Appendix D

Specialist Reports
(Including Terms of Reference)

GCS
Water & Environmental Consultants

BEC Report Reference:	GCS - BHU - 2013/26
Version:	2013.02.15.1
GCS Reference	12-429

Desk-top Biodiversity Basic Assessment for the Eskom Bighorn Substation Expansion Project, Marikana, North-West Province©

compiled by

February 2013

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I PROJECT DETAILS

Client:	GCS, on behalf of Eskom Limited SOC
Report name:	Strategic Biodiversity Basic Assessment for the Eskom Bighorn Substation Expansion Project, Marikana, North-West Province
Report type:	Biodiversity Basic Assessment Report
BEC Project number:	GCS – BHU – 2013/26
Report Version:	2013.02.15.1
GCS Reference:	12-429
Compiled by:	Riaan A. J. Robbeson (Pr.Sci.Nat.) - Bathusi Environmental Consulting
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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:

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Membership Number:	*667.08/08*
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1 EXECUTIVE SUMMARY

Due to load growth on the entire Eastern Limb of the Bushveld Igneous Complex (BIC), all of Rustenburg CLN's transmission stations are put at risk as the Customer Load Network (CLN) has come to a point where load shifting cannot provide a medium to longer-term solution. Eskom therefore needs to consider the expansion of transformation capacity. GCS was appointed as the independent Environmental Assessment Practitioner (EAP) for the project. Bathusi Environmental Consulting was appointed as specialist terrestrial ecologists to provide input into the biodiversity component of the project. A brief desktop assessment was conducted by Riaan Robbeson (botany) and Dewald Kamffer (fauna).

The existing Bighorn Substation is situated on the Farm Middelkraal 466, approximately 2km east of Marikana and 27km east of Rustenburg, in the Madibeng Municipality, North West Province. The N4 highway is situated approximately 7km to the south.

1.1 BIOPHYSICAL ASSESSMENT

The study area is situated within the Madibeng Local Municipality, which comprises 383,919ha, of which approximately 299,495ha (78%) are currently considered untransformed. These figures are however regarded an overestimation of the true extent of remaining natural (pristine) habitat in the region as extensive areas of degraded and poor quality woodland habitat area note accurately captured in the database. The surrounding region is characterised by high levels of habitat transformation, isolation and habitat fragmentation, resulting from persistent increases in mining, agricultural activities, urban developments, linear infrastructure and poor management practices.

The Magaliesberg Nature Area is situated approximately 8.5km to the south of the site. It is unlikely that this conservation area will be affected adversely by the proposed extension of the substation. The study area is situated within the Limpopo Primary Catchment. While no area of significant surface water is noted in the immediate vicinity of the site, various drainage lines and small impoundments are present, particularly the Middelkraal dam (1.5km to the southeast). Several drainage lines are present in the surrounds, including the Brakspruit, Hoedspruit and the Elandsdriftspruit.

The topography of the study site comprises 'Slightly Undulating Plains'. Altitude of the site is approximately 1,140m. Although the ENPAT (2003) database revealed no topographically heterogeneous areas (slopes exceeding 8%) present in the region, visual observations from Google Earth, indicates the presence of several isolated rocky outcrops in the immediate vicinity of the site.

The geological formations represented in the various study areas comprises of Pyramid Gabbro. The site is situated within the Ea3 land type unit, which is dominated by the Arcadia soil form, exhibiting extremely high clay content of the A-horizon (43 – 68%). Rocky outcrops comprise a small portion of the landscape, usually less than 2%, and these features are often dominated by open rock and the Mispah soil formation.

Part of the proposed site comprises a Critical Biodiversity Area (Cba_saveg 2) according to the North West Province Biodiversity Conservation Assessment Technical Report (Version 1.2, 2009). This category is defined as 'Remaining patches larger than 5ha of provincially endangered and vulnerable vegetation types (Marikana Thornveld).

1.2 BOTANICAL ASSESSMENT

The study site corresponds to the Savanna Biome as defined by Mucina & Rutherford (VegMap, 2006), more specifically, the Marikana Thornveld ecological type is spatially represented in the study site. This ecological type comprises 128,528ha in the North-West Province, of which 47.8% is already transformed (North West Province Biodiversity Conservation Assessment Technical Report, 2009) and a Vulnerable conservation status is ascribed.

Information obtained from the SANBI database (POSA, 2012) indicates the known presence of approximately 298 plant species within the ¼-degree grid that is spatially represented in the study area (2527DA). The high floristic diversity of the immediate region reflects the regional diversity context of the Savanna Biome. An appraisal of the growth forms reflects the diverse woodland physiognomy with 42 shrub species and 39 tree species. Grasses (35 species) and herbs (60 species), geophytes (28 species) comprise important aspects of the regional vegetation. This species richness also represents 95 plant families, typically dominated by Poaceae (35 species), Malvaceae (21 species), Fabaceae (17 species), Cyperaceae (21 species) and Asteraceae (18 species).

Data records indicate the presence of the following plant species of conservation importance within the ¼-degree grid that is sympatric to the study area:

Begonia cucullata	Conservation Act;
Brachystelma barberae	Conservation Act;
Gladiolus dalenii subsp. *dalenii*	Conservation Act;
Gladiolus sericeovillosus subsp. *calvatus*	Conservation Act;
Gladiolus vinosomaculatus	Conservation Act;
Haemanthus humilis subsp. *humilis*	Conservation Act;
Ilex mitis var. *mitis*	Declining;
Mimusops zeyheri	Protected Tree;
Pittosporum viridiflorum	Protected Tree;
Protea welwitschii	Conservation Act;
Prunus africana	Protected Tree;
Prunus africana	Vulnerable;
Sclerocarya birrea subsp. *caffra*	Protected Tree; and
Stenostelma umbelluliferum	Near Threatened.

The presence of these some of these species within the immediate surrounds of the proposed development area is regarded likely and it is therefore strongly recommended to conduct a survey to assess the presence of these species, guide permitting requirements applicable for the North-West Province and provide pertinent EMP recommendations.

The following habitat types were identified by means of aerial imagery:

- Degraded Woodland;
- Existing Substation;
- Road Infrastructure;
- Rocky Outcrop; and
- Transformed Woodland.

The floristic nature of the proposed site and the immediate surrounds bears significant evidence of the intensive nature of land use, of which agriculture is mostly responsible for habitat loss. Visual observations from Google Earth images indicate a moderately degraded status of much of the surrounding plains. Natural woodland has been degraded and the woody stratum, in particular, has been affected significantly. Agriculture, road infrastructure and urban development have resulted in large-scale decimation of the natural savanna on a regional level. Although these areas are regarded moderately/severely degraded, a number of conservation important plant taxa (specifically *Stenostelma umbelluliferum*) could potentially persist within these parts. A number of topographically important rocky outcrops are situated in close proximity to the existing substation and is likely to be affected by the planned development. These outcrops appear as embedded units within the larger regional ecological type (Marikana Thornveld) and is regarded outlying representations of neighbouring ecological types (Norite Koppies Bushveld), representing important and localised areas of high biodiversity. Floristic characteristics of these areas appear to be relatively intact, which is typical within transformed environments like these. The likelihood of plant species of conservation importance persisting within these areas is regarded high and it is therefore strongly recommended that a suitable survey be conducted in order to assess the presence/ absence of these species in this habitat type. A high ecological sensitivity is ascribed to these parts and impacts within these areas are regarded unacceptable. From the proposed development layout, it would appear as if the outcrops immediately to the east of the existing substation would be affected.

A relative high degree of uncertainty is indicate for this report as no site surveys were conducted; results are based on a desktop analysis of available imagery and regional floristic information. Considering the proposed layout, it is likely that the extension of the existing substation will adversely affect the nearby rocky outcrops. In addition, in view of the potential presence of conservation important plant taxa, it is strongly recommended that a suitable site investigation be conducted in order to verify the ecological status of the preliminary habitat types.

1.3 FAUNAL ASSESSMENT

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. Animals known to be present in the Q-grids of the study area were considered potential inhabitants of the study area (all species known from the North West Province were included to minimize the effect of sampling bias). The likelihood of each species' presence in the study areas was estimated based on known ecological requirements of species; these requirements were compared to the ecological conditions found in the study area and surrounding faunal habitat.

A total of 592 animal species (124 families, 33 orders and 5 classes - Insecta, Amphibia, Reptilia, Aves and Mammalia) are known from the region of the study area; this includes a total of 75 Red Data species.

The largest extent of the surrounds is regarded degraded, comprising of agricultural lands in various stages of succession. The existing vegetative layers appears not to be representative of the original Marikana Thornveld and it is reasonable to assume that the faunal assemblages that persist in these areas will not be representative of the original conditions. It is expected that the faunal assemblages will comprise mostly of

opportunistic species that typically persist in degraded and altered environments. The likelihood of conservation important fauna taxa persisting in these areas are regarded minimal.

Isolated rocky outcrops, although relative pristine, is regarded marginal habitat for common fauna or animal species of conservation importance. These areas are relative small and are unlikely to host significant numbers of either common or less abundant fauna species. However, their importance as ecological contributors cannot be over-emphasised. Within a larger environment where habitat transformation and degradation is rife, their role as 'stepping stones' between suitable areas of natural habitat is important, providing access between populations that might be located some distance apart. Therefore, their protection is strongly advised and a high ecological sensitivity is ascribed to these areas.

1.4 IMPACT EVALUATION

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 and surface mining. 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. The following impacts are relevant to this particular type of 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 habitat types (including loss and degradation);
- Loss of sensitive/ natural fauna habitat types;
- 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.

The planned development is unlikely affect the natural environment significantly. However, the presence of sensitive rocky outcrops in direct vicinity of the planned development is noted as the only aspect of concern. These areas should be excluded and a suitable buffer zone implemented in order to provide protection against adverse impacts resulting from the planned development.

2 TERMS OF REFERENCE

Objectives of this Biodiversity Basic Assessment Report are to establish the presence/absence of ecologically sensitive areas or species within the proposed project area. Secondly, in order to assist with, and guide, the planning of the proposed development it is necessary to identify and briefly 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 by means of a desk-top assessment;
- 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 Basic 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
- Assess the potential presence of Red Data fauna species by means of a desk-top assessment;
- 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 Basic 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 percent 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.

Mining is an extractive industry and is often viewed as more damaging to the environment than other developments. The mining and metals industry's biodiversity conservation performance is under increasing scrutiny from NGOs, commentators and financial analysts. In part, this is due to the legacy of industry environmental neglect, and in part, it is due to the very nature of mining. The activity of mining therefore requires vigilance to ensure that the heritage of future generations – the biological as well as cultural heritage – is not adversely affected by the activities of today. Achieving a balance while doing this requires better understanding and recognition of conservation and development imperatives by all stakeholders, including governments, business and conservation communities.

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

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

4 BRIEF PROJECT OVERVIEW

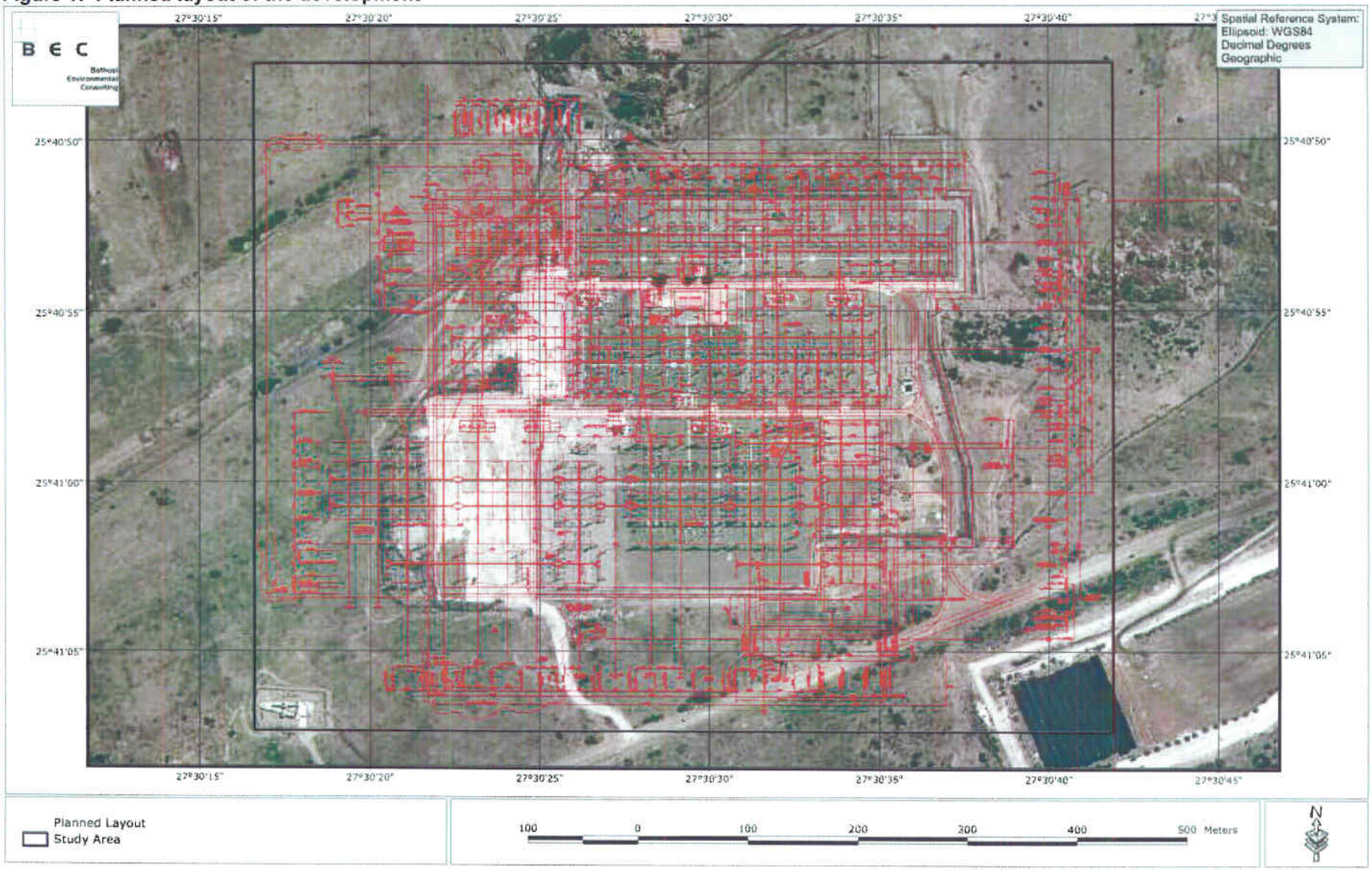
In the Rustenburg area, it is common practice to shift loads between substations when a capacity problem arises at any particular substation. However, due to load growth on the entire Eastern Limb of the Bushveld Igneous Complex (BIC), all of Rustenburg CLN's transmission stations are put at risk as the customer Load Network (CLN) has come to a point where load shifting cannot provide a medium to longer-term solution. Because substations to the west of Bighorn cannot be utilised to deload Bighorn and create capacity for the impending load growth, Eskom therefore needs to consider the expansion of transformation capacity. The proposed project will result in the following infrastructure upgrade:

