 46 - Damage to re-vegetated areas should be repaired promptly;

Mitigation Measure 47 - Exotic weeds and invaders that might establish on the re-vegetated areas should be controlled to allow the grasses to properly establish;

12.1.9 Waste

Mitigation Measure 48 - As far as possible, waste should be avoided, reduced, re-used and/or recycled. Where this is not feasible, all waste (general and hazardous) generated during the construction of the power station may only be disposed of at appropriately licensed waste disposal sites (in terms of Section 20 of the Environment Conservation Act, No 73 of 1989 and in accordance with the new waste act: National Environmental Waste Management Act 2008);

Mitigation Measure 49 - Prevent and advocate against the indiscriminate disposal of rubbish, litter or rubble;

Mitigation Measure 50 - The burning of general waste material under any circumstances is not to be allowed;

Mitigation Measure 51 - The use of small on-site incinerators for waste burning should be investigated, and if found feasible, be implemented;

Mitigation Measure 52 - Waste will be sorted at source (i.e. the separation of tins, glass, paper etc); recycled waste of this sort will be collected by an accredited waste removal contractor;

Mitigation Measure 53 - A stormwater management plan will be compiled that will address, inter alia, capturing and storage of stormwater;

Mitigation Measure 54 - All runoff water from fuel deposits, workshops, vehicles washing areas and other equipment must be collected and directed through oil traps to settlement ponds. These ponds must be suitably lined and should be cleaned as soon as practicable, and the sludge disposed off at a suitable waste site;

Mitigation Measure 55 - No wastewater or water containing any chemical or pollutant should be released from, or escape as effluent, from the site;

Mitigation Measure 56 - All pit water removed from mining pits will be evacuated to a suitably lined and constructed evaporation dam. No pitwater shall be released into the wetland area.

12.1.10 Animals

Mitigation Measure 57 - No animal may be hunted, trapped, snared or captured for any purpose whatsoever. Fences and boundaries should be patrolled weekly in order to locate and remove snares/ traps;

Mitigation Measure 58 - Vehicular traffic should not be allowed after dark in order to limit accidental killing of nocturnal animals;

Mitigation Measure 59 - Speed of vehicles should be limited to allow for sufficient safety margins;

Mitigation Measure 60 - Dangerous animals should be handled by a competent person;

Mitigation Measure 61 - Compile a graphic list of potentially dangerous animals and present this to all workers as part of site induction;

Mitigation Measure 62 - Sensitize all personnel to the presence, characteristics and behaviour of animals on the site;

Mitigation Measure 63 - Include suitable procedures in the event of encountering potentially dangerous animals on the site;

Mitigation Measure 64 - Ensure that a snake handler and/ or anti venom serum is available at all times, together with a competent person to administer this serum;

Mitigation Measure 65 - No domestic pets should be allowed on the site.

13 PHOTOGRAPHIC RECORDS

Photo 1: Grassland habitat, including poor status grasslands in the foreground and relatively degraded ephemeral grasslands in the middle, note agricultural fields in the background

Photo 2: Grassland characterised by insowing of grazing species, note the effect of harvesting

Photo 3: Pristine *Themeda triandra* grassland

Photo 4: Moderate status grassland

14 APPENDIX 1: FLORISTIC DIVERSITY OF THE SITE

**** indicates exotic or invasive nature, weeds**
Species indicted in **bold** refer to conservation important plants

Species Name	Growth Form	Family	Status/ Uses	Common Name
Abildgaardia ovata	Sedge	Cyperaceae	None	--
Agrostis lachnantha	Grass	Poaceae	Indicator of wet soils	South African Bent Grass (e) Vinkagrostis (a)
Anthospermum rigidum	Forb	Rubiaceae	None	--
Aristida aequiglumis	Grass	Poaceae	None	Krulgras (a)
Aristida bipartita	Grass	Poaceae	Unpalatable, indicator of degraded veld, Increaser IIC	Rolling grass (e), Grootrolgras (a)
Aristida congesta subsp. *barbicollis***	Grass	Poaceae	Poor grazing potential, Increaser IIC	Spreading Three-awn (e), Lossteekgras (a)
Aristida species	Grass	Poaceae	None	--
Asclepias eminens	Forb	Apocynaceae	None	Large Turret Flower (e)
*Berkheya carlinopsis***	Forb	Asteraceae	Weed	--
*Berkheya pinnatifida***	Forb	Asteraceae	Weed	--
*Berkheya rhapontica***	Forb	Asteraceae	Weed	--
*Berkheya setifera***	Forb	Asteraceae	Weed, widespread	Rasperdisseldoring (a)
*Bidens pilosa***	Forb	Asteraceae	Naturalised exotic, edible parts	Black-jack (e), Knapsekêrel (a)
Boophone disticha	**Geophyte**	**Amaryllidaceae**	**DECLINING STATUS, Poisonous, medicinal uses**	**Bushman Poison Bulb (e), Gifbol (a)**
Brachiaria eruciformis	Grass	Poaceae	Indicator of clayey soils, unpalatable, Increaser IIc	Sweet signal grass (e), Litjiesinjaalgras (a)
Brachiaria glomerata	Grass	Poaceae	None	--
*Bromus catharticus***	Grass	Poaceae	Weed, average grazing potential, Naturalised exotic	Rescue Grass (e), Reddingsgras (a)
Bulbostylis burchellii	Sedge	Cyperaceae	None	--
Casuarina species	Tree	Casuarinaceae	None	--
Chaetacanthus costatus	Forb	Acanthaceae	None	--
*Chenopodium album***	Forb	Chenopodiaceae	Naturalised exotic, weed, edible parts	Common pigweed (e), Bloubossie (a)
Chloris virgata	Grass	Poaceae	None	Feather-top Chloris (e), Witpluim-chloris (a)
Chlorophytum cooperi	Geophyte	Liliaceae	None	--
*Ciclospermum leptophyllum***	Hydrophilic	Apiaceae	Exotic weed (S America)	--
*Cirsium vulgare****	Forb	Asteraceae	Declared Invader - Category 1B, weed	Scottish thistle (e), Skotse dissel (a)
Commelina africana	Forb	Commelinaceae	Medicinal properties	Yellow Wandering Jew (e), Geeleendagsblom (a)
*Conyza podocephala***	Forb	Asteraceae	Weed, indicator of disturbed areas	Bakbossie (a)
*Cosmos bipinnatus***	Forb	Asteraceae	Weed, exotic (S. America), aesthetic uses	Cosmos (e), Kosmos (a)
*Crepis hypochoeridea***	Forb	Asteraceae	Weed, indicator of disturbed areas, Naturalised exotic	--

