9 BOTANICAL ASSESSMENT

9.1 Regional Floristic Traits

The study site corresponds to the Grassland Biome as defined by Mucina & Rutherford (VegMap, 2006). This unit is found in the eastern, precipitation-rich regions of the Highveld. Grasslands of these parts are regarded 'sour grasslands'. The vegetation of the study area corresponds to an ecological type known as Soweto Highveld Grassland.

The vegetation is situated on 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*. Only scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover in undisturbed areas. 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 Reserves. Almost half of the area is 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). Erosion is generally very low.

9.2 Regional Diversity

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)[1]. 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 (Table 3) 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

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%

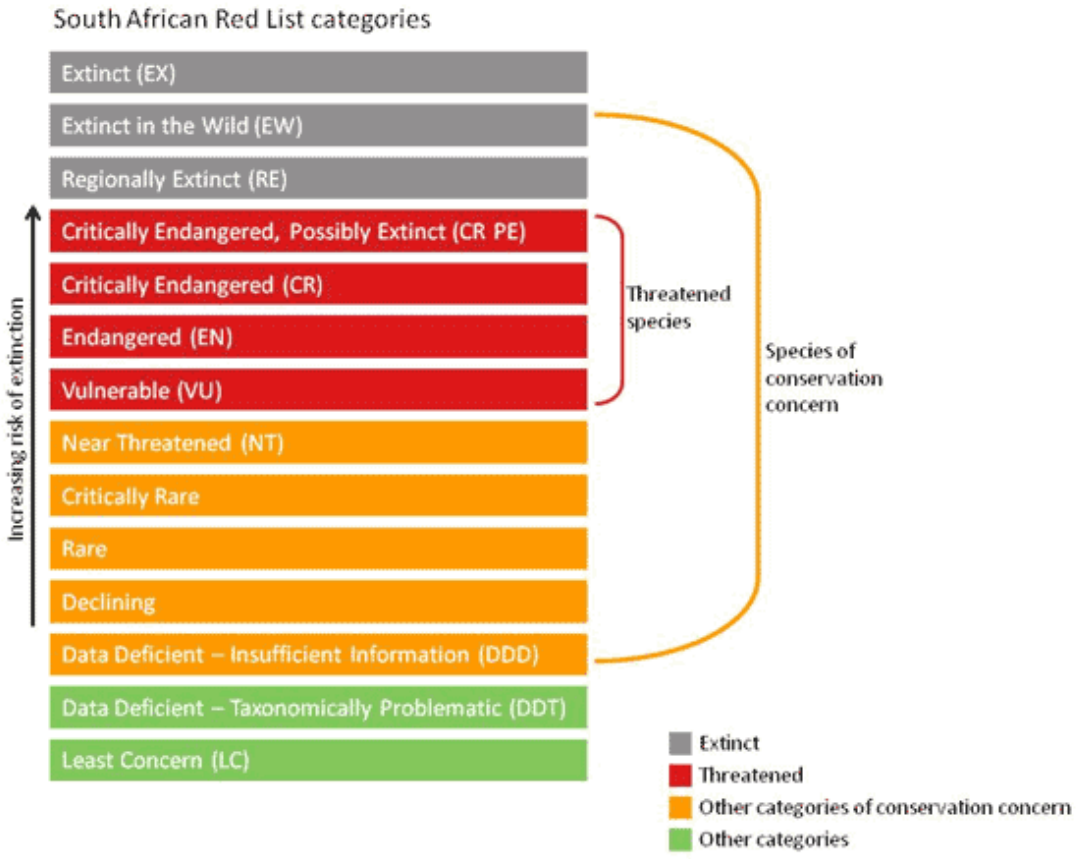
[1] This list is not included in the report due to the size, but can be presented separately on request.

Table 1: Growth forms of the region		
Growth Form	***Number***	***Percentage***
Parasite	3	1.1%
Shrub	10	3.7%
Succulent	11	4.1%
Tree	1	0.4%
Total	**269**	

9.2.2 Flora species of Conservation Importance of the Region

South Africa's Red List system is based on the IUCN Red List Categories and Criteria Version 3.1 (finalized in 2001), amended to include additional categories to indicate species that are of local conservation concern. The IUCN Red List system is designed to detect risk of extinction. Species that are at risk of extinction, also known as threatened or endangered species are those that are classified in the categories Critically Endangered (CR), Endangered (EN) and Vulnerable (VU). Species included in these categories are presented in Table 4. Taking the habitat that is available as well as the status thereof into consideration, it is regarded moderately likely that plant species included in the Threatened category might be present within the study areas, notwithstanding the lack of confirmed sampling records in the region..

Figure 1: South African Red List Categories (courtesy of SANBI)



- A species is Data Deficient when taxonomic problems hinder the distribution range and habitat from being well defined, so that an assessment of risk of extinction is not possible.

- A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

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

1 Extinct;
2 Critically Rare;
30 Endangered;
80 Vulnerable;
36 Near Threatened;
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) (Table 5).

Table 2: 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
Gladiolus elliotii	Iridaceae	Provincially protected
Gladiolus longicollis subsp. platypetalus	Iridaceae	Provincially protected
Haemanthus humilis subsp. *hirsutus*	Amaryllidaceae	Provincially protected
Haemanthus montanus	Amaryllidaceae	Provincially protected

9.3 Macro Habitat Types

For the purpose of the sensitivity assessment, no distinction was made between various types of natural terrestrial grassland habitats. The visual appearance of habitat units on aerial imagery was used as an indication of transformation; however, this could be deceiving in some instances, as cultivated pastures do resemble natural grassland in some cases. It should however be noted that numerous variations exist that are not addressed in this particular report. The designation of habitat types within the study area is illustrated in Figure 10.