- Relocate the 275kV Feeder-2 to the vacant 275kV Feeder-1;
- Reposition the exit direction of the 400kV Feeder-1;
- Establish 275kV and 400kV Transformer bays in the then vacant 275kV Feeder-2 position;
- Relocate the new 400/275 500MVA to former 275kV Feeder-2 overpass;
- Deviate the 88Kv Tailings lines within the proposed 132kV Yard;
- Terrance the remaining 275kV Yard and extend existing fence to the west;
- Establish a 132kV tubular busbar;
- Establish 3x132kV Feeder Bays (plus 1 future spare bay);
- Establish 132kV Bus Coupler;
- Establish 2x132kV Transformer Bays;
- Establish 1x400kV Transformer Bays;
- Install 2x400/132kV 500MVA Transformers;
- Establish 132kV overpass from the 500MVA transformers to 132kV Transformer Bay;
- Swing Makokokwe and Excarbo 1&2 88kV lines to new 132kV Bays; and
- Install all necessary Secondary Plant Equipment.

GCS was appointed as the independent Environmental Assessment Practitioner (EAP) for the project. Bathusi Environmental Consulting was appointed as specialist terrestrial ecologists to provide input into the biodiversity component of the project. A brief desktop assessment was conducted by Riaan Robbeson (botany) and Dewald Kamffer (fauna).

A basic illustration of the planned extensions is presented in Figure 1.

Figure 1: Planned layout of the development



5 THE BIOPHYSICAL ENVIRONMENT

5.1 LOCATION

The existing Bighorn Substation is situated on the Farm Middelkraal 466, approximately 2km east of Marikana and 27km east of Rustenburg, in the Madibeng Municipality, North West Province. The N4 highway is situated approximately 7km to the south. The regional location of the study area is illustrated in Figure 2. A Google Earth image is presented in Figure 3.

5.2 LAND COVER & LAND USE OF THE REGION

Land cover categories are presented in Figure 4. 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 do not necessarily 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. The transformation of natural habitat by land uses such as agriculture, mining and urbanisation results in the permanent decimation of available 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 exotic species that can effectively sterilise large tracts of remaining natural habitat.

The study area is situated within the Madibeng Local Municipality, which comprises 383,919ha, of which approximately 299,495ha (78%) are currently considered untransformed. These figures are however regarded an overestimation of the true extent of remaining natural (pristine) habitat in the region. This statement is based on the following:

- The current land cover, as presented in ENPAT (2006) does not accurately reflect the current land cover status in all instances; in particular, recent agricultural activities, mining activities and localised stands of exotics are not captured within the existing data (*pers. obs.*); and
- The status of much of the remaining portions of natural vegetation types is not accurately summarized in the assessment. These 'natural habitat types' frequently comprehend poor quality vegetation that exhibit severely altered species compositions and depleted diversity that does not reflect the natural vegetation of the region (*pers. obs.*).

By inclusion of portions of other land cover categories, sub-climax vegetation types in particular, within the category of 'Natural Woodland' a fallacious view is created of the extent of remaining natural habitat in the

region. It is therefore likely that remaining untransformed habitat within the municipality is lower than initially anticipated.

Ultimately, the surrounding areas are characterised by high levels of habitat transformation, isolation and habitat fragmentation, resulting from persistent increases in mining, agricultural activities, urban developments, linear infrastructure and poor management practices.

5.3 Declared Areas of Conservation

The Magaliesberg Nature Area is situated approximately 8.5km to the south of the site. It is unlikely that this conservation area will be affected adversely by the proposed extension of the substation.

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 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 study area is situated within the Limpopo Primary Catchment. While no area of significant surface water is noted in the immediate vicinity of the site, various drainage lines and small impoundments are present, particularly the Middelkraal dam (1.5km to the southeast). Several drainage lines are present in the surrounds, including the Brakspruit, Hoedspruit and the Elandsdriftspruit (refer Figure 5).

[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.

Figure 2: Regional setting of the study areas (courtesy of GCS)

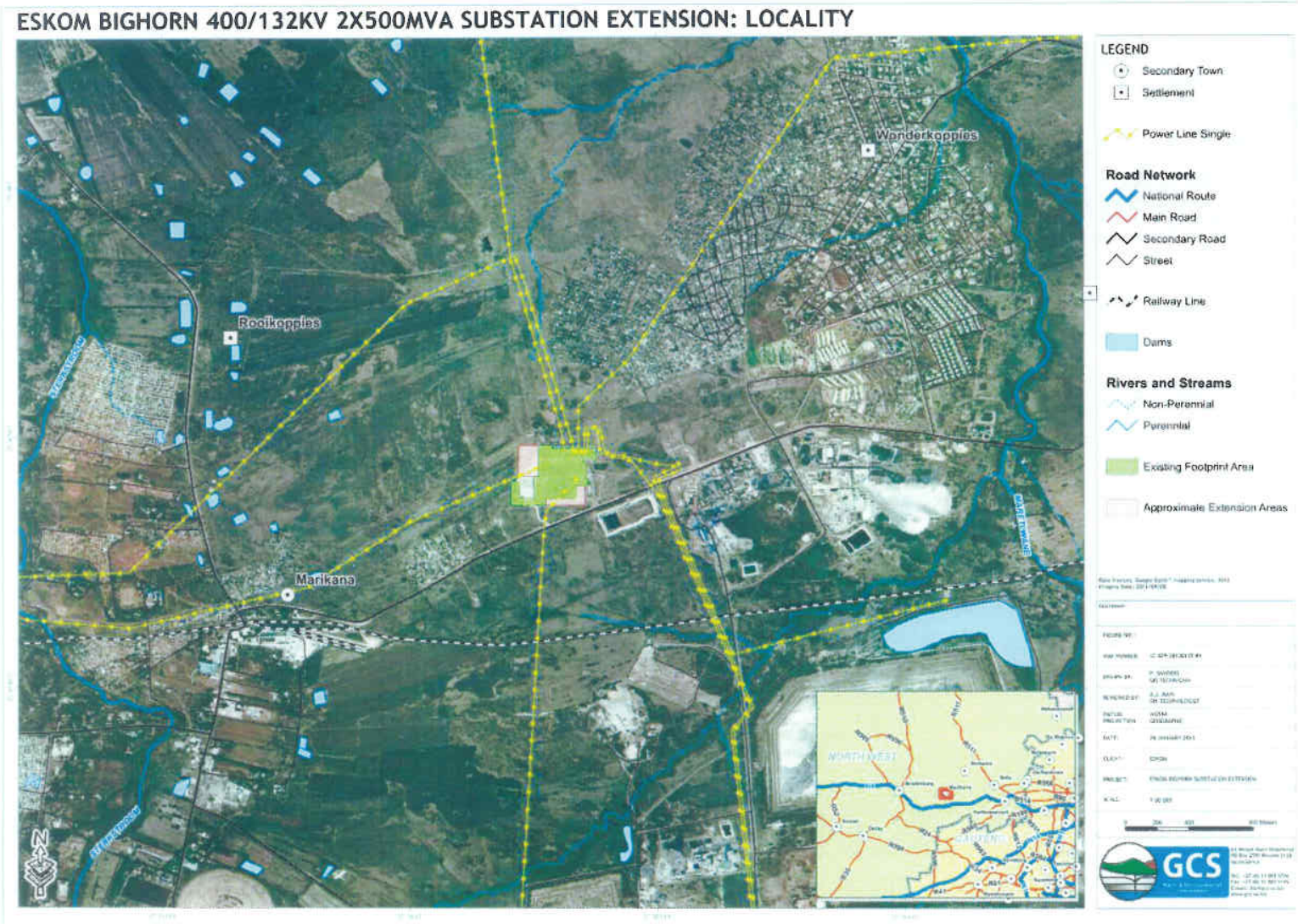


Figure 3: Composite aerial image of the study areas (courtesy of www.googleearth.com)

Figure 4: Land cover categories of the region

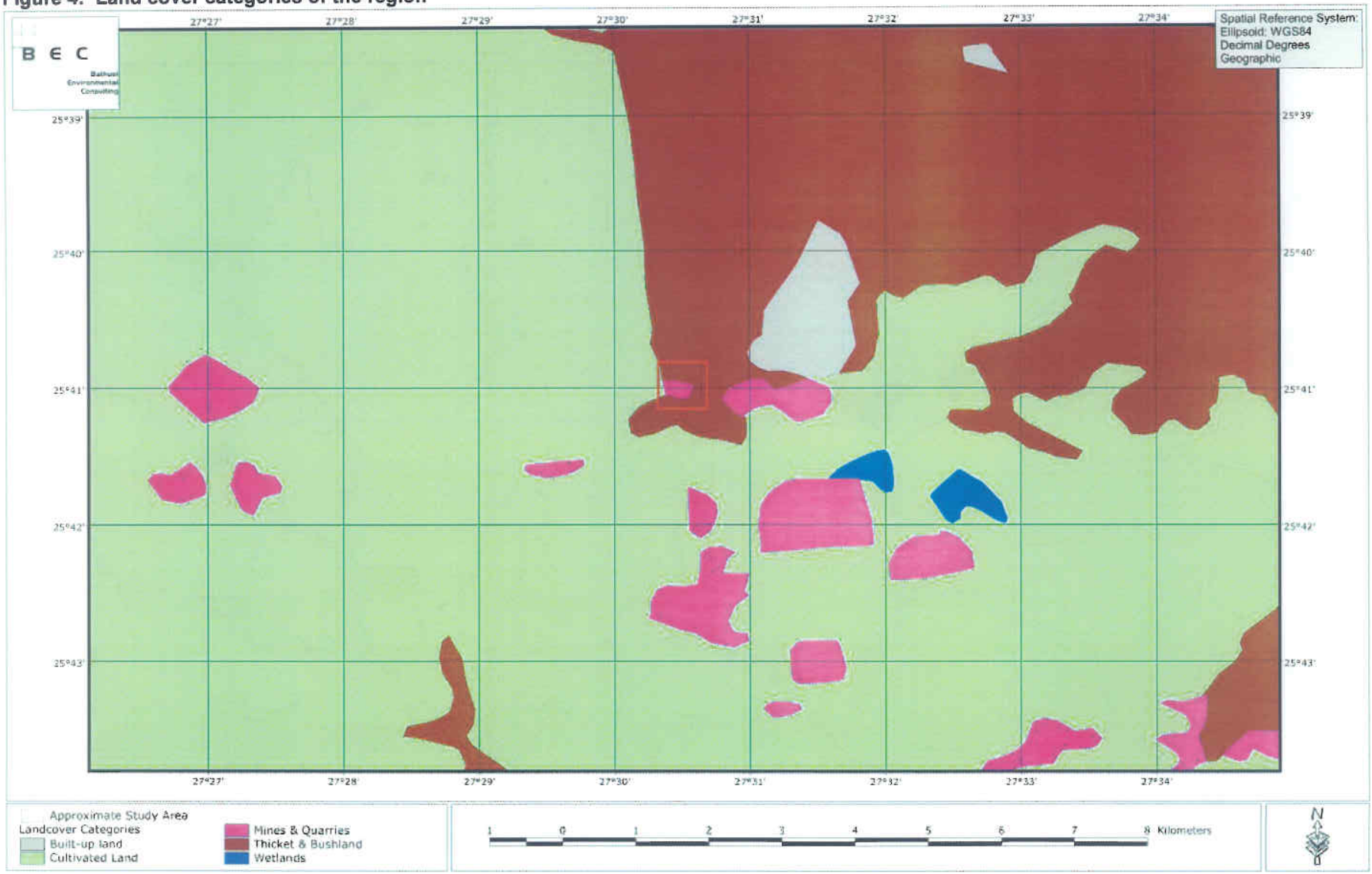
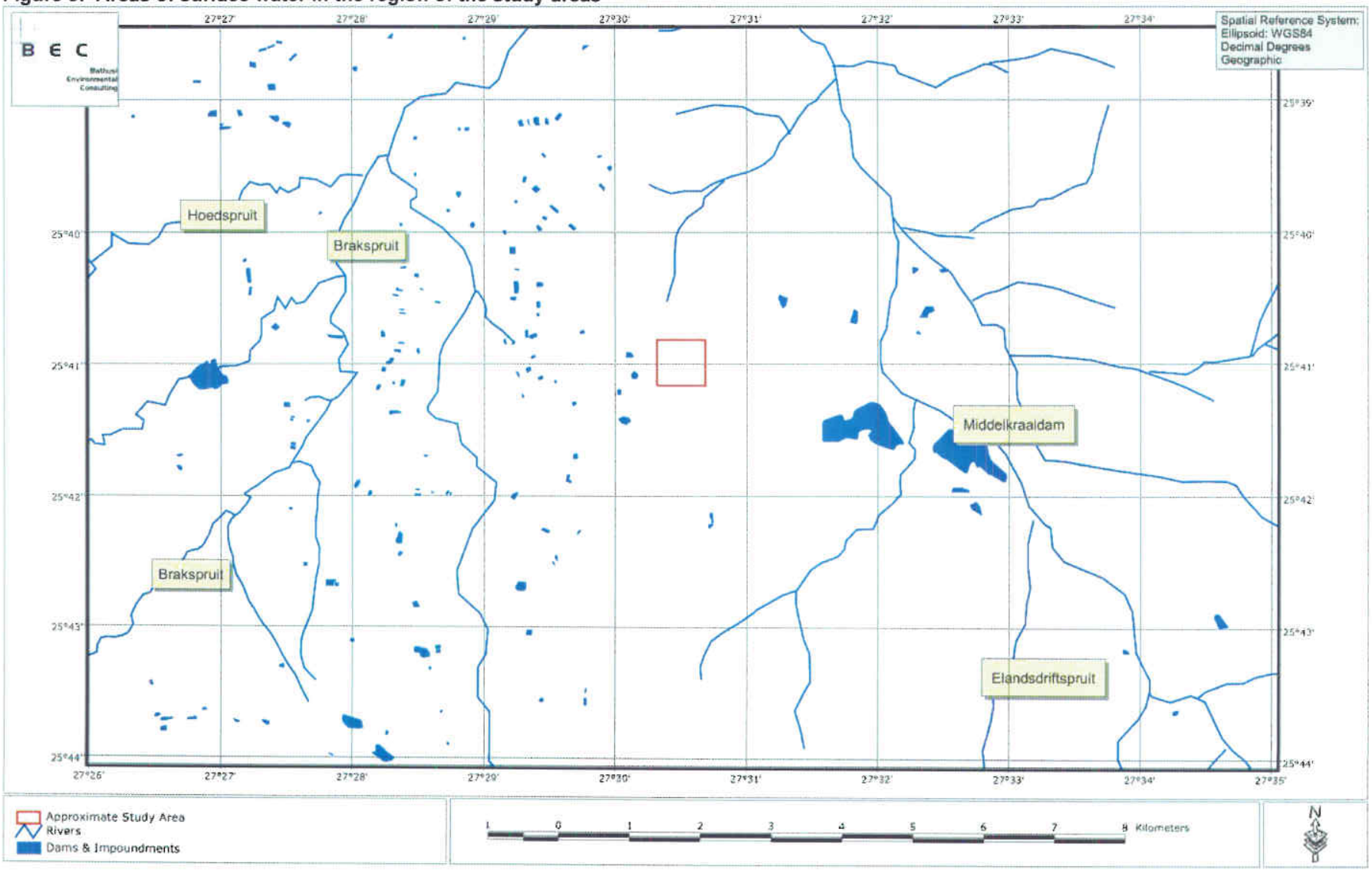