Crinum bulbispermum	**Geophyte**	**Amaryllidaceae**	**RD - Declining status, medicinal uses, indicator of moist conditions**	**Orange River Lily (e), Oranjerivierlelie (a)**
Cyanotis speciosa	Forb	Commelinaceae	Medicinal properties	Doll's powder puff (e), Bloupoeierkwassie (a)
Cymbopogon pospischilii	Grass	Poaceae	Aromatic grass, unpalatable, Increaser I	Narrow-leaved turpentine grass (e), Smalblaarterpentyngras (a)
Cynodon dactylon	Grass	Poaceae	Indicator of disturbed areas, grazing potential	Common Couch Grass (e), Gewone kweekgras (a)
Cyperus compressus	Sedge	Cyperaceae	None	--
*Cyperus esculentus***	Sedge	Cyperaceae	Weed, edible parts (tuber)	Yellow nutsedge (e), Geeluintjie (a)
*Datura stramonium***	Forb	Solanaceae	Declared Invader - Category 1B, weed	Common thorn apple (e)
Diclis species	Hydrophilic	Scrophulariaceae	None	--
Digitaria eriantha	Grass	Poaceae	Weaving, palatable grazing grass, Decreaser	Finger grass (e), Finger gras (a)
Digitaria ternata	Grass	Poaceae	Palatable, low grazing potential	Black-seed Finger Grass (e), Swartsaadvingergras (a)
Eleocharis dregeana	Sedge	Cyperaceae	None	Finger sedge (e)
Eragrostis capensis	Grass	Poaceae	Moderate grazing potential	Heart-seed love grass (e), Hartjiesgras (a)
Eragrostis chloromelas	Grass	Poaceae	Edible parts, Increaser IIB	Curly leaf (e), Krulblaar (a)
Eragrostis curvula	Grass	Poaceae	Edible parts, indicator of degraded areas	Weeping love grass (e), Oulandsgras (a)
Eragrostis plana	Grass	Poaceae	Weaving, unpalatable, indicator of degraded areas, Increaser IIc	Tough love grass (e), Taai-pol eragrostis
Eragrostis species	Grass	Poaceae	None	--
Eragrostis superba	Grass	Poaceae	None, palatable grazing	Saw toothed love grass (e), Weeluisgras (a)
Erythrina zeyheri	Shrub	Fabaceae	None	Plough breaker (e), Ploegbreker (a)
Eucalyptus species**	Tree	Myrsinaceae	Declared Invader - Category 2, essential oils	Eucalyptus gum tree (e), Bloekomboom (a)
Felicia muricata	Forb	Asteraceae	None	Wild Aster (e), Blouheuning (a)
*Flaveria bidentis***	Forb	Asteraceae	Declared Invader - Category 1B	Smelter's bush, Smelterbossie (a)
Gerbera piloselloides	Forb	Asteraceae	Medicinal uses	Small yellow Gerbera (e), Swartteebossie (a)
*Gleditsia triacanthos***	Tree	Fabaceae	Naturalised exotic, Category 1B	Honey locust (e), Driedoring Gleditsia (a)
Gomphocarpus fruticosus	Shrub	Apocynaceae	Medicinal uses	Milkweed (e), Melkbos (a)
*Gomphrena celosioides***	Forb	Amaranthaceae	Weed, South America	Bachelor's button (e), Mierbossie (a)
Helichrysum aureonitens	Forb	Asteraceae	Medicinal properties	--
Helichrysum pilosellum	Forb	Asteraceae	None	--
Helichrysum rugulosum	Forb	Asteraceae	None	--
Helictotrichon turgidulum	Grass	Poaceae	Indicator of moist conditions, palatable, Decreaser I	Small oat grass (e), Kleinhawergras (a)
Hermannia coccocarpa	Forb	Sterculiaceae	None	--
Hermannia depressa	Forb	Sterculiaceae	Medicinal uses	Rooiopslag (a)
Hermannia lancifolia	Forb	Sterculiaceae	None	--