9.3.1 *Natural Terrestrial Grassland Habitat*

Remaining natural terrestrial grassland are characterised 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 grazing by livestock and the altered species composition that accompanies insowing in some parts. The phytosociological characteristics are determined by the interplay between moisture levels, topographical placement and status.

The conservation status of these grasslands, on a regional scale, is Endangered. All 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. The likelihood of encountering Red Data plant species within these areas is high because of high habitat suitability for Red Data plant species that are known to occur in the region.

9.3.2 *Linear infrastructure*

Linear infrastructure within the 8km buffer zone, generally, limits the placement of the proposed ashing facility as a number of roads, power line servitudes, railways and conveyor facilities are present. While realignment of the major roads and power lines may be costly, it should remain an option in the event that only such a feature potentially prevents the selection of an otherwise suitable site. The presence of linear infrastructure should therefore not be considered a restriction to the proposed activity.

9.3.3 *Transformed & Degraded Grassland Habitat*

Commercial cultivation 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 most of the remaining grassland types. Vegetation altered for agricultural practices is unlikely to recover to a state that approximates the natural regional vegetation, even with the application of rehabilitation and management programmes. The likelihood of encountering Red Data plant species within these areas is regarded low because of habitat transformation and degradation. A low floristic status is frequently ascribed to these parts.

The use of these parts of the study area for the proposed activity is strongly recommended as it unlikely that floristic attributes of conservation importance will be affected within these parts. The challenge is to identify areas of suitable size that will suffice in the requirements for the project, or select portions that are located in close proximity to other habitat types of lower sensitivity in order to curb potential and likely impacts in the natural environment largely. It is important to note that, similar to remaining portions of natural grassland habitat, wetland related habitat types (streams, ephemeral grasslands, etc.) are generally situated in close proximity to these areas. Therefore, while the sensitivity of these parts is indicated to be low, their importance in terms of the contribution to nearby sensitive areas should not be underestimated.

9.3.4 Wetland Vegetation

Vegetation associated with aquatic habitat types are regarded highly sensitive and all impacts should ideally be avoided within, and near to, these features.

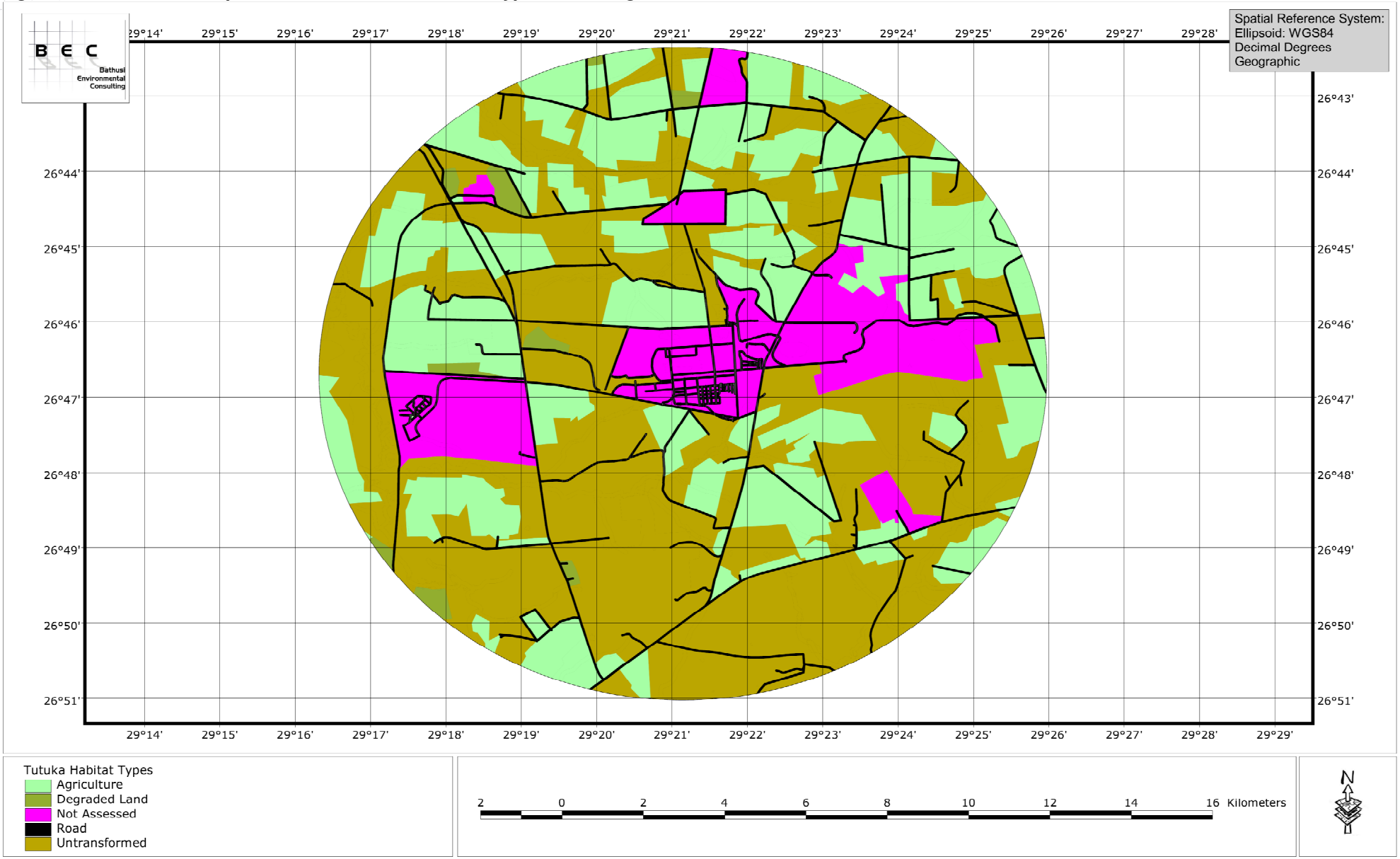
A wide variety of these habitat types feature in the study area, including perennial and non-perennial streams, rivers, small drainage lines, wetland marshes, hillslope seepages, artificial impoundments and unchannelled valley bottoms[2]. It is also important to note that these habitat types are frequently encountered in close proximity to existing land transformation activities, agricultural areas in particular. The high sensitivity ascribed to these habitat types is mainly a result of high biodiversity is associated with them, not only during periods when water is present within the system, but also during the austral winter period.