Figure 5: Areas of surface water in the region of the study areas



5.5 Topography, Relief & Slopes

The ENPAT (2003) database revealed no topographically heterogeneous areas (slopes exceeding 8%) in the immediate vicinity of the study area. It should however be noted that the ENPAT database slope classes is based on a high contour interval (probably 100m). With the use of more detailed data, the identification of smaller areas of significant slopes is likely and various smaller and localised areas could be identified that are regarded important in this regard. Visual observations from Google Earth, indicates the presence of several isolated rocky outcrops in the immediate vicinity of the site. The topography of the study site comprises 'Slightly Undulating Plains'. Altitude of the site is approximately 1,140m.

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 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. The presence of the rocky outcrops in the vicinity is therefore regarded a significant attribute, particularly since a high possibility exist that these features could be affected adversely by construction and operational activities (as well as future activities and upgrades) of the substation extension.

5.6 Geology

The geological formations represented in the region comprises of Pyramid Gabbro, which contains a few interlayers of anorthosite and a layer of pyroxenite near the top. It corresponds best with the Leolo Mountain Gabbro-Norite in the east. It stretches in the form of an arcuate strip from just north of Pretoria, past the Pilanesberg, up to the Crocodile River near Thabazimbi.

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 study site is situated within the Ea3 land type unit. E land types indicate land with 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 it does not qualify for inclusion in units A, B or C.

The Ea3 land type is dominated by midslopes (44.5%), which comprise mostly the Arcadia soil form, exhibiting extremely high clay content of the A-horizon (43 – 68%). Rocky outcrops comprise a small portion of the landscape, usually less than 2%, and these features are often dominated by open rock and the Mispah soil formation.

6 NORTH-WEST PROVINCE BIODIVERSITY CONSERVATION PLAN

Part of the proposed site comprises a Critical Biodiversity Area (Cba_saveg 2) according to the North West Province Biodiversity Conservation Assessment Technical Report (Version 1.2, 2009). This category is defined as 'Remaining patches larger than 5ha of provincially endangered and vulnerable vegetation types (Marikana Thornveld). The size remaining intact of this vegetation type is less than 60%'. Any further transformation of these vegetation types should be limited to existing transformed or heavily degraded areas.

Critical biodiversity areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (SANBI 2007). These form the key output of a systematic conservation assessment and are the biodiversity sectors inputs into multi-sectoral planning and decision making tools. The purpose of the critical biodiversity areas (CBA) map and guidelines is to mainstream biodiversity into land-use planning and decision-making by identifying those sites that are critical for biodiversity persistence. The overall aim is to avoid loss and degradation of natural habitat in CBA's, whilst managing sustainable development in other natural areas remaining. CBA's therefore need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services.

7 BOTANICAL ASSESSMENT

The study site corresponds to the Savanna Biome as defined by Mucina & Rutherford (VegMap, 2006), more specifically, the Marikana Thornveld ecological type is spatially represented in the study site.

7.1 REGIONAL TYPIFICATION

7.1.1 Background to the Savanna Biome

The Savanna Biome is known to support more than 5,700 plant species, exceed only by the Fynbos Ecoregion in species richness. Most savanna types have an herbaceous layer usually dominated by grass species and a discontinuous to sometimes very open tree layer. The woody component often forms an irregular series of interlocking, often low, canopies with openings and sometimes little distinction can be made between tall shrubs and small trees. 'Savanna grasslands' may grade into 'Tree savanna', 'Shrub savanna', Savanna woodland' or 'Savanna parkland'. Structure of the woody component of savanna is important to animals – for example tree height, which determines the available browse, dense woody entanglements forming impenetrably barriers, availability of shade and protection against predators or scavengers, etc.

Floristically similar vegetation can be structurally different, but there is often an excellent correlation between vegetation patterns and soil types, with much floristic variation along rainfall gradients, even with similar substrates. In addition, there are most often major differences in the herbaceous layer under canopies and areas between tree canopies; woody plants can serve as protection for certain grass species. Soil nutrient enrichments and increase soil organic matter is found underneath trees, especially large ones, due to various mechanisms including leaf litter, stem flow and throughfall of rain and N-fixation under leguminous trees. Thinning or even total removal of savanna trees is a common practice to counter the apparent suppression of herbaceous plants to improve grazing. In bottomland *Acacia* communities in the Pilanesberg Game Reserve, spatial analysis suggested competition among trees as a mechanism controlling their size and density.

7.1.2 Marikana Thornveld

The Marikana Thornveld comprises 128,528ha in the North-West Province and 47.8% of this ecological type is already transformed (North West Province Biodiversity Conservation Assessment Technical Report, 2009). This ecological type is structurally similar to open *Acacia* savanna woodland, occurring in valleys, slightly undulating plains, and some lowland hills. Shrubs are dense along drainage lines, on termitaria and rocky outcrop or in other habitat protected from fire. The Marikana Thornveld is a threatened ("Vulnerable") vegetation type of which less than 1% is nationally conserved within reserves. Alien invasive plants occur localised in high densities, especially along the drainage lines. The following species are regarded representative of the Marikana Thornveld vegetation type.

- **Tall Tree**

Acacia burkei

- **Small Trees**

Acacia caffra, *A. gerrardii*, *A. karroo*, *Combretum molle*, *Searsia lancea*, *Ziziphus mucronata*, *Acacia nilotica*, *A. tortilis* subsp. *heteracantha*, *Celtis africana*, *Dombeya rotundifolia*, *Pappea capensis*, *Peltophorum africanum* and *Terminalia sericea*.

- **Tall Shrubs**

Euclea crispa subsp. *crispa*, *Olea europaea* subsp. *africana*, *Searsia pyroides* var. *pyroides*, *Diospyros lycioides* subsp. *guerkei*, *Ehretia rigida* subsp. *rigida*, *Euclea undulata*, *Grewia flava* and *Pavetta gardeniifolia*.

- **Low Shrubs**

Asparagus cooperi, *Rhynchosia nitens*, *Indigofera zeyheri* and *Justicia flava*.

- **Woody Climbers**

Clematis brachiata and *Helinus integrifolius*.

- **Herbaceous Climbers**

Pentarrhinum insipidum and *Cyphostemma cirrhosum*.

- **Graminoids**

Elionurus muticus, *Eragrostis lehmanniana*, *Setaria sphacelata*, *Themeda triandra*, *Aristida scabrivalvis* subsp. *scabrivalvis*, *Fingerhuthia africana*, *Heteropogon contortus*, *Hyperthelia dissoluta*, *Melinis nerviglumis* and *Pogonarthria squarrosa*.

- **Herbs**

Hermannia depressa, *Ipomoea obscura*, *Barleria macrostegia*, *Dianthus mooiensis* subsp. *mooiensis*, *Ipomoea oblongata* and *Vernonia oligocephala*.

- **Geophytic Herbs**

Ledebouria revoluta, *Ornithogalum tenuifolium* and *Sansevieria aethiopica*.

7.2 PHYTODIVERSITY

7.2.1 Regional Phytodiversity (POSA, 2012)

Information obtained from the SANBI database (POSA, 2012) indicates the known presence of approximately 298 plant species within the ¼-degree grid that is spatially represented in the study area (2527DA) (Appendix 1). The high floristic diversity of the immediate region reflects the regional diversity context of the Savanna Biome.

An appraisal of the growth forms (Table 1) reflects the diverse woodland physiognomy with 42 shrubs (14.1%) and 39 tree species (13.1%). Grasses (35 species, 11.7%) and herb species (60 species, 20.1%), geophytes (28 species, 9.4%) comprise important aspects of the regional vegetation. This species richness also represents 95 plant families (refer Table 2), typically dominated by Poaceae (35 species, 11.7%), Malvaceae (21 species, 7.0%), Fabaceae (17 species, 5.7%), Cyperaceae (21 species, 7.0%) and Asteraceae (18 species, 6.0%).

Table 1: Growth forms of the region

Growth Form	*Number*	*Percentage*
Bryophyte	23	7.7%
Carnivore	1	0.3%
Climber	20	6.7%

Table 1: Growth forms of the region		
Growth Form	***Number***	***Percentage***
Cyperoid	21	7.0%
Dwarf shrub	20	6.7%
Geophyte	28	9.4%
Graminoid	35	11.7%
Helophyte	6	2.0%
Herb	60	20.1%
Parasite	1	0.3%
Scrambler	1	0.3%
Shrub	42	14.1%
Succulent	1	0.3%
Tree	39	13.1%
Total	**298**	

Table 2: Families of the ¼ degree grid 2527DA		
Family	***Number***	***Percentage***
Acanthaceae	2	0.7%
Amaranthaceae	2	0.7%
Amaryllidaceae	2	0.7%
Anacardiaceae	10	3.4%
Anemiaceae	1	0.3%
Aneuraceae	1	0.3%
Anthocerotaceae	1	0.3%
Apiaceae	1	0.3%
Apocynaceae	6	2.0%
Aquifoliaceae	1	0.3%
Archidiaceae	1	0.3%
Asparagaceae	5	1.7%
Aspleniaceae	1	0.3%
Asteraceae	18	6.0%
Aytoniaceae	1	0.3%
Bartramiaceae	1	0.3%
Begoniaceae	1	0.3%
Bryaceae	1	0.3%
Celastraceae	5	1.7%
Celtidaceae	1	0.3%
Chenopodiaceae	1	0.3%
Chrysobalanaceae	1	0.3%
Combretaceae	2	0.7%
Commelinaceae	3	1.0%
Convolvulaceae	7	2.3%
Cucurbitaceae	3	1.0%
Cyatheaceae	1	0.3%
Cyperaceae	21	7.0%
Dennstaedtiaceae	1	0.3%
Dicranaceae	2	0.7%
Dipsacaceae	1	0.3%
Dracaenaceae	1	0.3%
Ebenaceae	1	0.3%
Erpodiaceae	1	0.3%
Euphorbiaceae	9	3.0%
Fabaceae	17	5.7%
Fissidentaceae	1	0.3%

Table 2: Families of the ¼ degree grid 2527DA		
Family	***Number***	***Percentage***
Geraniaceae	1	0.3%
Gleicheniaceae	1	0.3%
Hyacinthaceae	1	0.3%
Hypnaceae	3	1.0%
Hypoxidaceae	1	0.3%
Icacinaceae	1	0.3%
Iridaceae	4	1.3%
Juncaceae	1	0.3%
Lamiaceae	6	2.0%
Lentibulariaceae	1	0.3%
Leskeaceae	1	0.3%
Lycopodiaceae	1	0.3%
Lythraceae	1	0.3%
Malpighiaceae	1	0.3%
Malvaceae	21	7.0%
Melastomataceae	1	0.3%
Meliaceae	2	0.7%
Mesembryanthemaceae	1	0.3%
Meteoriaceae	1	0.3%
Moraceae	1	0.3%
Ochnaceae	2	0.7%
Oleaceae	2	0.7%
Oleandraceae	1	0.3%
Ophioglossaceae	1	0.3%
Orobanchaceae	1	0.3%
Osmundaceae	1	0.3%
Pallaviciniaceae	1	0.3%
Passifloraceae	2	0.7%
Pedaliaceae	1	0.3%
Pilotrichaceae	2	0.7%
Pittosporaceae	1	0.3%
Plumbaginaceae	1	0.3%
Poaceae	35	11.7%
Polygonaceae	5	1.7%
Pottiaceae	1	0.3%
Proteaceae	2	0.7%
Pteridaceae	1	0.3%
Ptychomitriaceae	1	0.3%
Rhamnaceae	2	0.7%
Ricciaceae	3	1.0%
Rosaceae	2	0.7%
Rubiaceae	8	2.7%
Rutaceae	1	0.3%
Salicaceae	2	0.7%
Santalaceae	1	0.3%
Sapotaceae	2	0.7%
Scrophulariaceae	3	1.0%
Selaginellaceae	1	0.3%
Sinopteridaceae	7	2.3%
Solanaceae	3	1.0%
Strychnaceae	1	0.3%
Thelypteridaceae	1	0.3%