Heteropogon contortus	Grass	Poaceae	Moderate grazing potential, irritant	Spear grass (e), Assegaaigras (a)
Hibiscus trionum	Forb	Malvaceae	None	Bladderweed (e), Terblansbossie (a)
Hilliardiella oligocephala	Forb	Asteraceae	Medicinal uses	Bitterbossie (a) (previous *Vernonia oligocephala*)
Hyparrhenia filipendula	Grass	Poaceae	Moderate palatability, Increaser I	Red Thatching Grass (e), Rooitamboekiegras (a)
Hyparrhenia hirta	Grass	Poaceae	Thatching & weaving	Thatch Grass (e), Dekgras (a)
Hypoxis hemerocallidea	**Geophyte**	**Hypoxidaceae**	**RD - Declining status, medicinal uses**	**African Potato (e), Afrika aartappel (a)**
Hypoxis rigidula	Geophyte	Hypoxidaceae	None	Farmer's String (e), Botterblom (a)
Imperata cylindrica	Grass	Poaceae	Thatching & weaving, Increaser I	Cottonwool Grass (e), Donsgras (a)
Indigofera hedyantha	Forb	Fabaceae	None	--
Indigofera species	Forb	Fabaceae	None	--
Ipomoea crassipes	Creeper	Convolvulaceae	Medicinal uses, food source	Leavy-flowered Ipomoea (e), Wildewinde (a)
Ipomoea oblongata	Creeper	Convolvulaceae	None	--
Jamesbrittanea aurantiaca	Forb	Scrophulariaceae	Colours & dyes	Cape Saffron (e), Saffraanbossie (a)
Kyllinga alba	Sedge	Cyperaceae	Medicinal uses	White Buttonsedge (e), Witbiesie (a)
Lactuca inermis	Forb	Asteraceae	None	--
Leersia hexandra	Grass	Poaceae	None, host plant for *Metisella meninx*	Wild rice grass (e), Wilderysgras (a)
Lepidium africanum	Forb	Brassicaceae	None	Birdseed (e), Kanariesaadgras (a)
*Melia azedarach***	Tree	Meliaceae	Declared Invader - Category 1B	Seringa (e), Gewone sering (a)
Monsonia angustifolia	Forb	Geraniaceae	None	Crane's Bill (e), Angelbossie (a)
*Oenothera rosea***	Forb	Onagraceae	Weed (S. America), moist & degraded places	Rose evening primrose (e), Pienkaandblom (a)
*Oenothera tetraptera***	Forb	Onagraceae	Weed (Mexico)	White evening primrose (e), Witaandblom (a)
Oxalis semiloba	Geophyte	Oxalidaceae	Edible parts	Transvaal Sorrel (e), Transvaal Suring (a)
Oxalis species	Geophyte	Oxalidaceae	Edible parts	Bobbejaanuintjie (a)
Panicum species	Grass	Poaceae	None	--
Paspalum dilatatum	Grass	Poaceae	Moist places, palatable, Increaser IIB	Common Paspalum (e), Gewone Paspalum (a)
Paspalum notatum	Grass	Poaceae	None	--
Paspalum species	Grass	Poaceae	None	--
*Pennisetum clandestinum***	Grass	Poaceae	Invader (E. Africa), palatable grazing	Kikuyu Grass (e), Kikoejoegras (a)
Phragmites australis	Hydrophilic	Poaceae	Thatching, traditional uses, medicinal properties	Common Reed (e), Fluitjiesriet (a)
Physalis viscosa	Forb	Solanaceae	None	--
*Plantago lanceolata***	Forb	Plantaginaceae	Weed (Europe)	Buckhorn Plantain (e), Oorpynhoutjie (a)
*Populus canescens***	Tree	Salicaceae	Declared Invader - Category 2 - America, timber	Grey poplar (e), Gryspopulier (a)
*Pseudognaphalium luteo-album***	Forb	Asteraceae	Weed (Europe)	Jersey Cudweed (e), Roerkruid (a)
*Quercus robur***	Tree	Fagaceae	Naturalised exotic	Acorn Tree (e), Akkerboom (a)
Ranunculus multifidus	Forb	Ranunculaceae	Indicator of moist conditions	Buttercup (e), Botterblom (a)

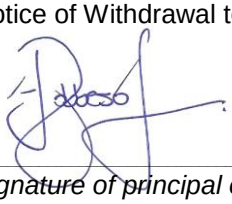
Rumex crispus	Hydrophilic	Polygonaceae	Edible parts	--
*Salix babylonica***	Tree	Salicaceae	Declared Invader - Category 2	Weeping willow (e), Treurwilger (a)
Scabiosa columbaria	Forb	Dipsacaceae	Medicinal uses	Morning Bride (e), Jonkmansknoop (a)
*Schkuhria pinnata***	Forb	Asteraceae	Medicinal uses, weed (S. America)	Dwarf Marigold (e), Bitterbossie (a)
Schoenoplectus corymbosus	Sedge	Cyperaceae	None	--
Selago densiflora	Forb	Selaginaceae	None	--
Senecio achilleifolius	Forb	Asteraceae	Indicator of moist conditions	Slootopdammer (a)
Senecio erubescens	Forb	Asteraceae	None	--
Senecio inaequidens	Forb	Asteraceae	None	Canary Weed (e), Geelopslag (a)
Senecio inornatus	Forb	Asteraceae	None, indicator of moist conditions	--
Setaria sphacelata	Grass	Poaceae	Edible parts, palatable, Decreaser	Common bristle grass (e), Gewone Mannagras (a)
*Solanum panduriforme***	Forb	Solanaceae	Weed, traditional medicine, poisonous	Poison Apple (e), Gifappel (a)
Sphenostylis angustifolia	Forb	Fabaceae	None	Wild sweetpea (e), Wilde-ertjie (a)
Stachys species	Forb	Lamiaceae	None	--
Tagetes minuta	Forb	Asteraceae	Essential oils, colours & dyes	Khaki Weed (e), Kakiebos (a)
Talinum caffrum	Forb	Portulacaceae	Edible parts	Ysetervarkwortel (a)
Themeda triandra	Grass	Poaceae	Palatable grazing, Decreaser	Red grass (e), Rooigras (a)
*Typha capensis***	Hydrophilic	Typhaceae	Cosmopolitan weed, edible parts, medicinal uses	Bulrush (e), Papkuil (a)
Urochloa brachyura	Grass	Poaceae	Moderate grazing potential	Signal grass (e), Beesgras (a)
*Verbena bonariensis***	Forb	Verbenaceae	Declared Invader - Category 1B, Weed (S. America)	Purple Top (e), Blouwaterbossie (a)
Wahlenbergia undulata	Forb	Campanulaceae	None	African Bluebell (e)
Xysmalobium undulatum	Succulent	Apocynaceae	Medicinal uses, diarrhoea, colic	Bitterhout (a)

15 APPENDIX 2: DECLARATION OF INDEPENDENCE

Individual declarations attached as addendums. All specialist investigators, project investigators and members of companies employed for conducting this biodiversity investigation declare that:

- We act as independent specialist consultants conducting the assessment and compiling the report;
- We consider ourselves bound to the rules and ethics of the South African council for natural scientific professions;
- Bathusi Environmental Consulting cc is not a subsidiary, legally or financially, of either the proponent or GCS (Pty) Ltd;
- At the time of completing this report, we did not have any interest, hidden or otherwise, in the proposed development or activity as outlined in this document, other than fair financial compensation for work performed in a professional capacity;
- We will not be affected in any manner by the outcome of the environmental process of which this assessment forms part of, other than being part of the general public;
- We do not necessarily object to or endorse the proposed development, but aim to present facts and recommendations based on scientific data and relevant professional experience; and
- We do not have any influence over decisions made by the governing authorities;
- Undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the environmental impact assessment regulations, 2005; and
- Will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

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



Signature of principal ecologist:

Bathusi Environmental Consulting cc (CK1999/052182/23)

Name of company:

8th May 2014

Date:

16 APPENDIX 3: LEGISLATION

This report has been prepared in terms of the *National Environmental Management Act* No. 107 of 1998 (NEMA) and is compliant with Regulation 385 Section 33 – Specialist reports and reports on specialised processes under the Act. Relevant clauses of the above regulation include:

Regulation 33.(1): An applicant or the EAP managing an application may appoint a person who is independent to carry out a specialist study or specialised process.

Regulation 33.(2): A specialist report or a report on a specialised process prepared in terms of these Regulations must contain:

(a) Details of (i) The person who prepared the report, and
(ii) The expertise of that person to carry out the specialist study or specialised process;
(b) A declaration that the person is independent in a form as may be specified by the competent authority;
(c) An indication of the scope of, and the purpose for which, the report was prepared;
(d) A description of the methodology adopted in preparing the report of carrying out the specialised process;
(e) A description of any assumptions made and any uncertainties or gaps in knowledge;
(f) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
(g) Recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority;
(h) A summary and copies of any comments that were received during any consultation process;
(i) Any other information requested by the competent authority.

Compliance with provincial, national and international legislative aspects is strongly advised during the planning, assessment, authorisation and execution of this particular project. Legislative aspects of which cognisance were taken during the compilation of this report are summarised in, but not necessarily limited to, include:

Table 21: Legislative guidance for this project

Biodiversity Act (No. 10 of 2004)	To provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act 1998; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute; and for matters connected therewith.
Conservation of Agricultural Resources Act 43 of 1983	The conservation of soil, water resources and vegetation is promoted. Management plans to eradicate weeds and invader plants must be established to benefit the integrity of indigenous life.
Constitution of the Republic of South Africa (Act 108 of 1996)	The Bill of Rights, in the Constitution of South Africa (No. 108 of 1996), states that everyone has a right to a non-threatening environment and requires that reasonable measures are applied to protect the environment. This protection encompasses preventing pollution and promoting conservation and environmentally sustainable development. These principles are embraced in NEMA and given further expression.
Convention on Biological Diversity, 1995	International legally binding treaty with three main goals; conserve biological diversity (or biodiversity); ensure sustainable use of its components and the fair and equitable sharing of benefits arising from genetic resources.
Convention on International Trade in Endangered Species of Wild Life and Fauna	International agreement between governments, drafted because of a resolution adopted in 1963 at a meeting of members of the International Union for Conservation of Nature (IUCN). Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival and it accords varying degrees of protection to more than 33,000 species of animals and plants.
Environmental Conservation Act (No. 73 of 1989)	To provide for the effective protection and controlled utilization of the environment and for matters incidental thereto.
Mineral and Petroleum Resources Development Act (Act No.28 of 2002) (MPRDA)	Compilation of Environmental Impact Assessment (EIA) and Environmental Management Programme (Reports) (EMPR).
Mpumalanga Environmental Management Act (Act No. 10 of 1998)	

Table 21: Legislative guidance for this project	
Mpumalanga Tourism and Parks Agency Act (Act No. 5 of 2005)	To provide for the establishment of the Mpumalanga Tourism and Parks Agency and for the management thereof by a Board; to provide for the sustainable development and improvement of the tourism industry in Mpumalanga; to provide for conservation management of the natural resources of Mpumalanga; to confer powers and functions upon the Agency; to provide for the registration of certain persons and entities directly involved in tourism; to provide for transitional arrangements; and to provide for matters incidental thereto
Mpumalanga Parks Board Act of 1995	
National Veld & Forest Act Fire Act (Act No. 101 of 1998)	To prevent and combat veld, forest and mountain fires throughout the Republic, to provide for a variety of institutions, methods and practices for achieving the purpose.
National Environmental Management Act (No. 107 of 1998)	Requires adherence to the principles of Integrated Environmental Management (IEA) in order to ensure sustainable development, which, in turn, aims to ensure that environmental consequences of development proposals be understood and adequately considered during all stages of the project cycle and that negative aspects be resolved or mitigated and positive aspects enhanced.
National Environmental Management: Biodiversity Act (Act No. 10 of 2004)	To provide for matters relating to threatened or protected species regulations
National Environmental Management Protected Areas Act (No. 57 of 2003)	To provide for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas; and for matters in connection therewith.
White Paper on Conservation and Sustainable Use of South Africa's Biological Diversity (July 1997)	Identifies a number of strategies to be developed to give effect to the specific policies, including the enhancement of the protected area network, development of specific strategies such as conservation and sustainable use of reptiles and amphibians. Promotes a "Prosperous, environmentally conscious nation, whose people are in harmonious co-existence with the natural environment, and which derives lasting benefits from the conservation and sustainable use of its rich biological diversity"

17 APPENDIX 4: METHOD STATEMENT

In order to address existing information gaps and satisfy requirements for EIA investigations, an over-arching approach was followed to allow for the capture of maximum data and adequate subsequent analysis thereof during the allotted timeframe. This approach is based on a single summer survey. Botanical and faunal data were captured in point samples (releveès) that was placed in a stratified random means across the entire study area. Care was taken to ensure that all identified macro habitat types were sampled adequately during the allotted timeframe.