These areas are furthermore frequently colonised by plant taxa of conservation importance. Considering the significant increase in recent impacts in the grassland biome (past 20 years), their persistence in a natural environment is strongly dependent on the effective ecological functioning, with emphasis on an uninterrupted status of the linear nature. Also of particular importance is the ecological dependency that wetland features have with surrounding grassland catchments.

Inherent and constant interaction with nearby and downstream areas is characteristic of riparian wetland systems. Impacts therefore are not only reflected on the actual site, but are also 'exported' downstream, resulting in cumulative impacts with large footprints. These types of cumulative impacts are evident in most of South Africa's larger rivers.

[2] Please note that hillslope seepage were not included in the mapping exercise, for an illustration thereof, the reader is referred to the wetland report. The true of wetlands within the study area is therefore likely to higher than indicated on the accompanying map

Figure 2: Probabilistic representation of macro habitat types of the region



10 FAUNAL ASSESSMENT

10.1 Regional Faunal Diversity

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 (except for the avifauna which focuses on the Q-grids of the study area). Data on all faunal groups are lacking (notably for most of the invertebrate groups), 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. At present, the following faunal groups are 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.organd 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); and
- 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.

10.2 Red Data Fauna Assessment

In order to assess the probability of occurrence (PoC) of Red Data species not recorded in the study area during the field assessment, the following criteria were employed:

- the size of the study area;
- the location and connectivity of the study area with regards to other natural faunal habitats; and,
- the presence/absence, status and diversity of natural faunal habitats within the study area.

These criteria were used in conjunction with the known distribution of Red Data species as well as their known habitat requirements to estimate their likelihood of occurring in the study area.

A total of 109 Red Data species from five categories (IUCN) are known to occur in Mpumalanga (Invertebrates, Reptiles, Frogs and Mammals) and the Q-grids 2629CB and 2629CD (birds), included in the following conservation categories:

- 22 species are listed as Data Deficient (DD);
- 41 species are listed as Near Threatened (NT);
- 30 species are listed as Vulnerable (VU);

- 11 species are listed as Endangered (EN); and
- 4 species are listed as Critically Endangered (CR)

Estimations for the PoC for Red Data fauna taxa for the study area yielded the following results (Table 5):

- 40 species have a low PoC;
- 21 species have a moderate-low PoC;
- 25 species have a moderate PoC;
- 8 species have a moderate-high PoC; and
- 15 species have a high PoC.

Table 3: Red Data assessment for the study area (PoC)

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
Butterflies			
Aloeides barbarae	Barbara's Copper	Endangered	low
Aloeides merces	Wakkerstroom Copper	Vulnerable	moderate-low
Aloeides nubilus	Cloud Copper	Endangered	low
Aloeides rossouwi	Rossouw's Copper	Endangered	low
Chrysoritis aureus	Heidelberg Opal	Vulnerable	low
Chrysoritis phosphor borealis	Scarce Scarlet	Data Deficient	moderate-low
Lepidochrysops irvingi	Irving's Blue	Vulnerable	low
Lepidochrysops jefferyi	Jeffrey's Blue	Endangered	low
Lepidochrysops swanepoeli	Swanepoel's Blue	Vulnerable	low
Metisella meninx	Marsh Sylph	Vulnerable	moderate
Frogs			
Breviceps sopranus	Whistling Rain Frog	Data Deficient	low
Hemisus guttatus	Spotted Shovel-nosed Frog	Vulnerable	moderate-low
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	moderate
Strongylopus wageri	Plain Stream Frog	Near Threatened	low
Reptiles			
Acontias breviceps	Short-headed Legless Skink	Near Threatened	moderate-low
Afroedura major	Swazi Flat Gecko	Near Threatened	low
Chamaesaura aenea	Coppery Grass Lizard	Near Threatened	moderate
Chamaesaura macrolepis	Large-scaled Grass Lizard	Near Threatened	low
Homoroselaps dorsalis	Striped Harlequin Snake	Near Threatened	moderate-low
Kininyx natalensis	Natal Hinged Tortoise	Near Threatened	low
Lamprophis fuscus	Yellow-bellied House Snake	Near Threatened	moderate-low
Smaug giganteus	Giant Girdled Lizard	Vulnerable	moderate
Tetradactylus breyeri	Breyer's Long-tailed Seps	Vulnerable	moderate-low
Birds			
Phoenicopterus roseus	Greater Flamingo	Near Threatened	moderate-high
Phoenicopterus minor	Lesser Flamingo	Near Threatened	moderate-high
Mycteria ibis	Yellow-billed Stork	Near Threatened	moderate-low
Ciconia nigra	Black Stork	Near Threatened	moderate
Leptoptilos crumeniferus	Marabou Stork	Near Threatened	moderate-low
Geronticus calvus	Southern Bald Ibis	Vulnerable	moderate
Botaurus stellaris	Eurasian Bittern	Critically Rare	moderate
Sagittarius serpentarius	Secretarybird	Near Threatened	high
Gyps coprotheres	Cape Vulture	Vulnerable	moderate
Circus ranivorus	African Marsh Harrier	Vulnerable	high
Circus maurus	Black Harrier	Vulnerable	high
Circus macrourus	Pallid Harrier	Near Threatened	high