Table 2: Families of the ¼ degree grid 2527DA		
Family	*Number*	*Percentage*
Urticaceae	2	0.7%
Velloziaceae	1	0.3%
Verbenaceae	3	1.0%
Viscaceae	1	0.3%
Vitaceae	5	1.7%
Xyridaceae	2	0.7%

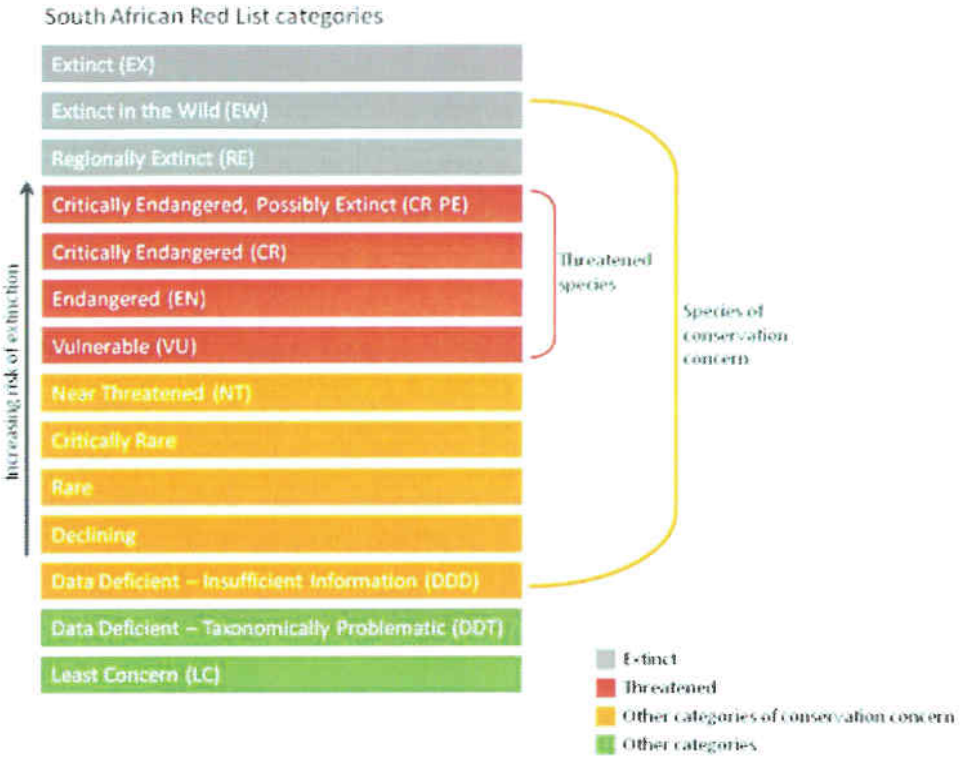
7.3 PLANT TAXA OF CONSERVATION IMPORTANCE

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 6: South African Red List Categories (courtesy of SANBI)



Data records indicate the presence of a number of plant species of conservation importance within the ¼-degree grids that are sympatric to the study area (refer Table 5).

Table 3: Conservation important taxa recorded in the region (POSA, 2009)		
Taxa	***Family***	***Status***
Ilex mitis var. *mitis*	Aquifoliaceae	Declining
Prunus africana	Rosaceae	Vulnerable
Stenostelma umbelluliferum	Apocynaceae	Near Threatened

7.3.2 Provincially Protected Species

The following provincially protected plant taxa are known to occur in the region of the study area.

Table 4: Conservation important taxa recorded in the study area		
Species Name	***Family***	***Status***
Begonia cucullata	Begoniaceae	Conservation Act
Brachystelma barberae	Apocynaceae	Conservation Act
Gladiolus dalenii subsp. *dalenii*	Iridaceae	Conservation Act
Gladiolus sericeovillosus subsp. *calvatus*	Iridaceae	Conservation Act
Gladiolus vinosomaculatus	Iridaceae	Conservation Act
Haemanthus humilis subsp. *humilis*	Amaryllidaceae	Conservation Act
Mimusops zeyheri	Sapotaceae	Protected Tree
Pittosporum viridiflorum	Pittosporaceae	Protected Tree
Protea welwitschii	Proteaceae	Conservation Act
Prunus africana	Rosaceae	Protected Tree
Sclerocarya birrea subsp. *caffra*	Anacardiaceae	Protected Tree

The presence of these some of these species within the immediate surrounds of the proposed development area is regarded likely and it is therefore strongly recommended to conduct a survey to assess the presence of these species, guide permitting requirements applicable for the North-West Province and provide pertinent EMP recommendations.

7.4 Floristic Habitat

The following habitat types were identified by means of aerial imagery (refer Figure 7[2]):

- Degraded Woodland;
- Existing Substation;
- Road Infrastructure;
- Rocky Outcrop; and
- Transformed Woodland.

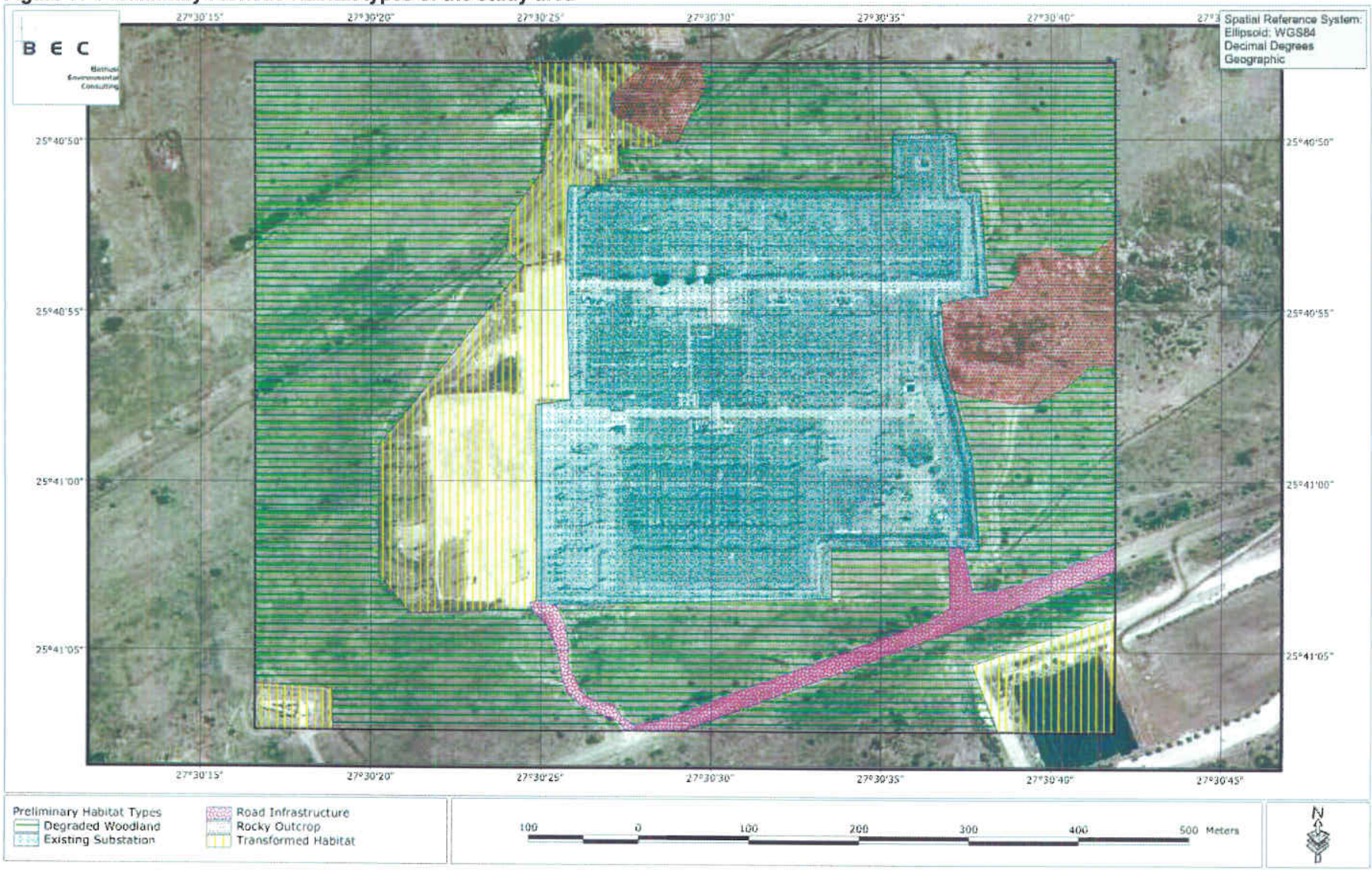
From visual observations from Google Earth images, it would appear as if the general surrounds of the existing substation is relatively degraded. Natural woodland has been degraded and the woody stratum, in particular, has been affected significantly. Agriculture, road infrastructure and urban development have resulted in large-scale decimation of the natural savanna on a regional level. Although these areas are regarded moderately/severely degraded, a number of conservation important plant taxa (specifically *Stenostelma umbelluliferum*) could potentially persist within these parts. The Precautionary Principle therefore dictates that at least a medium ecological sensitivity be ascribed until such time that the absence of plant taxa of conservation importance from all affected areas could be demonstrated. In spite of the moderate degraded nature of these areas, the vegetation is still likely to be moderately representative of the regional ecological type (Marikana Thornveld), which has a Vulnerable conservation status.

Furthermore, a number of topographically important rocky outcrops are situated in close proximity to the existing substation and is likely to be affected by the planned development. These outcrops appear as embedded units within the larger regional ecological type (Marikana Thornveld) and is regarded outlying representations of neighbouring ecological types (Norite Koppies Bushveld), representing important and localised areas of high biodiversity. Floristic characteristics of these areas appear to be relatively intact, which is typical within transformed environments like these. The likelihood of plant species of conservation importance persisting within these areas is regarded high and it is therefore strongly recommended that a suitable survey be conducted in order to assess the presence/ absence of these species in this habitat type. A high ecological sensitivity is ascribed to these parts and impacts within these areas are regarded unacceptable. From the proposed development layout, it would appear as if the outcrops immediately to the east of the existing substation would be affected.

Parts of the proposed site are entirely transformed and no natural habitat remains within these parts. A low ecological sensitivity is ascribed to these parts.

[2] Please note that no site investigation was conducted for this assessment, there is therefore always a distinct possibility that habitat types identified from aerial imagery might not correspond to actual habitat conditions of the site.

Figure 7: Preliminary Floristic Habitat types of the study area



7.5 DISCUSSION

The floristic nature of the proposed site and the immediate surrounds bears significant evidence of the intensive nature of land use, of which agriculture is mostly responsible for habitat loss. Furthermore, intensive agriculture has resulted in degradation of remaining portions of natural woodland to a sub-climax status. This is particularly evident in the isolated events of rocky outcrops within a larger environment of degraded and transformed savanna. These outcrops are characterised by a high degree of surface rock and the species composition associated with these areas are specific and atypical to the surrounding woodland situated on clayey plains. Due to the atypical, and relatively pristine, nature of these areas, the sensitivity ascribed to these portions is high.

Surrounding plains are characterised by clayey soils that have been extensively cultivated. The vegetation component of these areas appears to be degraded and is likely to consist of pioneer species and *Acacia* shrubs. While a moderate ecological sensitivity is ascribed, the potential presence of conservation important plant taxa is indicated. It is important to note that, although these areas are considered to be in sub-climax status, it forms part of a Critical Biodiversity area as per the North-West Conservation planning, situated within a 'Vulnerable' ecological type.

A relative high degree of uncertainty is indicate for this report as no site surveys were conducted; results are based on a desktop analysis of available imagery and regional floristic information. Considering the proposed layout, it is likely that the extension of the existing substation will adversely affect the nearby rocky outcrops. In addition, in view of the potential presence of conservation important plant taxa, it is strongly recommended that a suitable site investigation be conducted in order to verify the ecological status of the preliminary habitat types indicated in Figure 7.

While the planned extension of the Bighorn Substation is unlikely to result in significant impacts on a regional or local scale, the potential for adverse impacts within the isolate and small rocky outcrops is a matter of concern. It is strongly recommended to exclude all areas of rocky outcrops from the planned activities. Furthermore, a suitable buffer (protective) zone should be implemented around these areas. Planned activities within areas of low ecological sensitivity are unlikely to affect ecological attributes of low conservation importance.

8 FAUNAL ASSESSMENT

8.1 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 the area and the region loses its ecological integrity (Kamffer 2004). Savanna habitat of the North-West Province, particularly in this region, is no exception and the presence of numerous minerals has led to the significant transformation, degradation and fragmentation of the region's woodlands. Agriculture and pastoral activities have also 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 Marikana Thornveld, which is listed as Vulnerable.

Because of restrictions about database availability, only specific faunal groups are used during the species-specific element of this faunal assessment. Data on the Q-degree level is available for the following faunal groups:

- Invertebrates: Butterflies (South African Butterfly Conservation Assessment – http://sabca.adu.org.za);
- Amphibians: Frogs (Atlas and Red Data Book of the South Africa, Lesotho and Swaziland)
- Reptiles: Snakes and other Reptiles (South African Reptile Conservation Assessment - http://sarca.adu.org.za);
- Mammals: Terrestrial Mammals (Red Data Book of the Mammals of South Africa: A Conservation Assessment); and
- Birds of the ¼-degree grid 2527DA.