Subsequent to the data analysis process, an impact assessment process was conducted during which the nature and extent of the proposed development on the natural environment was assessed.

Floristic and faunal sampling of the study area was conducted between the 5th and 9th November 2012.

17.1 ASSESSMENT PHILOSOPHY

Inherent characteristics of a project of this nature imply that no method will be foolproof. These shortcomings are typical of EIA type investigations and stems from the use of databases with a high degree of paucity and the lack of site-specific detail that could be obtained from limited site surveys that were conducted over a short period and during a single (part) season. This is also a limitation of all scientific studies; it simply is not possible to know everything or to consider every aspect to a molecular level of detail. However, to present an objective opinion of the biodiversity sensitivity of the study area and how this relates to the suitability/ unsuitability of the study area in terms of the proposed development, all opinions and statements presented in this document are based on the following aspects, namely:

- A desk-top assessment of all available biological and biophysical data;
- Augmentation of existing knowledge by means of site specific and detailed field surveys;
- Specialist analysis and interpretation of collated data; and
- An objective impact assessment, estimating potential impacts on biological and biophysical attributes.

The Ecosystem Approach employed for the purpose of this assessment is advocated by the Convention on Biological Diversity. It recognizes that people and biodiversity are part of the broader ecosystems on which they depend, and that it should thus be assessed in an integrated way. Principles of the Ecosystem Approach include the following:

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

The Ecosystem Approach includes the assessment of biophysical and societal causes, consequences of landscape heterogeneity and factors that causes disturbance to these attributes. Species conservation is therefore largely replaced by the concept of habitat conservation. This investigation will therefore aim to:

- Determine the biological sensitivity of the receiving natural environment as it relates to the construction and operation of the mining operation and associated infrastructure in a natural environment;
- Highlight the known level of biodiversity for the study area;
- Highlight flora and fauna species of conservation importance that are likely to occur within the study area;
- Estimate the level of potential impacts of the construction, operation and decommissioning of the proposed development on the biological resources of the study area; and
- Apply the Precautionary Principal throughout the assessment[4].

17.2 FLORISTIC ASSESSMENT

The floristic assessment was conducted by Riaan A. J. Robbeson (Pr.Sci.Nat.).

17.2.1 Sampling Approach

The number of sample plots to be distributed in a given area depends on various factors, such as the scale of the classification, environmental heterogeneity and the accuracy required for the classification (Bredenkamp 1982). Stratification of sample plots was therefore based on visual observations made during the initial site investigation as well as aerial imagery. The Zurich-Montpellier approach of phytosociology (Braun-Blanquet 1964) was followed; this is a standardised and widely used sampling technique for general vegetation surveying in South Africa. During the surveys, all plant species within in sample plots were identified and recorded. In addition, a suitable selection of the following biophysical attributes was recorded within each relevè:

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

In addition to species recorded within the sample plots, general observations were made in order to present a comprehensive species list that will include taxa that, because of low abundance levels, are unlikely to be captured within the sample areas (relevèes). Particular reference is made to Red Data plants, which normally do not occur at great densities.

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

17.2.2 Floristic Sensitivity

The aim of this exercise is to determine the inherent sensitivity of vegetation communities or habitat types by means of the comparison of weighted floristic attributes. Results of this exercise are not 'stand-alone' and will be presented in conjunction with results obtained from the faunal investigation.

Each vegetation unit is subjectively rated on a scale of 1 to 10 in terms of the following attributes:

- The confirmed presence of flora species of conservation importance, the known presence of flora species of conservation importance or the presence of protected flora species (provincially or other legislation);
- Conservation status of the regional vegetation type;
- The observed ecological status, based on degradation gradients, utilisation, habitat fragmentation and isolation, etc.
- The observed (or potential) floristic diversity, compared to surrounding areas and also compared to a pristine status of the particular habitat type within the regional vegetation type; and
- The functionality of the habitat type in a larger landscape that may, or not, be dominated by degradative and transformative anthropogenic activities.

These values are weighted in order to emphasise the importance/ triviality that the individual Sensitivity Criteria have on the status of each community. Ranked Values are expressed as a percentage of the maximum possible value (Floristic Sensitivity Value) and placed in a particular class.

In addition to the general floristic attributes that are being considered when estimating the sensitivity of floristic habitat types, additional (regional) attributes are also taking cognisance of during the estimation process. The aim of this exercise is to present an opinion on the inherent floristic sensitivity of macro habitat types of the study area. These issues are assessed by documenting whether any important biodiversity features occur on site, including species, ecosystems or processes that maintain ecosystems and/or species. The application of these criteria is a matter of professional judgement. These criteria are ranked as follows:

- Threatened and/or Protected-:
  - plant species **(YES)**;
  - ecosystems **(YES)**;
- Critical conservation areas, including:
  - areas of high biodiversity **(NO)**;
  - centres of endemism **(NO)**;
- Important Ecological Processes, including:
  - Corridors **(YES)**;
  - Mega-conservancy networks (**NO)**;
  - Rivers and wetlands **(YES)**; and
  - Important topographical features **(NO)**.

17.3 FAUNAL ASSESSMENT

The faunal assessment was conducted by D. Kamffer (Pr.Sci.Nat.).

Field investigations commonly employed for EIA studies are normally limited by time and budget and scientific approaches generally have to be adapted to allow for limitations that are normal to EIA type investigations. Ecology and biodiversity are growing fields of science and much is still unknown. Limited information pertaining to mammals and birds exist for the study area. Similarly, information on herpetofauna and invertebrates of the region and farms is lacking in detail and significant information gaps exist in this regard.

For these reasons, the following EIA study methods were implemented to gain an understanding of the ecology of the study area as well as the biodiversity contribution of the study area within a larger topographical context.