Table 3: Red Data assessment for the study area (PoC)			
Species Details			**Probability Assessment**
Biological Name	**English Name**	**RD**	
Hieraaetus ayresii	Ayres's Hawk-Eagle	Near Threatened	moderate-low
Polemaetus bellicosus	Martial Eagle	Vulnerable	moderate-high
Falco naumanni	Lesser Kestrel	Vulnerable	high
Falco biarmicus	Lanner Falcon	Near Threatened	high
Eupodotis caerulescens	Blue Korhaan	Near Threatened	high
Crex crex	Corn Crake	Vulnerable	moderate
Balearica regulorum	Grey Crowned Crane	Vulnerable	moderate-high
Anthropoides paradisea	Blue Crane	Vulnerable	high
Charadrius pallidus	Chestnut-banded Plover	Near Threatened	moderate-low
Rostratula benghalensis	Greater Painted-snipe	Near Threatened	moderate-low
Glareola nordmanni	Black-winged Pratincole	Near Threatened	moderate
Hydroprogne caspia	Caspian Tern	Near Threatened	moderate-low
Tyto capensis	African Grass-owl	Vulnerable	high
Alcedo semitorquata	Half-collared Kingfisher	Near Threatened	moderate
Mirafra cheniana	Melodious Lark	Near Threatened	moderate
Heteromirafra ruddi	Rudd's Lark	CR Critically	moderate-low
Spizocorys fringillaris	Botha's Lark	Endangered	moderate-low
Mammals			
Chrysospalax villosus	Rough-haired Golden Mole	Critically Rare	moderate-low
Amblysomus hottentotus	Hottentot's Golden Mole	Data Deficient	moderate-low
Amblysomus robustus	Robust Golden Mole	Endangered	low
Amblysomus septentrionalis	Highveld Golden Mole	Near Threatened	high
Neamblysomus julianae	Juliana's Golden Mole	Vulnerable	low
Atelerix frontalis	South African Hedgehog	Near Threatened	moderate
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	Data Deficient	low
Myosorex cafer	Dark-footed Forest Shrew	Data Deficient	moderate-low
Myosorex varius	Forest Shrew	Data Deficient	high
Crocidura cyanea	Reddish-grey Musk Shrew	Data Deficient	high
Crocidura flavescens	Greater Musk Shrew	Data Deficient	moderate-high
Crocidura fuscomurina	Tiny Musk Shrew	Data Deficient	moderate
Crocidura hirta	Lesser Red Musk Shrew	Data Deficient	moderate
Crocidura maquassiensis	Maquassie Musk Shrew	Vulnerable	low
Crocidura mariquensis	Swamp Musk Shrew	Data Deficient	high
Crocidura silacea	Lesser Grey-brown Musk Shrew	Data Deficient	moderate-high
Suncus infinitesimus	Least Dwarf Shrew	Data Deficient	moderate
Suncus lixus	Greater Dwarf Shrew	Data Deficient	low
Suncus varilla	Lesser Dwarf Shrew	Data Deficient	moderate
Cloeotis percivali	Percival's Short-eared Trident Bat	Vulnerable	moderate-low
Rhinolophus blasii	Blasius's Horseshoe Bat	Near Threatened	moderate
Rhinolophus swinnyi	Swinny's Horseshoe Bat	Near Threatened	moderate-low
Miniopterus natalensis	Natal Long-fingered Bat	Near Threatened	moderate-high
Scotophilus nigrita	Giant Yellow House Bat	Near Threatened	low
Cercopithecus mitis	Samango Monkey	Vulnerable	low
Cercopithecus mitis labiatus	Samango Monkey	Endangered	low
Manis temminckii	Ground Pangolin	Vulnerable	low
Graphiurus platyops	Rock Dormouse	Data Deficient	low
Mystromys albicaudatus	White-tailed Rat	Endangered	moderate
Tatera leucogaster	Bushveld Gerbil	Data Deficient	low
Lemniscomys rosalia	Single-striped Mouse	Data Deficient	moderate
Dasymys incomtus	Water Rat	Near Threatened	moderate
Grammomys dolichurus	Woodland Mouse	Data Deficient	low