Animals known to be present in the Q-grids of the study area were considered potential inhabitants of the study area (all species known from the North West Province were included to minimize the effect of sampling bias). The likelihood of each species' presence in the study areas was estimated based on known ecological requirements of species; these requirements were compared to the ecological conditions found in the study area and surrounding faunal habitat.

A total of 592 animal species (124 families, 33 orders and 5 classes - Insecta, Amphibia, Reptilia, Aves and Mammalia) are known from the region of the study area. This includes a total of 75 Red Data species.

8.2 FAUNAL DIVERSITY OF THE SITE

8.2.1 General Diversity

No site surveys were conducted for this assessment, as it is based on a desktop assessment of available data.

8.3 RED DATA FAUNA ASSESSMENT

A total of 75 Red Data animals are known to occur in immediate region of the study area (refer Table 3).

Table 5: Red Data fauna assessment for the study area

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
Butterflies			
Metisella meninx	Marsh Sylph	Vulnerable	moderate-low
Frogs			
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	moderate
Reptiles			
Crocodylus niloticus	Nile Crocodile	Vulnerable	low
Birds			
Alcedo semitorquata	Half-collared Kingfisher	Near Threatened	moderate-low
Anthropoides paradisea	Blue Crane	Vulnerable	moderate-low
Aquila rapax	Tawny Eagle	Vulnerable	moderate-low
Ardeotis kori	Kori Bustard	Vulnerable	low
Buphagus erythrorhynchus	Red-billed Oxpecker	Near Threatened	moderate-high
Charadrius pallidus	Chestnut-banded Plover	Near Threatened	low
Ciconia nigra	Black Stork	Near Threatened	moderate
Circus macrourus	Pallid Harrier	Near Threatened	moderate
Circus ranivorus	African Marsh Harrier	Vulnerable	moderate-low
Eupodotis senegalensis	White-bellied Korhaan	Near Threatened	moderate-low
Falco biarmicus	Lanner Falcon	Near Threatened	moderate
Falco naumanni	Lesser Kestrel	Vulnerable	moderate-high
Falco peregrinus	Peregrine Falcon	Near Threatened	moderate-low
Glareola nordmanni	Black-winged Pratincole	Near Threatened	moderate
Gyps africanus	White-backed Vulture	Vulnerable	moderate-low
Gyps coprotheres	Cape Vulture	Vulnerable	moderate
Hydroprogne caspia	Caspian Tern	Near Threatened	moderate-low
Leptoptilos crumeniferus	Marabou Stork	Near Threatened	moderate
Mirafra cheniana	Melodious Lark	Near Threatened	moderate-low
Mycteria ibis	Yellow-billed Stork	Near Threatened	moderate
Neotis denhami	Denham's Bustard	Vulnerable	moderate-low
Pelecanus rufescens	Pink-backed Pelican	Vulnerable	low
Phoenicopterus minor	Lesser Flamingo	Near Threatened	moderate-low
Phoenicopterus roseus	Greater Flamingo	Near Threatened	moderate-low
Podica senegalensis	African Finfoot	Vulnerable	low
Polemaetus bellicosus	Martial Eagle	Vulnerable	moderate
Rostratula benghalensis	Greater Painted-snipe	Near Threatened	moderate-low
Sagittarius serpentarius	Secretarybird	Near Threatened	moderate-high
Torgos tracheliotus	Lappet-faced Vulture	Vulnerable	low
Tyto capensis	African Grass-owl	Vulnerable	low
Mammals			
Acinonyx jubatus	Cheetah	Vulnerable	low
Atelerix frontalis	South African Hedgehog	Near Threatened	moderate
Ceratotherium simum	White Rhinoceros	Near Threatened	low
Cloeotis percivali	Short-eared Trident Bat	Vulnerable	moderate-low
Crocidura cyanea	Reddish-grey Musk Shrew	Data Deficient	moderate-high
Crocidura fuscomurina	Tiny Musk Shrew	Data Deficient	moderate
Crocidura hirta	Lesser Red Musk Shrew	Data Deficient	moderate-high
Crocidura maquassiensis	Maquassie Musk Shrew	Vulnerable	moderate-low

Crocidura mariquensis	Swamp Musk Shrew	Data Deficient	moderate
Crocidura silacea	Lesser Grey-brown Musk Shrew	Data Deficient	moderate
Crocuta crocuta	Spotted Hyaena	Near Threatened	low
Damaliscus lunatus lunatus	Tsessebe	Endangered	low
Diceros bicornis	Black Rhinoceros	Vulnerable	low
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	Data Deficient	moderate
Elephantulus intufi	Bushveld Elephant-shrew	Data Deficient	low
Felis nigripes	Black-footed Cat	Vulnerable	low
Graphiurus platyops	Rock Dormouse	Data Deficient	moderate-low
Hippopotamus amphibius	Common Hippopotamus	Vulnerable	low
Hipposideros caffer	Sundevall's Leaf-nosed Bat	Data Deficient	moderate
Hippotragus equinus	Roan Antelope	Vulnerable	low
Hippotragus niger niger	Sable Antelope	Vulnerable	low
Lemniscomys rosalia	Single-striped Mouse	Data Deficient	moderate
Leptailurus serval	Serval	Near Threatened	high
Lutra maculicollis	Spotted-necked Otter	Near Threatened	moderate-low
Lycaon pictus	African Wild Dog	Endangered	low
Manis temminckii	Pangolin	Vulnerable	low
Mellivora capensis	Honey Badger	Near Threatened	moderate-high
Miniopterus natalensis	Natal Long-fingered Bat	Near Threatened	moderate
Myosorex varius	Forest Shrew	Data Deficient	moderate
Mystromys albicaudatus	White-tailed Rat	Endangered	moderate-low
Ourebia ourebi	Oribi	Endangered	low
Panthera leo	Lion	Vulnerable	low
Panthera pardus	Leopard	Near Threatened	moderate-low
Parahyaena brunnea	Brown Hyaena	Near Threatened	moderate-low
Pipistrellus rusticus	Rusty Bat	Near Threatened	moderate-low
Poecilogale albinucha	African Weasel	Data Deficient	moderate
Raphicerus sharpei	Sharp's Grysbok	Near Threatened	low
Rhinolophus blasii	Peak-saddle Horseshoe Bat	Near Threatened	moderate-low
Suncus infinitesimus	Least Dwarf Shrew	Data Deficient	moderate
Suncus lixus	Greater Dwarf Shrew	Data Deficient	moderate
Suncus varilla	Lesser Dwarf Shrew	Data Deficient	moderate
Tatera leucogaster	Bushveld Gerbil	Data Deficient	moderate-low

8.4 FAUNAL HABITAT TYPES

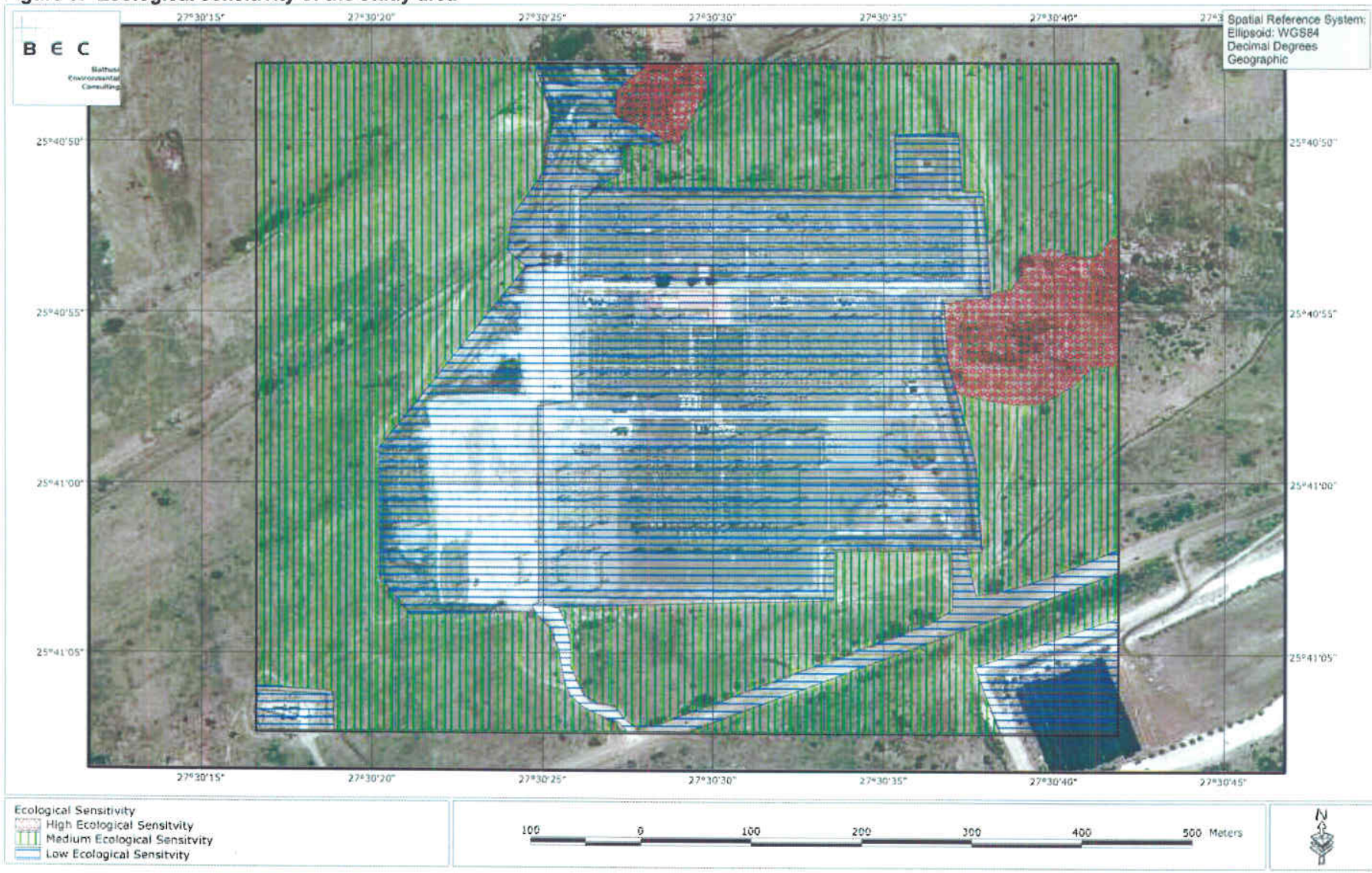
Animals of terrestrial as well as aquatic ecosystems are closely linked to and significantly influenced by plant community structures and species diversities. Similarly, terrestrial animals' ecological reactions depend on plant community structure; studies on arthropod species richness have indicated 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 singularly without considering vegetation habitat diversity; therefore, the plant communities or macro habitat types described in this document (7.4) are considered the main faunal habitats within the study area for the purposes of this EIA assessment.

The largest extent of the surrounds is regarded degraded, comprising of agricultural lands in various stages of succession. The existing vegetative layers appears not to be representative of the original Marikana Thornveld and it is reasonable to assume that the faunal assemblages that persist in these areas will not be representative of the original conditions. It is expected that the faunal assemblages will comprise mostly of opportunistic species that typically persist in degraded and altered environments. The likelihood of conservation important fauna taxa persisting in these areas are regarded minimal.

Isolated rocky outcrops, although relative pristine, is regarded marginal habitat for common fauna or animal species of conservation importance. These areas are relative small and are unlikely to host significant numbers of either common or less abundant fauna species. However, their importance as ecological contributors cannot be over-emphasised. Within a larger environment where habitat transformation and degradation is rife, their role as 'stepping stones' between suitable areas of natural habitat is important, providing access between populations that might be located some distance apart. Therefore, their protection is strongly advised and a high ecological sensitivity is ascribed to these areas.

Figure 8: Ecological sensitivity of the study area



9 BRIEF ECOLOGICAL IMPACT DISCUSSION

This discussion is aimed at presenting a description of the nature and extent significance of identified impacts on the ecological environment.

9.1 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.

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 and surface disturbances. 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. The following impacts are relevant to this particular type of 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 habitat types (including loss and degradation);
- Loss of sensitive/ natural fauna habitat types;
- 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.

9.2 NATURE OF IMPACTS

Impacts that are likely to result from the planned 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.

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

Transformative 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, 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 being included in conservation categories. 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.

The potential presence of several plants of conservation importance within the general surrounds was established during this desktop assessment, although habitat within the immediate surrounds is not considered particularly suitable for most of the species that could potentially persist in the region. A medium-high significance is therefore ascribed to this impact until such time that the absence of plant species of conservation importance from the site can be confirmed.

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

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 highly 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. These requirements are frequently stricter than for most generalist fauna taxa and impacts on their habitat are likely to be more significant than for most other, common fauna species. 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 that is suitable for these species 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 the development area is doubtful and a low significance is ascribed to this potential impact. However, sensitive habitat could potentially be affect and exclusion of these areas is strongly advised.

9.2.3 Impacts on sensitive or protected flora 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. Rocky outcrop habitat within the proposed development areas are regarded potentially sensitive and should be excluded from the planned development.

9.2.4 Loss of sensitive/ natural fauna habitat types

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.

Extremely little of the original savanna habitat remains within the immediate surrounds; a low significance is therefore ascribed to this potential impact.

9.2.5 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 amongst 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 lack of understanding from personnel frequently results in the unnecessary killing of these animals. A medium significance is ascribed to this potential impact.

9.2.6 Impacts on ecological connectivity & ecosystem functioning

The larger region is characterised by highly transformed and fragmented woodland habitat. In order to ensure the consistent presence 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.

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.

The contribution that the planned development area will have on a local or regional scale is minimal. However, the presence of sensitive habitat in close proximity to the planned development is noted. These areas can potentially have a significant role in providing animals access to remote habitat. A medium-high significance is therefore ascribed to impacts that will result in decimation of these areas. The exclusion of these areas from the planned development is strongly advocated.