17.3.1 Invertebrates

Invertebrates are by far the most abundant animals present anywhere. They are extremely useful bio-indicators and include meaningful surrogates, flagships and diversity indicators. Invertebrate sampling was twofold, including:

- Firstly, sweepnet sampling bouts of invertebrates were used to compare sample plots in terms of species richness (number of species) and species diversity (relative abundances between species groups). Species found in these samples were also included in the species inventory; and
- Secondly, a species inventory of the study area was compiled using above-mentioned methods as well as active searches for scorpions (under rocks and using UV-lights), for butterflies (using a hand-held net) and beetles (under rocks, bark, hand-netting, etc.).

17.3.2 Herpetofauna

Frogs were recorded using species-specific calls of males as identification; also, active searches for active adults during early evenings. Snakes, lizards and other reptiles were sampled by active searches in likely habitats (under rocks, inactive termitaria, etc.)

17.3.3 Birds

Recording the avifaunal diversity of the study area included three components:

- Visual sightings;
- Audio observations; and
- Habitat assessments.

While most bird species of any given area is normally visible and readily distinguishable using visual observation methods, other bird species are cryptically coloured and can only be identified using sound. The calls of most cryptic bird species are species-specific and are useful in compiling a species inventory list. Binoculars were used to assist in identifying smaller and more cryptic species.

Ideally, seasonal collation of presence records are needed to create an “avifauna image” of the study area that supports bird communities in the area. Since this is rarely accomplished in reality, brief habitat assessments are employed to create a “model” of the bird communities likely to be found in the study area. Comprehensive data is fortunately available on the birds of Southern Africa, including distribution records, habitat requirements, etc. By assessing the available habitat within the study area (with focus on habitat characteristics available, diversity and quality of habitats), the potential presence (PoC) of bird species (with particular reference to Red Data birds) are

assessed. The final stage of the avifaunal study utilises the image that was created of the avifaunal communities of the study area in assessing the impacts of the proposed project on the avifaunal component of the study area.

17.3.4 Mammals

Visual sightings as well as ecological indicators such as tracks, dung, calls and diggings were used to compile a species inventory of the mammals of the study area.

17.3.5 Ecology

Species inventory lists and indications of species richness and -diversity recorded with the aid of above-mentioned methods are used to interpret the relative ecological status of the study area/s and to compare areas and variations in faunal habitats present. These comparisons are done in collaboration with vegetation characteristics in order to gain an ecological understanding of the study area and the potential impacts of the study area/s.

17.3.6 Faunal Sensitivity

Faunal habitat sensitivities are subjectively estimated based on the following criteria:

- Habitat status;
- Connectivity;
- Observed species richness & RD Probabilities; and
- Functionality.

17.3.7 Impact Evaluation

The Risk assessment needs to be determined for the following variables and ranking scales:

Occurrence:

- Probability of occurrence (likelihood of the impact occurring), and
- Duration of occurrence.

Severity:

- Magnitude (severity) of impact; and
- Scale/extent of impact.

In order to assess relevant impacts, the following ranking scales are implemented:

Table 22: EIA Ratings used in this assessment

Extent	Duration	Magnitude	Probability
5 - International	5 - Permanent	10 - Very high/ don't know	5 - Definite/ don't know
4 - National	4 - Long term (ceases with the operational life)	8 - High	4 - Highly probable
3 - Regional	3 - Medium term (5-15 years)	6 - Moderate	3 - Medium probability
2 - Local	2 - Short Term (0-5 years)	4 - Low	2 - Low Probability
1 - Site only	1 - Immediate	2 - Minor	1 - Improbable
		0 - None	

Once the above factors have been ranked for each impact, the environmental significance of each impact can be assessed using the following formula:

SP = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). Environmental effects were rated as either of high, moderate or low significance on the following basis:

- More than 60 SP indicate High (H) environmental significance.
- Between 30 and 60 SP indicate Moderate (M) environmental significance.
- Less than 30 SP indicate Low (L) environmental significance.

18 APPENDIX 5: LIMITATIONS OF THIS INVESTIGATION

- Findings, results, observations, conclusions and recommendations presented in this report are based on the authors' best scientific and professional knowledge as well as the interpretation of information available to them at the time of compiling this report.
- Due care and diligence is exercised by the authors, consultants and/or specialist investigators in rendering services and preparing this document. BEC, the consultants and/or specialist investigators accepts no liability for conclusions, suggestions, limitations and recommendations made in good faith, based on available information, or based on data that was obtained from surveys.
- The client, by accepting this document, indemnifies BEC, its members, consultants and/or specialist investigators against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by BEC and by the use of the information contained in this document.
- Results presented in this report are based on a snapshot investigation of the study area and not on detailed and long-term investigations of all environmental attributes and the varying degrees of biological diversity that may be present in the study area.
- This report is based on surveys that were conducted during a time that reflects an early summer period; although vegetation was found to be in a vegetative state, many plants could not be identified accurately due to the lack of reproductive material.
- Rare and endemic species normally do not occur in great densities and, because of customary limitations in the search and identification of Red Listed species, the detailed investigation of these species was not possible. Results are ultimately based on estimations and specialist interpretation of imperfect data.
- It is emphasised that information, as presented in this document, only have bearing on the site as indicated on accompanying maps. This information cannot be applied to any other area, however similar in appearance or any other aspect, without proper investigation.
- Furthermore, additional information may become known during a later stage of the process or development. The authors therefore reserve the right to modify aspects of the report including the recommendations should new information may become available from ongoing research or additional work in this particular area, or pertaining to this investigation.
- This report should always be considered as a whole. Reading and representing portions of the report in isolation could lead to incorrect conclusions and assumptions. In case of any uncertainty, the authors should be contacted to clarify any viewpoints, recommendations and/ or results.