Table 3: Red Data assessment for the study area (PoC)			
Species Details			**Probability Assessment**
Biological Name	**English Name**	**RD**	
Otomys slogetti	Sloggett's Rat	Data Deficient	moderate
Panthera pardus	Leopard	Near Threatened	moderate
Panthera leo	Lion	Vulnerable	low
Leptailurus serval	Serval	Near Threatened	high
Acinonyx jubatus	Cheetah	Vulnerable	low
Felis nigripes	Black-footed Cat	Vulnerable	low
Crocuta crocuta	Spotted Hyaena	Near Threatened	low
Parahyaena brunnea	Brown Hyaena	Near Threatened	high
Paracynictis selousi	Selous's Mongoose	Data Deficient	low
Rhynchogale melleri	Meller's Mongoose	Data Deficient	low
Canis adustus	Side-striped Jackal	Near Threatened	low
Lycaon pictus	African Wild Dog	Endangered	low
Mellivora capensis	Honey Badger	Near Threatened	moderate-high
Poecilogale albinucha	African Striped Weasel	Data Deficient	moderate
Hydrictis maculicollis	Spotted-necked Otter	Near Threatened	moderate
Loxodonta africana	African Savanna Elephant	Vulnerable	low
Diceros bicornis	Black Rhinoceros	Critically Rare	low
Ceratotherium simum	White Rhinoceros	Near Threatened	low
Hippopotamus amphibius	Common Hippopotamus	Vulnerable	low
Raphicerus sharpei	Sharpe's Grysbok	Near Threatened	low
Ourebia ourebi	Southern Oribi	Vulnerable	moderate-low
Hippotragus equinus	Roan Antelope	Vulnerable	low
Hippotragus niger	Southern Sable Antelope	Vulnerable	low
Damaliscus lunatus	Western Tsessebe	Endangered	low

10.3 Protected Faunal Taxa

Mpumalanga Province includes 31 provincially listed protected species (www.speciesstatus.sanbi.org – NEMBA status, refer Table 6).

Table 4: Protected species of Mpumalanga			
Species Details			**Probability Assessment**
Biological Name	**English Name**	**NEMBA status**	
Aonyx capensis	African Clawless Otter	protected	high
Atelerix frontalis	South African Hedgehog	protected	moderate
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
Leptailurus serval	Serval	protected	high
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
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	high
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

It is estimated that three of the eight species listed in Table 6 are unlikely to occur in the study area (low) and 16 species moderately unlikely (moderate-low). Three species are considered at least moderately likely (moderate) and four species highly likely to occur in the study area (high).

11 ECOLOGICAL SENSITIVITY & PREFERENCE RANKING OF HABITAT FRAGMENTS

11.1 Sensitivity Criteria & Categorisation

The ecological importance ascribed to existing protected areas and species are simple and self-explanatory. Outside of protected areas but within areas that are clearly of value for biodiversity, the evaluation of importance or sensitivity is more complex and vague. The absence of protected status should therefore never be interpreted as low biodiversity importance; many areas of international biodiversity importance lie outside of protected areas.

For this particular screening assessment, the degree of transformation was used as a primary decision tool in determining the level of sensitivity of a particular site. A secondary decision was made based on the level of conservation importance ascribed to the regional vegetation type. Lastly, historic sampling records of conservation important flora and fauna taxa within the region were also implemented to ascribe a high level of importance/ sensitivity to a particular site. The ecological sensitivity of areas characterised by natural habitat was assessed using the application of the following criteria:

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

Estimated ecological sensitivity values are presented in Figure 14 and are categorised as follows:

Low (1) 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 (2) Indigenous natural habitat that comprehend habitat with a high diversity, but characterised by moderate to high levels of degradation, fragmentation and habitat isolation. This category also include areas where flora species of conservation importance could potentially occur, but habitat is regarded marginal;

High (3) 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 NEMBA, 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;