9.2.7 Indirect impacts on surrounding habitat

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.

The small size of the planned development renders this potential impact unlikely and a low significance is ascribed.

9.2.8 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. These vegetation types are included in the 'Vulnerable' category.

Minimal natural habitat remains in the immediate surrounds of the planned development. The development is therefore unlikely to affect the conservation status of the regional ecological type.

9.2.9 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 and this development is unlikely to affect the habitat fragmentation and isolation levels on a local or regional scale.

10 APPENDIX 1: RECORDED PHYTODIVERSITY OF 2527DA

Taxon	Family	RD Status	Growth Form
Abrus laevigatus	Fabaceae	LC	Climber
Abutilon angulatum var. *macrophyllum*	Malvaceae	LC	Shrub
Abutilon galpinii	Malvaceae	LC	Dwarf shrub
Abutilon sonneratianum	Malvaceae	LC	Shrub
Acacia erubescens	Fabaceae	LC	Tree
Acacia karroo	Fabaceae	LC	Tree
Acalypha angustata	Euphorbiaceae	LC	Dwarf shrub
Acalypha villicaulis	Euphorbiaceae	LC	Dwarf shrub
Adenia digitata	Passifloraceae	LC	Climber
Adenostemma caffrum	Asteraceae	LC	Herb
Aerva lanata	Amaranthaceae	LC	Herb
Albizia anthelmintica	Fabaceae	LC	Tree
Alloteropsis semialata subsp. *semialata*	Poaceae	LC	Graminoid
Alsophila dregei	Cyatheaceae		Tree
Ancylobotrys capensis	Apocynaceae	LC	Climber
Andropogon eucomus	Poaceae	LC	Graminoid
Andropogon schirensis	Poaceae	LC	Graminoid
Aneilema hockii	Commelinaceae	LC	Herb
Antherotoma debilis	Melastomataceae	LC	Herb
Anthoceros natalensis	Anthocerotaceae		Bryophyte
Apodytes dimidiata subsp. *dimidiata*	Icacinaceae	LC	Tree
Archidium acanthophyllum	Archidiaceae		Bryophyte
Aristida adscensionis	Poaceae	LC	Graminoid
Ascolepis capensis	Cyperaceae	LC	Cyperoid
Asparagus angusticladus	Asparagaceae	LC	Climber
Asparagus flavicaulis subsp. *flavicaulis*	Asparagaceae	LC	Shrub
Asparagus plumosus	Asparagaceae	LC	Dwarf shrub
Asparagus transvaalensis	Asparagaceae	LC	Shrub
Asparagus virgatus	Asparagaceae	LC	Shrub
Asplenium phillipsianum	Aspleniaceae	LC	Geophyte
Begonia cucullata	**Begoniaceae**	**Protected**	**Herb**
Bothriochloa bladhii	Poaceae	LC	Graminoid
Bothriochloa insculpta	Poaceae	LC	Graminoid
Brachiaria xantholeuca	Poaceae	LC	Graminoid
Brachystelma barberae	**Apocynaceae**	**Protected**	**Geophyte**
Bryum argenteum	Bryaceae		Bryophyte
Bulbostylis burchellii	Cyperaceae	LC	Cyperoid
Callicostella tristis	Pilotrichaceae		Bryophyte
Callilepis lancifolia	Asteraceae	LC	Herb
Campylopus pilifer var. *pilifer*	Dicranaceae		Bryophyte
Campylopus robillardei	Dicranaceae		Bryophyte
Canthium suberosum	Rubiaceae	LC	Shrub
Carex rhodesiaca	Cyperaceae		Sedge
Carex spicato-paniculata	Cyperaceae	LC	Cyperoid
Carissa bispinosa	Apocynaceae	LC	Shrub
Cheilanthes hirta var. *brevipilosa forma laxa*	Sinopteridaceae		Fern
Cheilanthes involuta var. *obscura*	Sinopteridaceae	LC	Geophyte
Cheilanthes viridis var. *glauca*	Sinopteridaceae	LC	Geophyte
Cheilanthes viridis var. *viridis*	Sinopteridaceae	LC	Geophyte
Chloris virgata	Poaceae	LC	Graminoid

Chrysopogon serrulatus	Poaceae	LC	Graminoid
Cineraria parvifolia	Asteraceae	LC	Herb
Citrullus lanatus	Cucurbitaceae	LC	Climber
Clutia pulchella var. *pulchella*	Euphorbiaceae	LC	Dwarf shrub
Coccinia adoensis	Cucurbitaceae	LC	Climber
Coleochloa setifera	Cyperaceae	LC	Cyperoid
Combretum molle	Combretaceae	LC	Tree
Combretum zeyheri	Combretaceae	LC	Tree
Commelina africana var. *lancispatha*	Commelinaceae	LC	Herb
Convolvulus aschersonii	Convolvulaceae	LC	Herb
Conyza chilensis	Asteraceae	NE	Herb
Conyza ulmifolia	Asteraceae	LC	Herb
Corchorus argillicola	Malvaceae		Herb
Corchorus asplenifolius	Malvaceae	LC	Herb
Croton gratissimus var. *subgratissimus*	Euphorbiaceae	LC	Tree
Cyanotis lapidosa	Commelinaceae	LC	Herb
Cyclodictyon vallis-gratiae	Pilotrichaceae		Bryophyte
Cynodon dactylon	Poaceae	LC	Graminoid
Cyperus albostriatus	Cyperaceae	LC	Cyperoid
Cyperus capensis	Cyperaceae	LC	Cyperoid
Cyperus cyperoides subsp. *pseudoflavus*	Cyperaceae	LC	Cyperoid
Cyperus leptocladus	Cyperaceae	LC	Cyperoid
Cyperus obtusiflorus var. *obtusiflorus*	Cyperaceae	LC	Cyperoid
Cyperus rupestris var. *rupestris*	Cyperaceae	LC	Cyperoid
Cyperus sphaerospermus	Cyperaceae	LC	Cyperoid
Cyphostemma lanigerum	Vitaceae	LC	Climber
Cyphostemma sandersonii	Vitaceae	LC	Climber
Cyphostemma sulcatum	Vitaceae	LC	Climber
Dalechampia capensis	Euphorbiaceae	LC	Dwarf shrub
Diandrochloa namaquensis	Poaceae	LC	Graminoid
Dichanthium annulatum var. *papillosum*	Poaceae	LC	Graminoid
Dichrostachys cinerea subsp. *africana* var. *africana*	Fabaceae	LC	Tree
Digitaria ternata	Poaceae	LC	Graminoid
Digitaria velutina	Poaceae	LC	Graminoid
Diospyros lycioides subsp. *lycioides*	Ebenaceae	LC	Shrub
Dovyalis zeyheri	Salicaceae	LC	Tree
Dumasia villosa var. *villosa*	Fabaceae	LC	Climber
Echinochloa colona	Poaceae	LC	Graminoid
Emex australis	Polygonaceae	NE	Herb
Englerophytum magalismontanum	Sapotaceae	LC	Tree
Eragrostis barrelieri	Poaceae	NE	Graminoid
Eragrostis heteromera	Poaceae	LC	Graminoid
Eragrostis nindensis	Poaceae	LC	Graminoid
Erpodium coronatum subsp. *transvaaliense*	Erpodiaceae		Bryophyte
Euphorbia heterophylla	Euphorbiaceae	NE	Herb
Evolvulus alsinoides	Convolvulaceae	LC	Herb
Faurea saligna	Proteaceae	LC	Tree
Ficus abutilifolia	Moraceae	LC	Tree
Fimbristylis dichotoma subsp. *dichotoma*	Cyperaceae	LC	Cyperoid
Fissidens sciophyllus	Fissidentaceae		Bryophyte
Geigeria burkei subsp. *burkei* var. *zeyheri*	Asteraceae	LC	Herb
Gladiolus dalenii* subsp. *dalenii	**Iridaceae**	**Protected**	**Geophyte**
Gladiolus sericeovillosus* subsp. *calvatus	**Iridaceae**	**Protected**	**Geophyte**

Gladiolus vinosomaculatus	**Iridaceae**	**Protected**	**Geophyte**
Gleichenia polypodioides	Gleicheniaceae	LC	Herb
Gnaphalium filagopsis	Asteraceae	LC	Herb
Grewia flava	Malvaceae	LC	Shrub
Grewia flavescens	Malvaceae	LC	Shrub
Grewia monticola	Malvaceae	LC	Tree
Grewia occidentalis var. *occidentalis*	Malvaceae	LC	Tree
Grewia subspathulata	Malvaceae	LC	Shrub
Gymnosporia buxifolia	Celastraceae	LC	Tree
Gymnosporia tenuispina	Celastraceae	LC	Shrub
Haemanthus humilis* subsp. *humilis	**Amaryllidaceae**	**Protected**	**Geophyte**
Halleria lucida	Scrophulariaceae	LC	Tree
Helichrysum argyrosphaerum	Asteraceae	LC	Herb
Helichrysum difficile	Asteraceae	LC	Herb
Helichrysum harveyanum	Asteraceae	LC	Herb
Helichrysum kraussii	Asteraceae	LC	Shrub
Helichrysum nudifolium var. *nudifolium*	Asteraceae	LC	Herb
Helichrysum nudifolium var. *oxyphyllum*	Asteraceae	LC	Herb
Helichrysum polycladum	Asteraceae	LC	Herb
Helichrysum stenopterum	Asteraceae	LC	Herb
Hermannia burkei	Malvaceae	LC	Climber
Hermannia depressa	Malvaceae	LC	Herb
Hermannia floribunda	Malvaceae	LC	Dwarf shrub
Hermannia quartiniana	Malvaceae	LC	Herb
Heteromorpha arborescens var. *abyssinica*	Apiaceae	LC	Tree
Hibiscus engleri	Malvaceae	LC	Herb
Hibiscus subreniformis	Malvaceae	LC	Dwarf shrub
Hyparrhenia anamesa	Poaceae	LC	Graminoid
Hyparrhenia dregeana	Poaceae	LC	Graminoid
Hyparrhenia hirta	Poaceae	LC	Graminoid
Hyparrhenia tamba	Poaceae	LC	Graminoid
Hypoxis rigidula var. *pilosissima*	Hypoxidaceae	LC	Geophyte
Ilex mitis* var. *mitis	**Aquifoliaceae**	**Declining**	**Tree**
Ipomoea gracilisepala	Convolvulaceae	LC	Herb
Ipomoea magnusiana	Convolvulaceae	LC	Herb
Ipomoea obscura var. *obscura*	Convolvulaceae	LC	Herb
Ipomoea papilio	Convolvulaceae	LC	Herb
Ipomoea transvaalensis	Convolvulaceae	LC	Herb
Ischaemum afrum	Poaceae	LC	Graminoid
Isolepis costata	Cyperaceae	LC	Cyperoid
Isolepis fluitans var. *fluitans*	Cyperaceae	LC	Cyperoid
Isopterygium leucophanes	Hypnaceae		Bryophyte
Isopterygium leucopsis	Hypnaceae		Bryophyte
Isopterygium punctulatum	Hypnaceae		Bryophyte
Jamesbrittenia burkeana	Scrophulariaceae	LC	Shrub
Juncus exsertus	Juncaceae	LC	Helophyte
Justicia anagalloides	Acanthaceae	LC	Herb
Khadia acutipetala	Mesembryanthemaceae	LC	Succulent
Kyllinga alba	Cyperaceae	LC	Cyperoid
Kyllinga melanosperma	Cyperaceae	LC	Cyperoid
Kyphocarpa angustifolia	Amaranthaceae	LC	Herb
Lannea discolor	Anacardiaceae	LC	Tree
Lantana rugosa	Verbenaceae	LC	Shrub

Ledebouria ovatifolia	Hyacinthaceae	LC	Geophyte
Leptochloa eleusine	Poaceae	LC	Graminoid
Lindbergia viridis	Leskeaceae		Bryophyte
Lipocarpha chinensis	Cyperaceae	LC	Cyperoid
Lippia javanica	Verbenaceae	LC	Shrub
Lippia scaberrima	Verbenaceae	LC	Herb
Lycopodiella cernua	Lycopodiaceae	LC	Geophyte
Maytenus undata	Celastraceae	LC	Tree
Melhania prostrata	Malvaceae	LC	Dwarf shrub
Melinis repens subsp. *repens*	Poaceae	LC	Graminoid
Melolobium microphyllum	Fabaceae	LC	Dwarf shrub
Microlepia speluncae	Dennstaedtiaceae	LC	Geophyte
Mimusops zeyheri	**Sapotaceae**	**Declining**	**Tree**
Mohria vestita	Anemiaceae	LC	Geophyte
Nesaea sagittifolia var. *sagittifolia*	Lythraceae	LC	Dwarf shrub
Nidorella auriculata	Asteraceae	LC	Herb
Obetia tenax	Urticaceae	LC	Succulent
Ochna holstii	Ochnaceae	LC	Tree
Ochna pulchra	Ochnaceae	LC	Tree
Ocimum americanum var. *americanum*	Lamiaceae	LC	Herb
Ocimum obovatum subsp. *obovatum* var. *obovatum*	Lamiaceae	LC	Herb
Olea capensis subsp. *enervis*	Oleaceae	LC	Shrub
Olea europaea subsp. *africana*	Oleaceae	LC	Tree
Oleandra distenta	Oleandraceae	LC	Herb
Ophioglossum polyphyllum var. *polyphyllum*	Ophioglossaceae	LC	Geophyte
Ophrestia oblongifolia var. *oblongifolia*	Fabaceae	LC	Herb
Oplismenus hirtellus	Poaceae	LC	Graminoid
Osmunda regalis	Osmundaceae	LC	Geophyte
Osyris lanceolata	Santalaceae	LC	Shrub
Otholobium nigricans	Fabaceae	LC	Shrub
Pachycarpus concolor subsp. *concolor*	Apocynaceae	LC	Herb
Parinari capensis subsp. *capensis*	Chrysobalanaceae	LC	Dwarf shrub
Paspalum distichum	Poaceae	LC	Graminoid
Paspalum urvillei	Poaceae	NE	Graminoid
Passiflora edulis	Passifloraceae	NE	Climber
Pelargonium luridum	Geraniaceae	LC	Geophyte
Pellaea calomelanos var. *calomelanos*	Sinopteridaceae	LC	Geophyte
Pellaea dura var. dura	Sinopteridaceae	LC	Geophyte
Pellaea pectiniformis	Sinopteridaceae	LC	Geophyte
Pentanisia angustifolia	Rubiaceae	LC	Herb
Peponium caledonicum	Cucurbitaceae	LC	Climber
Persicaria attenuata subsp. *africana*	Polygonaceae	LC	Helophyte
Persicaria decipiens	Polygonaceae	LC	Helophyte
Persicaria lapathifolia	Polygonaceae	NE	Helophyte
Philonotis africana	Bartramiaceae		Bryophyte
Phragmites australis	Poaceae	LC	Graminoid
Phylica paniculata	Rhamnaceae	LC	Tree
Pittosporum viridiflorum	**Pittosporaceae**	**Declining**	**Tree**
Plagiochasma rupestre var. *volkii*	Aytoniaceae		Bryophyte
Plectranthus hereroensis	Lamiaceae	LC	Herb
Plumbago zeylanica	Plumbaginaceae	NE	Shrub
Pouzolzia mixta var. *mixta*	Urticaceae	LC	Succulent
Protea welwitschii	**Proteaceae**	**Protected**	**Dwarf shrub**