19 REFERENCES

AGIS, 2007. Agricultural Geo-Referenced Information System, accessed from www.agis.agric.za on 2010.
ALEXANDER, G. & MARAIS, J. 2007. A Guide to the Reptiles of Southern Africa. Struik Publishers, Cape Town.
BARNES, K.N. 1998. *The Important Bird Areas of southern Africa*. BirdLife South Africa, Johannesburg.
BARNES, K.N. 2000. *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.
BEGON, M., HARPER, J.L. & TOWNSEND, C.R. 1990. Ecology. Individuals, Populations and Communities. Blackwell Scientific Publications, USA.
BirdLife International 2008. *Eupodotis caerulescens*. In: IUCN 2011. IUCN Red List of Threatened
BOTHMA, J. (ed.). 2002. Game Ranch Management, 4th ed. Van Schaik Publishers, Pretoria.
BRACKENBURY, J. 1995. Insects and Flowers. A Biological Partnership. Wellington House, London, UK.
BRANCH, B. 1998. Field Guide to Snakes and Other Reptiles of Southern Africa. Struik Publishers, Cape Town.
BRANCH, W.R. 1998. South African Red Listed Book – Reptiles and Amphibians. National Scientific Programmes Report No 151.
CARRUTHERS, V. (ed.). 2000. The Wildlife of Southern Africa. A Field Guide to the Animals and Plants of the Region. Struik Publishers, Cape Town.
CARRUTHERS, V. 2001. Frogs & Frogging in Southern Africa. Struik Publishers, Cape Town.
CHANNING, A. 2001. Amphibians of Central and Southern Africa. Protea Book House, Pretoria.
COLWELL, R. K. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8. Persistent URL <purl.oclc.org/ estimates>.
COWLING, R. Foresight biodiversity report. Department of Science and Technology. South Africa. 2000.
CONVENTION ON BIOLOGICAL DIVERSITY. Signed 1993 and ratified 2 November 1995.
DEL HOYO, J. ELLIOTT, A. & SARGATAL, J. (eds). 1992. *Handbook of the birds of the World*. Vol. 1. Lynx Editions, Barcelona.
DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM. 2001. Environmental Potential Atlas. DEAT, Pretoria.
DIPPENAAR-SCHOEMAN, A.S. 2002. Baboon and Trapdoor Spiders of Southern Africa: An Identification Manual. ARC – Plant Protection Research Institute, Pretoria.
DIPPENAAR-SCHOEMAN, A.S. & JOCQUE, R. 1997. African Spiders, an Identification Manual. ARC – Plant Protection Institute, Pretoria.
DIPPENAAR-SCHOEMAN, A.S. & JOCQUĖ, R. 1997. African Spiders: An Identification Manual.
DU PREEZ, L. & CARRUTHERS, V. 2009. A Complete Guide to the Frogs of Southern Africa. Struik Nature, Cape Town.
DWAF. 2002. The Working for Water Programme. Department of Water Affairs and Forestry. [Online Available: http://www.dwaf.gov.za/wfw/]. 15 January 2004.
ELDRIDGE D. & FREUDENBERGER D. (eds). Proceedings of the VI International Rangeland Congress, Townsville, Queensland, Australia. July 19-23 1999. 566-571.
ENDANGERED WILDLIFE TRUST. 2002. The Biodiversity of South Africa 2002. Indicators, Trends and Human Impacts. Struik Publishers, Cape Town.
ENDANGERED WILDLIFE TRUST. 2004. Red Listed 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.
FILMER, M.R. 1991. Southern African Spiders. An identification guide. Struik Publishers, Cape Town.
GIANT BULLFROG CONSERVATION GROUP. 2004. www.giantbullfrog.org.
GIBBON, G. 2003. Roberts' Multimedia Birds of Southern Africa. Version 3. Southern African Birding cc, Westville.
GOVERNMENT GAZETTE [of the Republic of South Africa]. 2001. Amendments to the Conservation of Agricultural Resources Act, 1983 (Act No.43 of 1983). Government Gazette, 429 (22166) of 30 March 2001. Department of Agriculture, Republic of South Africa.
GROVE, A.J. & NEWELL, G.E. 1962. Animal Biology, 6th ed. revised. University Tutorial Press, London.
HENNING, S.F. & HENNING, G.A. 1989. South African Red Listed Book – Butterflies. South African National Scientific Programmes Report No 158.
HILDEBRAND, M. 1988. Analysis of Vertebrate Structure, 3rd ed. John Wiley & Sons, Inc., New York.
HOCKEY, P.A.R., DEAN, W.R.J. & RYAN, P.G. (eds.) 2005. *Roberts – Birds of Southern Africa*, VIIth ed. The Trustees of the John Voelker Bird Book Fund, Cape Town.
HOCKEY, P.A.R.; DEAN, W.R.J. & RYAN, P.G. (eds.). 2005. Roberts - Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.
HOFFMAN T. & ASHWELL A. 2001. Nature Divided: Land degradation in South Africa. University of Cape Town Press, Cape Town
HOLM, E. 1986. Insekgedrag Menslik Betrag. Ekogilde cc, Pretoria.
HOLM, E. & MARAIS, E. 1992. Fruit Chafers of southern Africa. Ekogilde, Hartebeespoort.
HOLM, E. 2008. Inseklopedie van Suider-Afrika. Lapa Uitgewers, Pretoria.
http://sabap2.adu.org.za. South African Bird Atlas Project 2.
http://sabca.adu.org.za. South African Butterfly Conservation Assessment.
http://sarca.adu.org.za. South African Reptile Conservation Assessment.
INTERIM RED LISTED LIST OF SOUTH AFRICAN PLANT SPEICIES. (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 Red List of Threatened Species. Version 2011.1. http://www.iucnredlist.org/.
IUCN. 2001. IUCN Red List Categories & Criteria. In: Red Listed Book of the Mammals of South Africa: A Conservation Assessment. CBSG Southern Africa, Parkview, South Africa.