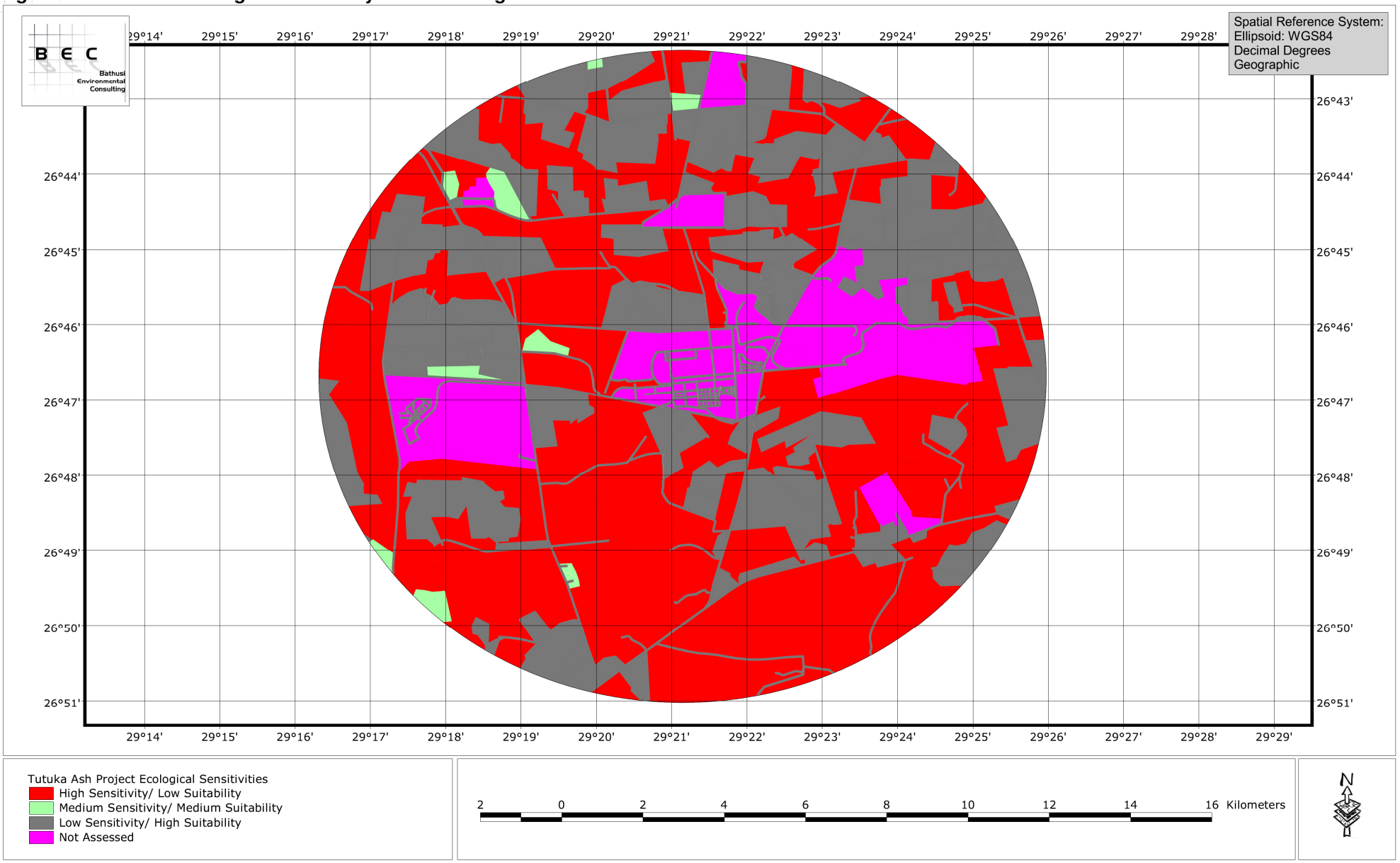
These areas are also characterised by low transformation and habitat isolation levels and contribute significantly on a local and regional scale in the ecological functionality of nearby and dependent ecosystems, with particular reference to catchment areas, pollination and migration corridors, genetic 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).

Not Assessed (6) Areas not included in the assessment due to unsuitability for the proposed project include Tutuka Power Station and associated infrastructure such as existing ashing facilities and areas of significant road and civil infrastructure.

11.2 Discussion & Recommendations

The sensitivity assessment indicates clearly the high sensitivity that is associated with remaining natural grassland within the region. This is mainly the result of high land transformation and habitat fragmentation rates. It should however be noted that the high sensitivity of natural grassland is ascribed without taking cognisance of the current status of remaining portions. Visual evidence suggests that the status might not be as pristine as initially anticipated and that the suitability of certain portions is therefore more acceptable. This is particularly the case in point of the preferred site as visual observations revealed a moderately disturbed status of the portion of land under consideration. A preliminary recommendation is therefore that this portion of land is likely to be acceptable for the use of the proposed project, but EIA investigations still need to confirm the absence of conservation important flora and fauna taxa.

Figure 3: Estimated ecological sensitivity of habitat fragments



12 IDENTIFICATION & DESCRIPTIONS OF POTENTIAL & LIKELY IMPACTS

12.1 Identification of Impacts

No impacts were identified that could lead to a beneficial impact on the biological environment since the proposed development is largely destructive, involving the alteration of natural habitat.

Impacts resulting from the proposed development on ecological attributes are largely restricted to the physical effects. 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 conservation consideration. 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 specific moment in time; the extent of the effect is frequently at a scale that is larger than the actual site of impact. A measure of estimation, or extrapolation, 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.

A list of potential and likely impacts was compiled from a generic list of impacts derived from previous projects of this nature and from a literature review of the potential impacts of this type of development on the natural environment. The following impacts were identified:

- Direct impacts on threatened flora species;
- Direct impacts on protected flora species;
- Direct impacts on threatened faunal taxa;
- Direct impacts on common fauna species/ faunal assemblages (including migration patterns, corridors, etc);
- Human - Animal conflicts;
- Loss or degradation of natural vegetation/ pristine habitat (including ecosystem functioning);
- Loss/ degradation of surrounding habitat;
- Impacts on SA's conservation obligations & targets;
- Increase in local and regional fragmentation/ isolation of habitat; and
- Increase in environmental degradation, pollution (air, soils, surface water).

12.2 Nature of Impacts

12.2.1 Direct Impacts on Threatened Flora Species

This direct impact results in physical damage or destruction of Red Data species/ communities, areas where these species are known to occur or areas that are considered particularly suitable for these species. Threatened plant species, in most cases, do not contribute significantly to the species richness 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, having adapted to a narrow range of specific habitat requirements. Changes in habitat conditions resulting from human activities is one of the greatest reasons for these species having a threatened status. 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 largely be limited.

The likelihood of Red Data flora species occurring within the study area is relatively high and the conservation of these areas is likely to provide protection of plant species of conservation importance.

12.2.2 Direct Impacts on Protected Flora Species

Data records indicate the presence of some protected plant taxa within the general surrounds. It is therefore reasonable to assume that some of these species could be present within the preferred area. Similar to Red Data plants, these species do not contribute significantly towards the local and regional species richness, but their presence indicates a relatively pristine status of the habitat. Preservation of these species is a social obligation in light of increasing pressure on these species that causes a continuous decline and an eventual inclusion in conservation categories.