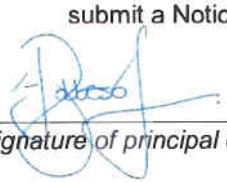
Prunus africana	**Rosaceae**	**VU**	**Tree**
Psydrax livida	Rubiaceae	LC	Tree
Pteris catoptera var. *catoptera*	Pteridaceae	LC	Geophyte
Pterocelastrus echinatus	Celastraceae	LC	Tree
Ptychomitrium crispatum	Ptychomitriaceae		Bryophyte
Rauvolfia caffra	Apocynaceae	LC	Tree
Rhoicissus revoilii	Vitaceae	LC	Climber
Rhoicissus tridentata subsp. *tridentata*	Vitaceae	NE	Shrub
Rhynchosia albissima	Fabaceae	LC	Dwarf shrub
Rhynchosia monophylla	Fabaceae	LC	Herb
Rhynchosia nitens	Fabaceae	LC	Shrub
Rhynchosia sordida	Fabaceae	LC	Dwarf shrub
Rhynchosia totta var. *totta*	Fabaceae	LC	Climber
Rhynchospora brownii	Cyperaceae	LC	Cyperoid
Riccardia fastigiata	Aneuraceae		Bryophyte
Riccia albolimbata	Ricciaceae		Bryophyte
Riccia atropurpurea	Ricciaceae		Bryophyte
Riccia okahandjana	Ricciaceae		Bryophyte
Rotheca louwalbertsii	Lamiaceae	LC	Herb
Rothmannia capensis	Rubiaceae	LC	Tree
Rubia horrida	Rubiaceae	LC	Herb
Rubus rigidus	Rosaceae	LC	Shrub
Rumex sagittatus	Polygonaceae	LC	Climber
Ruttya ovata	Acanthaceae	LC	Shrub
Salacia rehmannii	Celastraceae	LC	Dwarf shrub
Salsola glabrescens	Chenopodiaceae	LC	Dwarf shrub
Sansevieria aethiopica	Dracaenaceae	LC	Geophyte
Scabiosa columbaria	Dipsacaceae	LC	Herb
Scadoxus puniceus	Amaryllidaceae	LC	Geophyte
Schoenoplectus brachyceras	Cyperaceae	LC	Cyperoid
Sclerocarya birrea subsp. _caffra_	**Anacardiaceae**	**Declining**	**Tree**
Scolopia zeyheri	Salicaceae	LC	Tree
Searsia chirindensis	Anacardiaceae	LC	Tree
Searsia dentata	Anacardiaceae	LC	Tree
Searsia lancea	Anacardiaceae	LC	Tree
Searsia leptodictya forma *leptodictya*	Anacardiaceae	NE	Tree
Searsia pyroides var. *gracilis*	Anacardiaceae	LC	Tree
Searsia pyroides var. *pyroides*	Anacardiaceae	LC	Shrub
Searsia rigida var. *margaretae*	Anacardiaceae	LC	Shrub
Searsia zeyheri	Anacardiaceae	LC	Shrub
Selaginella dregei	Selaginellaceae	LC	Geophyte
Sesamum triphyllum var. *triphyllum*	Pedaliaceae	LC	Herb
Sesbania transvaalensis	Fabaceae	LC	Herb
Setaria lindenbergiana	Poaceae	LC	Graminoid
Setaria sphacelata var. *torta*	Poaceae	LC	Graminoid
Sida cordifolia subsp. *cordifolia*	Malvaceae	LC	Dwarf shrub
Sida dregei	Malvaceae	LC	Dwarf shrub
Solanum aculeatissimum	Solanaceae	LC	Shrub
Solanum mauritianum	Solanaceae	NE	Tree
Solanum panduriforme	Solanaceae	LC	Dwarf shrub
Sorghum versicolor	Poaceae	LC	Graminoid
Sphedamnocarpus pruriens subsp. *pruriens*	Malpighiaceae	LC	Climber
Squamidium brasiliense	Meteoriaceae		Bryophyte

Stenostelma umbelluliferum	**Apocynaceae**	**NT**	**Geophyte**
Stipagrostis uniplumis var. *neesii*	Poaceae	LC	Graminoid
Striga forbesii	Orobanchaceae	LC	Herb
Strychnos pungens	Strychnaceae	LC	Tree
Symphyogyna brasiliensis	Pallaviciniaceae		Bryophyte
Syncolostemon pretoriae	Lamiaceae	LC	Herb
Tarchonanthus camphoratus	Asteraceae	LC	Tree
Tarchonanthus parvicapitulatus	Asteraceae	LC	Tree
Thelypteris confluens	Thelypteridaceae	LC	Geophyte
Tragia incisifolia	Euphorbiaceae	LC	Herb
Tragia prionoides	Euphorbiaceae	LC	Climber
Tragia rupestris	Euphorbiaceae	LC	Climber
Tragus berteronianus	Poaceae	LC	Graminoid
Trema orientalis	Celtidaceae	LC	Tree
Tricalysia lanceolata	Rubiaceae	LC	Tree
Trichostomum brachydontium	Pottiaceae		Bryophyte
Triumfetta annua forma piligera	Malvaceae	NE	Herb
Triumfetta rhomboidea var. *rhomboidea*	Malvaceae	LC	Herb
Turraea floribunda	Meliaceae	LC	Tree
Turraea obtusifolia	Meliaceae	LC	Climber
Tylosema esculentum	Fabaceae	LC	Succulent
Urochloa mosambicensis	Poaceae	LC	Graminoid
Utricularia livida	Lentibulariaceae	LC	Carnivore
Vangueria infausta subsp. *infausta*	Rubiaceae	LC	Tree
Vangueria parvifolia	Rubiaceae		Tree
Viscum rotundifolium	Viscaceae	LC	Parasite
Vitex zeyheri	Lamiaceae	LC	Tree
Xanthium strumarium	Asteraceae	NE	Herb
Xerophyta viscosa	Velloziaceae	LC	Herb
Xyris capensis	Xyridaceae	LC	Helophyte
Xyris congensis	Xyridaceae	LC	Helophyte
Zaluzianskya elongata	Scrophulariaceae	LC	Herb
Zanthoxylum capense	Rutaceae	LC	Tree
Ziziphus mucronata subsp. *mucronata*	Rhamnaceae	LC	Tree

11 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;
- 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:

15th February 2013

Date:

12 APPENDIX 3: 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 frequently have a high paucity.
- No site surveys were conducted for the purpose of this investigation, all results, maps, descriptions, recommendations and findings are based on a desktop assessment of available data.
- 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.
- 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.

13 APPENDIX 4: 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 6: 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.

Table 6: Legislative guidance for this project	
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)	
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"

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February 2013

ESKOM BIGHORN SUBSTATION UPGRADE SOIL, LAND USE AND LAND CAPABILITY REPORT

terraafrica
environmentalconsultants

SOIL, LAND USE AND LAND CAPABILITY STUDY FOR THE PROPOSED ESKOM BIGHORN SUBSTATION UPGRADE PROJECT

PREPARED FOR

PREPARED BY

Prepared by: ***Terra-Africa Consult cc***

Report Author: ***Mariné Pienaar***

Professional Registration: SACNASP Reg. No. 400274/10

Date: ***February 2013***

GLOSSARY OF TERMS

Base status: A qualitative expression of base saturation. See base saturation percentage. Base Saturation Base saturation refers to the proportion of the cation exchange sites in the soil that are occupied by the various cations (hydrogen, calcium, magnesium, potassium). The surfaces of soil minerals and organic matter have negative charges that attract and hold the positively charged cations. Cations with one positive charge (hydrogen, potassium, sodium) will occupy one negatively charged site. Cations with two positive charges (calcium, magnesium) will occupy two sites.

Buffer capacity: The ability of soil to resist an induced change in pH.

Calcareous: Containing calcium carbonate or magnesium carbonate.

Catena: A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Fine textured soils: Soils with a texture of sandy clay, silty clay or clay.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Overburden: A material which overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock.

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedocutanic, diagnostic B-horizon: The concept embraces B-horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B-horizon, the transition to the overlying A-horizon is clear or abrupt.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand sub-separates.

Vertic, diagnostic A-horizon: A-horizons that have both, high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

EXECUTIVE SUMMARY

A soil survey was conducted during February 2013 on two small areas surrounding the current Eskom Bighorn Substation for a proposed expansion project. The survey site was a total of 3.2 ha and consisted of 1.1 ha that was already covered in concrete and another 0.8 hectare that was previously disturbed by construction activities and the surface is now covered by coarse gravel. The remaining 1.3 hectare consists of the vertic Arcadia soil form that is dominated by smectitic clays and has swelling-shrinking properties. The soil chemistry of this soil form has high base status and mineral content of calcium, magnesium and potassium and a slightly acidic pH.

The current land use of the site consists of grazing by goats (probably belonging to a local community) as well as wilderness and industrial in areas where disturbance has removed vegetation. The surrounding land use mainly consists of platinum mining, game farming as well as citrus farming in smaller areas.

Based on the findings of the soil and land capability study it is the opinion of the soil scientist, from a soil conservation and land capability point of view, that the proposed development be considered favourably. The Bighorn Substation Upgrade will not result in loss of land with high potential agricultural value nor have a negative impact on food production on a local and regional scale.

The anticipated impacts are related to soil and can be mitigated by minimising the construction footprint, managing storm water run-off and taking due care to prevent chemical pollution by construction materials and fuel from construction vehicles.

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1. INTRODUCTION

Terra-Africa Consult cc was appointed by GCS (Pty) Ltd to conduct a soil, land use and land capability study for two small areas outside the existing Eskom Bighorn Substation near Marikana in Northwest Province where a proposed upgrade is planned. The need for the substation upgrade has arisen from electricity load growth on the entire Eastern Limb of the Bushveld Igneous Complex (BIC) which puts all of Rustenburg Customer Load Network's transmission stations at risk in the same period. Hence substations to the west of Bighorn cannot be utilised to deload Bighorn and create capacity for the impending load growth.

A soil survey of the project area was conducted during February 2013 by M. Pienaar of Terra-Africa Consult cc, a registered Professional Natural Scientist. The purpose of the study was to determine the soil forms and current land capability of the area where the proposed new infrastructure for the upgrade will be constructed. Soil samples for chemical analysis were also sampled during the site visit.

The objectives of this survey are:

- to describe the soil forms present as well as its inherent agricultural production potential
- to determine the pre-development land capability,
- to determine the present land use,
- to conduct an Impact Assessment for the soils and land capability which will feed into the overall Environmental Impact Assessment, and
- to propose mitigation measures for the impacts to form part of the Environmental Management Programme

Since agricultural potential of land is largely determined by the soil characteristics together with climatic conditions, a soil survey was conducted to establish homogenous soil units and their distribution. These units could in turn be assessed in terms of agricultural potentials for different farming operations like animal production and irrigated crop production taking the rainfall, temperature and soil potential into consideration.

2. PROJECT INFORMATION

The proposed upgrade project will include the following components:

- Relocate the 275kV Feeder-2 to the vacant 275kV Feeder-1.
- Reposition the exit direction of the 400kV Feeder-1.
- Establish 275kV and 400kV Transformer bays in the then vacant 275kV Feeder-2 position.
- Relocate the new 400/275 500MVA to former 275kV Feeder-2 overpass.
- Deviate the 88Kv Tailings lines within the proposed 132Kv Yard.
- Terrance the remaining 275kV Yard and extend existing fence to the west.
- Establish a 132kV tubular busbar.
- Establish 3x132Kv Feeder Bays (plus 1 future spare bay).
- Establish 132kV Bus Coupler.
- Establish 2x132Kv Transformer Bays.
- Establish 1x400kV Transformer Bays.
- Install 2x400/132kV 500MVA Transformers.
- Establish 132kV overpass from the 500MVA transformers to 132kV Transformer Bay.
- Swing Makokokwe and Excarbo 1&2 88kV lines to new 132kV Bays.
- Install all necessary Secondary Plant Equipment.

3. ENVIRONMENTAL LAW APPLICABLE TO STUDY

The most recent South African Environmental Legislation that needs to be considered for any new development with reference to management of soil and land use includes:

- Soils and land capability are protected under the National Environmental Management Act 107 of 1998, the Minerals Act 28 of 2002 and the Conservation of Agricultural Resources Act 43 of 1983.
- The National Environmental Management Act 107 of 1998 requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimised and remedied.
- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal.

- The Conservation of Agriculture Resources Act 43 of 1983 requires the protection of land against soil erosion and the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and water courses are also addressed.