KAMFFER, D. 2004. Community-level effects of fragmentation of the afromontane grassland in the escarpment region of Mpumalanga, South Africa. M.Sc. Theses, University of Pretoria, Pretoria.
KERLEY, G.I.H. & ERASMUS, T. 1987. Cleaning and rehabilitation of oiled Jackass Penguins. *South African Journal of Wildlife Research* 17: 64-69.
KNOBEL, J. 1999. The magnificent natural heritage of South Africa. Sunbird Publishing, South Africa.
KURE, N. 2003. Living with Leopards. Sunbird Publishing, Cape Town.
LEEMING, J. 2003. Scorpions of Southern Africa. Struik Publishers, Cape Town.
LEROY, A. & LEROY, J. 2003. Spiders of Southern Africa. Struik Publishers, Cape Town.
LIEBENBERG, L. 2000. Tracks & Tracking in 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 Listed Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington DC.
MUCINA, L. & RUTHERFORD, M.C. (eds.). 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia 19*. South African National Biodiversity Institute, Pretoria.
National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004).
PEACOCK, F. 2006. Pipits of Southern Africa. Published by the author, Pretoria; www.pipits.co.za
PERRINS, C. & HARRISON, C.J.O. 1979. Birds: Their Life, Their Ways, Their World, Reader's Digest Ed. Elsevier Publishing Projects, New York.
PICKER, M., GRIFFITHS, C. & WEAVING, A. 2002. Field Guide to Insects of Southern Africa. Struik Publishers, Cape Town.
PRINGLE, E.L.L., HENNING, G.A. & BALL, J.B. 1994. Pennington's Butterflies of Southern Africa. Struik Publishers, Cape Town.
RETIEF, E & HERMAN, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characters. National Botanical Institute, Pretoria.
SCHOLTZ, C.H. & HOLM, E. 1989. Insects of Southern Africa. Butterworths, Durban.
SINCLAIR, I. & DAVIDSON, I. 1995. Suider-Afrikaanse Voëls, 'n Fotografiese Gids. Struik Publishers, Cape Town.
SINCLAIR, I., HOCKEY, P. & TARBOTON, W. 2002. SASOL: Birds of Southern Africa. Struik Publishers, Cape Town.
SKINNER, J.D. & SMITHERS, R.H.N. 1990. The Mammals of the Southern African Subregion. University of Pretoria, Pretoria.
SMITH, M.M. & HEEMSTRA, P.C. (eds.). 2003. Smiths' Sea Fishes. Struik Publishers, Cape Town.
SMITHERS, R.H.N. 1986. South African Red Listed 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 Mammals of Southern Africa. Struik Publishers, Cape Town.
STUART, C. & STUART, T. 2000. A field Guide to the Tracks and Signs of Southern and East African Wildlife. Struik Publishers, Cape Town.
SUTHERLAND, W.J. (ed.). 2006. Ecological Census Techniques, 2nd ed. Cambridge University Press, UK.
SWANEPOEL, D.A. 1953. Butterflies of South Africa. Where, When and How they fly. Maskew Miller Limited, Cape Town.
TAYLOR, P.J. 2000. Bats of Southern Africa. University of Natal Press, South Africa.
THREATENED SPECIES PROGRAMME (TSP). 2007. *Interim Red Data List of South African Plant Species*. Produced in collaboration with the National Botanical Institute (NBI), NORAD and the Department of Environmental Affairs and Tourism (DEAT).
TOLLEY, K. & BURGER, M. 2007. Chameleons of Southern Africa. Struik Publishers, Cape Town.
UNEP. 2002. Global Environment Outlook –3: Past, present and future perspectives. United Nations Environment Programme, Earthscan Publications Ltd, London.
VAN OUDTSHOORN, F. 2002. Gids tot die Grasse van Suider-Afrika. Briza Publikasies, Pretoria.
VAN RIET, W., P. CLAASSEN, J. VAN RENSBURG, T. VILJOEN & L. DU PLESSIS. 1997. *Environmental Potential Atlas for South Africa*. J.L. van Schaik, Pretoria.
VAN WILGEN B.W. & VAN WYK E. 1999. Invading alien plants in South Africa: impacts and solutions. In: People and rangelands building the future.
VAN WYK B. & GERICKE N. (2000). People's Plants. Briza Publications, Pretoria.
VELDSMAN, S.,G. 2008, *Vegetation degradation gradients and ecological index of key grass species in the south-eastern Kalahari South Africa*, MSc dissertation, University of Pretoria, Pretoria, viewed 2010/07/28. http://upetd.up.ac.za/thesis/available/etd-08112009-165447/ >.
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.
WIEDER, R.K. 1989. A survey of constructed wetlands for acid coal mine drainage treatment in the eastern United States. *Wetlands*. 9(2): p. 299-315.
WILSON, D.E. & MITTERMEIER, R.A. (eds.). 2009. Handbook of the Mammals of the World – Volume 1: Carnivores. Lynx Editions, Barcelona.
WINDINGSTAD, R.M., F. X. KARTCH, R.K. STROUD, and M. R. SMITH. 1987. Salt toxicosis in waterfowl in North Dakota. *Journal of Wildlife Diseases* 23:443-446.
WOOD, J., Low, A.B., Donaldson, J.S., & Rebelo, A.G. 1994. *Threats to plant species through urbanisation and habitat fragmentation in the Cape Metropolitan Area, South Africa*. In: Huntley, B.J. (Ed.) Botanical Diversity in Southern Africa. National Botanical Institute, Pretoria.
WOODHALL, S. 2005. Field Guide to the Butterflies of South Africa. Struik Publishers, Cape Town.
www.nwgp.gov.za/Agriculture/NW_ENVIRONMENTAL_OUTLOOK

www.southafricanbiodiversity.co.za/endangered
WYNBERG R. 2002. A decade of biodiversity conservation and use in South Africa: tracking progress from the Rio Earth Summit to the Johannesburg World Summit on Sustainable Development. South African Journal of Science 98: 233-243.