12.2.3 *Direct Impacts on Threatened Fauna Taxa*

The presence of Red Data fauna species cannot be discounted at this stage and any disturbance therefore represents a direct and significant impact on these species. While some species are highly mobile and will ultimately be able to avoid impacts that result from the proposed development, some will not be able to avoid effects of microhabitat destruction. A direct approach, which is likely to be hugely costly, can be implemented in order to capture and relocate some animals to adjacent suitable habitat. Similar to Red Data plants, the presence of Red Data animal species is seen as a significant attribute to the biodiversity of an area. Any impact is therefore viewed as significant. Additional aspects that will be affected include migration patterns and suitable habitat for breeding and foraging purposes.

12.2.4 *Direct impacts on Common Fauna Species/ Faunal Assemblages*

The presence of diverse faunal assemblages in most areas is accepted. Considering the low levels of habitat transformation and degradation on a local scale, animal species are likely to evacuate towards adjacent areas of natural habitat during periods of high impact. While the tolerance levels of most animal species is generally of such a nature that surrounding areas will suffice in their habitat requirements, some species are not able to relocate, such as ground living and small species. The proposed activity will therefore result in severe impacts on these species.

In light of the low fragmentation and habitat isolation levels of the region, it is reasonable to assume that the animals utilising habitat within the proposed areas will also 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.

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 or habitat. The loss of an area as large, as this property, will affect the migration and daily movement patterns of a number of species that are present in the immediate region.

12.2.5 *Human / Animal conflict*

While animals generally avoid contact with human structures, they do grow accustomed to structures after a period. While the structures are visible, injuries and death of animals could potentially occur because of accidental contact. An aspect that is of concern is the presence of vehicles on access and infrastructure roads, leading to road kills, particularly amongst nocturnal animals that abound in the study area.

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

Furthermore, the creation of artificial habitat and the abundance of litter and spoils that are associated with any construction and development site will attract prey species such as rodents, exotic birds and pets (feral

cats and dogs). Strongly associated with the presence of these animals are predators that include venomous snakes, larger raptors, wild cat species (Cerval, Leopard, Caracal, etc.), Jackal, Hyaena, Honey Badger, etc. These species are frequently regarded with false beliefs and killed for little reason.

While most of the significant impacts are associated with habitat clearance that precede the actual development and operational phases, this impact is also particularly relevant during the period when construction activity peaks and worker numbers are high.

12.2.6 Loss or Degradation of Natural Vegetation/ Sensitive Habitat

The loss or degradation of natural/ pristine vegetation 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 and faunal assemblages that occupy these areas as they contribute significantly to the biodiversity of a region.

The vegetation is indicated to be highly representative of the regional vegetation type and is, for most parts, in a pristine condition, implying that the species composition, structure and other floristic attributes does not indicate variance on a local or regional scale.

The larger region is furthermore characterised by relative low transformation and fragmentation factors. Therefore, the existing ecological connectivity is significant in the functioning of the regional and local ecological processes. Indirect effects resulting from construction and operational activities on 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 factors such as these may lead to a reduction in the resilience of ecological communities and ecosystems or loss or changes in ecosystem function.

12.2.7 *Impacts on Surrounding Habitat/ Species & Ecosystem Functioning*

Surrounding areas and species present in the direct vicinity of the study area could potentially be affected by indirect impacts resulting from construction and operational activities. This indirect 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 factors such as these may lead to a reduction in the resilience of 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 the drainage line, 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 status of numerous such small drainage lines will determine the quality of larger rivers further downstream.

12.2.8 *Impacts on SA's Conservation Obligations & Targets*

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

12.2.9 *Increase in Local & Regional Fragmentation/ Isolation of Habitat*

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

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

The general region is characterised by moderate levels of transformation and habitat fragmentation. However, a high degree of connectivity is still present outside development areas. This connectivity is critical

in the preservation of pollinator species that provide important ecological services. The isolation of parcels of natural habitat is likely to contribute to loss of genetic variability, decrease in diversity and accentuated impacts from surrounding land uses.

12.2.10 Cumulative Increase in Environmental Degradation, Pollution

Cumulative impacts associated with this type of development could 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. Similarly, developments in untransformed and pristine areas are usually not characterised by visibly significant environmental degradation and these impacts are usually most prevalent in areas where continuous and long-term impacts have been experienced.

The nature of the development is such that pollution and degradation of the immediate surrounds is reasonably expected, although mitigation efforts are expected to ameliorate the occurrence and effect ot this impact to a large extent

13 EIA RECOMMENDATIONS

In order to address existing information gaps and satisfy legal requirements of EIA investigations, it is suggested that an over-arching approach be followed to allow for the capture of maximum data and adequate subsequent analysis thereof. The approach suggested here is based on separate austral winter and summer surveys during which a scientific approach to data assimilation will be followed. Botanical and faunal data will ultimately be captured in point samples (releveès) placed in a stratified random mean across the entire study area. Acquired data will be holistically analysed to illustrate the ecological interaction of plants and animals. Data analysis will be performed by PC-ORD for Windows, Version 6.07 (2011), allowing for an analysis through TWINSPAN, DECORANA, etc.

13.1 Botanical Impact Assessment

13.1.1 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 will be based on visual observations made during the initial site investigation as well as aerial imagery. The Zurich-Montpellier approach of phytosociology (Braun-Blanquet 1964) will be followed, which is a standardised and widely used sampling technique for general vegetation surveying in South Africa. During the surveys, all plant species in the sample plots and the cover and/or abundance of each species will be estimated according to the following Braun-Blanquet cover abundance scale:

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

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

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

In addition to species captured within the sample plots, general observations will be made in order to compile a comprehensive species list that will include taxa that, because of low abundance levels, are unlikely to be

captured within the sample areas. Particular reference is made to Red Data plants, which normally do not occur at great densities.

13.1.2 Data Processing

The combined floristic and faunal data sets will be subjected to the Two- Way Indicator Species Analysis technique (TWINSPAN) (Hill 1979) and subsequently refined by Braun-Blanquet procedures. TWINSPAN will be applied to derive a first approximation of the vegetation units. These classifications will be further refined by the application of Braun-Blanquet procedures to determine the plant communities.

A phytosociological table showing the vegetation lines will be used to compile a synoptic table of the datasets. A synoptic table summarises and confirm the vegetation types/ habitat types and variations. Relevant descriptions will follow from the data analysis, based on the presence/ absence and abundance of taxa.

13.2 Faunal Impact Assessment

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 these limitations. Ecology and biodiversity are growing fields of science and much is still unknown. As always, information on the herpetofauna and invertebrates of the region and farms is lacking in detail and significant information gaps exist in this regard.

It is therefore strongly recommended that the following EIA study methods be implemented to gain an ecological understanding of the study area as well as the biodiversity contribution of the study area within a regional and provincial context.

13.2.1 Invertebrates

Invertebrates are by far the most important animals present anywhere. They are very useful bio-indicators and include meaningful surrogates, flagships and diversity indicators. The invertebrate studies will be twofold: Firstly, sweep samples and pitfall samples of invertebrates would be used to compare sample plots in terms of species richness (number of species) and species diversity (relative abundances between species groups). Species recorder in these sampling bouts will also be included in the species inventory. Secondly, a species inventory of the study area/s will be 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.)

13.2.2 Herpetofauna

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

13.2.3 Birds

It is important to note that a separate avifaunal study has been commissioned by Eskom. However, an avifaunal component is included in the faunal study as it forms an important aspect of biodiversity in general. The aims and objectives of the separate avifaunal investigation will therefore be entirely different to this particular assessment. Assessing avifaunal diversity of an area includes three components:

- Visual sightings
- Audio observations
- Habitat assessments

A large number of bird species are highly visible and easily identifiable using visual observations. Binoculars are used to assist the observer in identifying smaller and more cryptic species. Many bird species are cryptically coloured and can only be identified using sound; calls of many cryptic bird species are species-specific and very useful in compiling a species inventory list of the area under investigation.

Ideally, various field assessments during all seasons of the year are needed to start to create an “avifauna image” of the study area that supports the reality of bird communities in the area. Since this is never accomplished in reality, habitat assessments are used to create a “model” of the bird communities likely to be found in the area investigated. Fortunately, much data is available on the birds of Southern Africa; distribution records, habitat requirements etc. By assessing the available habitat within the study area (with focus on habitat characteristics available and diversity and quality of habitats present), all bird species (including Red Data birds) are assessed in terms of likelihood of occurring within the study area. The final stage of the avifaunal study is using the image created of the avifaunal communities of the study area in assessing the impacts of the proposed project on the avifauna of the study area. Impacts are weighed and mitigations measures proposed where possible.

13.2.4 Mammals

Visual sightings as well as ecological indicators such as tracks, dung, calls and diggings will be used to compile a species inventory of the mammals of the study area. Additionally, small mammal live traps will be used to sample for rodents and insectivores.

13.2.5 Ecology

Species inventory lists and indications of species richness and -diversity recorded with the aid of above-mentioned methods will be 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 the vegetation characteristic in order to gain an ecological understanding of the study area and the potential impacts of the study area/s.

14 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.

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.

BUCKLAND, S.T., ANDERSON, D.R., BURNHAM, K.P., LAAKE, J.L. 1993. *Distance Sampling: Estimating abundance of biological populations*. Chapman and Hall, London.

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.

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.

FEINSINGER, P. 2001. *Designing field studies for biodiversity conservation*. The Nature Conservancy. Island Press.

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.

HARRISON, J.A., ALLAN, D.G., UNDERHILL, L.G., HERREMANS, M., TREE, A.J., PARKER, V. & BROWN, C.J. (eds.). 1997. *The Atlas of Southern African Birds. Vol. 1 & 2*. BirdLife South Africa, Johannesburg.

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, VII[th] 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.
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.
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.
LOTTER, M.C. & FERRAR, A.A. 2006. *Mpumalanga Biodiversity Conservation Plan Map*. Mpumalanga Parks Board, Nelspruit.
McCUNE, B. and M. J. MEFFORD. 2011. PC-ORD. Multivariate Analysis of Ecological Data. Version 6.07. MjM Software, Gleneden Beach, Oregon, U.S.A.
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.
MORRISON, K.L. 1998. Habitat utilization and the population ecology of cranes in the Dullstroom area of the Mpumalanga Province. MSc Thesis, University of Pretoria.
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).
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.
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, 2[nd] 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.

WILSON, D.E. & MITTERMEIER, R.A. (eds.). 2009. Handbook of the Mammals of the World – Volume 1: Carnivores. Lynx Editions, Barcelona.

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.sabap2.adu.org.za

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.