4. TERMS OF REFERENCE

Following the guidelines as stipulated by the National Department of Agriculture, Forestry and Fisheries, the soil study has to fulfil certain requirements. The requirements for the study report are:

- A detailed soil of assessment of the site in question that incorporates a radius of 50 m surrounding the site on a scale of 1:10 000 or finer. The soil assessment should include:
    - Identification of the soil forms present on site
    - The size of the area where a particular soil form is found
    - GPS readings of soil survey points
    - The depth of the soil at each survey point
    - Soil colour
    - Limiting factors
    - Clay content
    - Slope of the site
    - A detailed map indicating the locality of the soil forms within the specified area
    - Size of the site
- Exact locality of the site
- Current activities on the site, developments, buildings
- Surrounding developments / land uses and activities in a radius of 500m of the site
- Access routes and the conditions thereof
- Current status of the land
- Possible land use options for the site
- Water availability, source and quality (if available)
- Detailed descriptions of why agriculture should or should not be the land use of choice
- Impact of the change of land use on the surrounding area

5. LOCALITY OF THE PROPOSED BIGHORN SUBSTATION UPGRADE SITE

The Eskom Bighorn Substation is located near Marikana and east of Rustenburg in the Northwest Province (**Figure 1**). The proposed upgrade project site consists of two separate areas on the northwest and southeast of the existing Bighorn Substation. The area on the northwest corner lies between the following four corner points:

- 25°40'51.84"S and 27°30'21.77"E
- 25°40'51.66"S and 27°30'25.94"E
- 25°40'57.49"S and 27°30'25.96"E
- 25°40'57.51"S and 27°30'21.80"E

The expansion area to the southeast of the existing substation is an L-shaped area with the following six corner points:

- 25°41'2.18"S and 27°30'27.31"E
- 25°41'3.29"S and 27°30'27.26"E
- 25°41'3.35"S and 27°30'35.09"E
- 25°40'59.66"S and 27°30'35.13"E
- 25°40'59.67"S and 27°30'33.36"E
- 25°41'2.19"S and 27°30'33.39"E

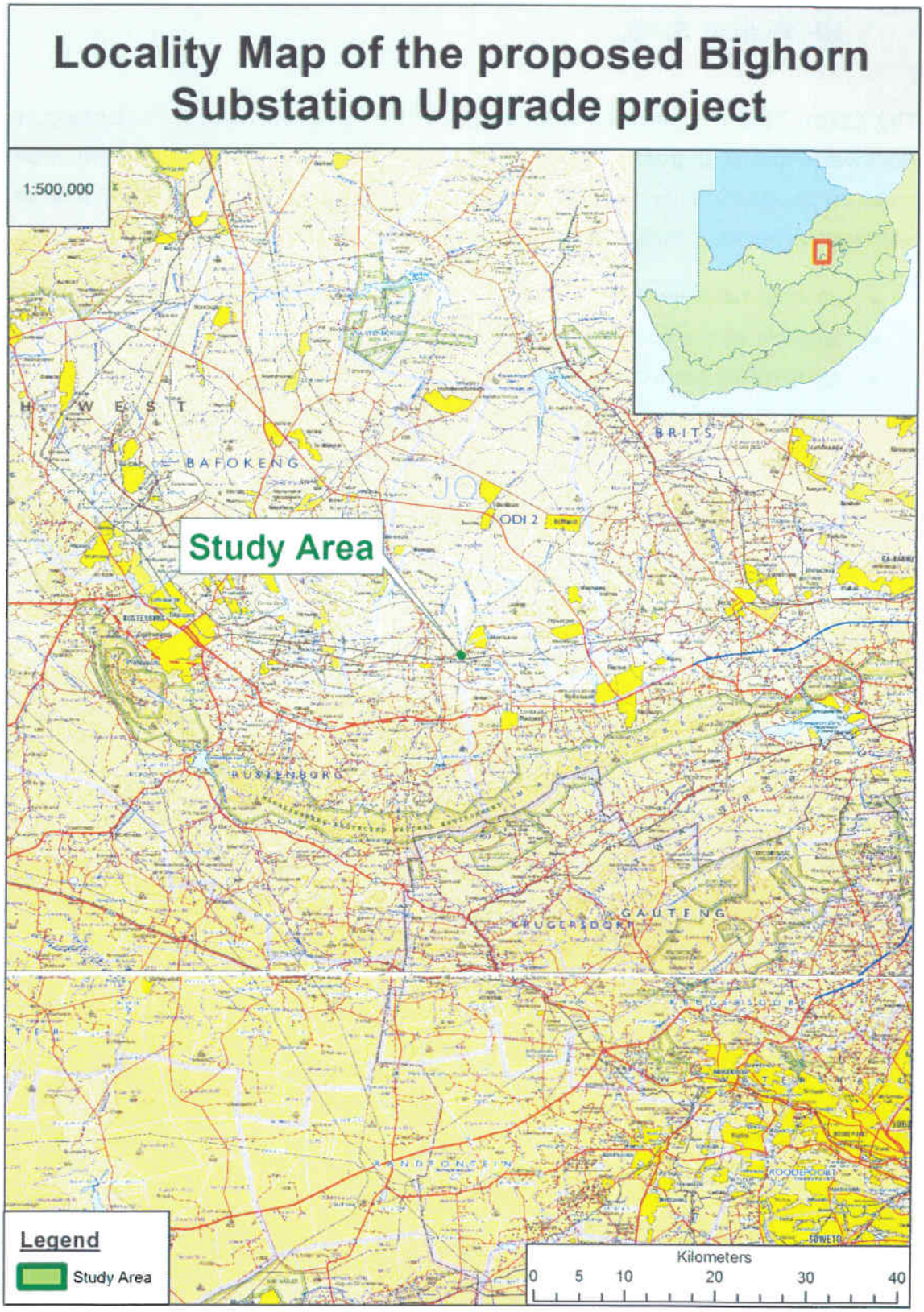

Figure 1: Locality map for the proposed Bighorn Substation Upgrade Project

6. IDENTIFICATION OF ASSUMPTIONS AND LIMITATIONS

It was assumed that the activities in the proposed new development area will be restricted to:

- Removal of vegetation;
- Traffic by construction vehicles that will only drive on access roads and site;
- Stripping and stockpiling of available topsoil for construction purposes.

7. LAND TYPE DATA ASSESSMENT

7.1 Background information

Land type data was developed by superimposing broad soil groups developed from the Binomial Soil Classification System (MacVicar et al., 1977) with maps of climate zone. This resulted in the land type maps that indicated land type boundaries with an inventory for each land type that include clay percentage as well as other information regarding the area that can be used to interpret soil classification results more successfully.

7.2 Land type results

One land type was identified on the proposed expansion site for the Bighorn Substation. This land type is Ea3. Land type Ea3 consists mainly of fairly deep, black, swelling clay (turf) soils, which have a moderate agricultural potential. The clay has mainly smectitic nature, with consequent shrinking and swelling properties. When swelling clay soils become wet, the pores fill up, they saturate easily and drain slowly, causing anaerobic conditions (especially under irrigation) and a deficit of oxygen in the root zone. The geology underlying this land type is norite, gabbro, pyroxenite and anorthosite of the Bushveld Complex.

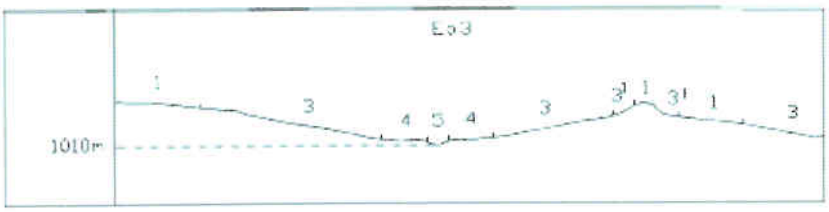

Figure 2: Terrain form sketch for Land Type Ae3

8. SOIL CLASSIFICATION

8.1 Survey method

A systematic soil survey was undertaken with sampling points between 50 and 100m apart on study area. Twelve survey points were observed in the study area (**Figure 4**). Observations were made regarding soil texture, structure, soil depth and slope of the area. The soils are described using the S.A. Soil Classification Taxonomic System (Soil Classification Working Group, 1991) published as memoirs on the Agricultural Natural Resources of South Africa No.15. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil.

Three soil samples were collected in this area (at Sample Points 1, 5 and 7), stored in perforated soil sampling plastic bags on site and sent per courier to Geolab for chemical soil analysis. Samples were analyzed for pH, phosphorus content, electrical conductivity, macro nutrients (calcium, magnesium, potassium, sodium) and density.

10.2 Soil classification

The total area assessed is 3.2 hectares (ha). Of this, 1.1 ha has already been covered with surface infrastructure such as concrete slabs, etc. The soils in these areas could not be surveyed and were classified as surface infrastructure. Of the remaining area, 0.8 ha has already been disturbed by human activities to such an extent that it can only be classified as an anthropogenic soil of the Witbank form. The soil layers have been disturbed by mechanical disturbance and a gravel component has been added to this. The undisturbed soil profiles in the remaining areas of 1.3 ha are characterised by deep vertic soils, dark in colour and with a high clay content making the soils prone to expansion and heave and creating difficult working conditions during the wet season. A more detailed description of the characteristics of these two soil forms follow after **Figure 3** below.

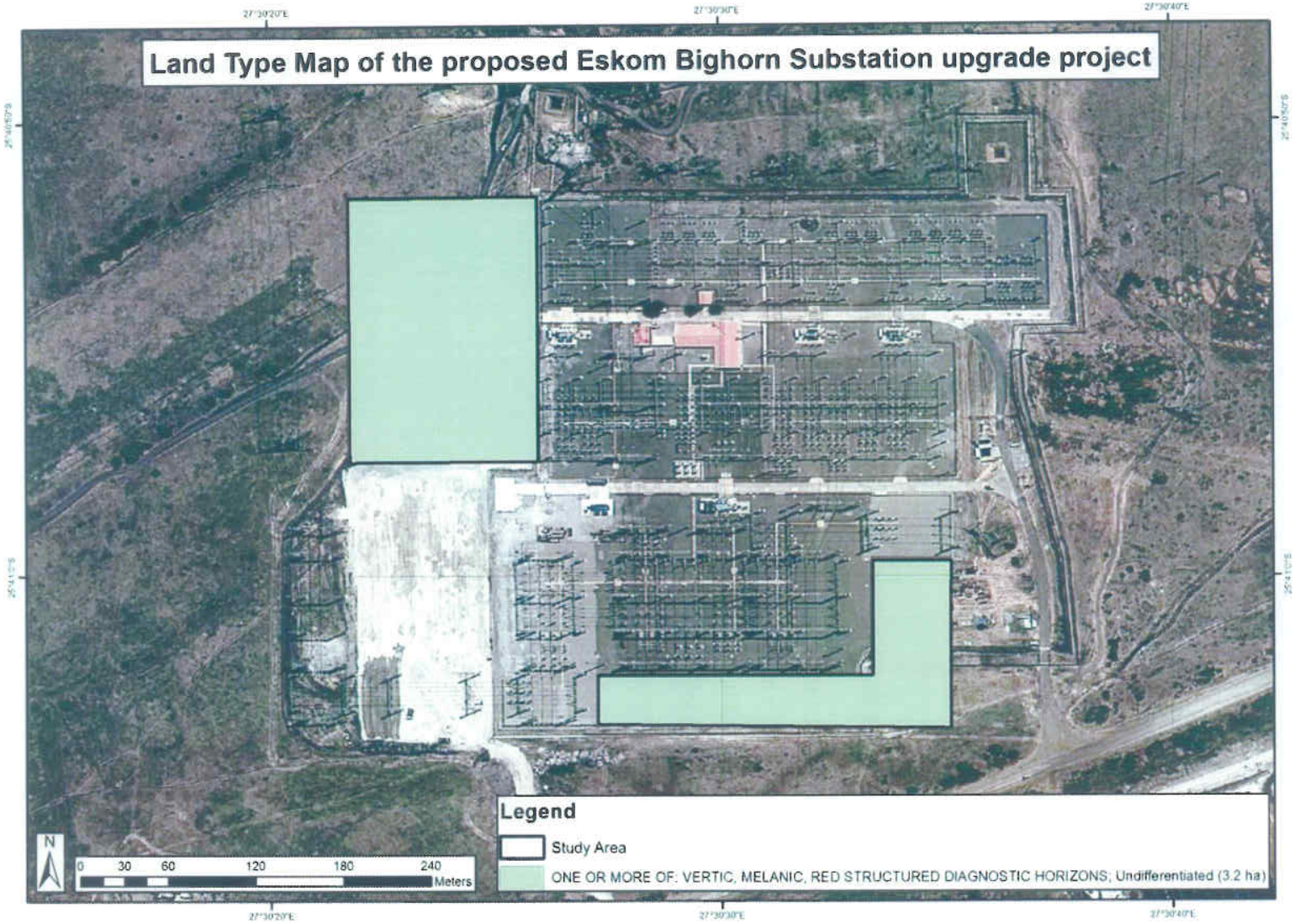

Figure 3: Land type map for the proposed Bighorn Substation Upgrade Project

Vertic soils of the Arcadia form (1.3 ha or 40.6% of the study area)

Vertic soils were found on 1.3 ha (40.6% of study area). These vertic soils have A-horizons that have both high clay content and a predominance of smectitic clay mineral possesses the capacity to swell and shrink markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

Swell-shrink potential is manifested typically by the formation of conspicuous vertical cracks in the dry state and the presence, at some depth, of slickensides (polished or grooved glide planes produced by internal movement). However, the presence of these planes is also a function of vertical thickness, being dependent on the total volume of the material which swells and shrinks.

Anthropogenic soils of the Witbank form (0.8 ha or 25% of the study area)

Soils with horizons that consist of man-made deposits are found on 5.3 ha or 2.4% of the study area. These soils are deposits of soil material, with or without rock or man-made materials that occur beneath an orthic A horizon or, if this is absent, at the soil surface. The presence of this soil form indicates previous soil disturbance, most likely due to construction activities. The soil surface has been covered by gravel.

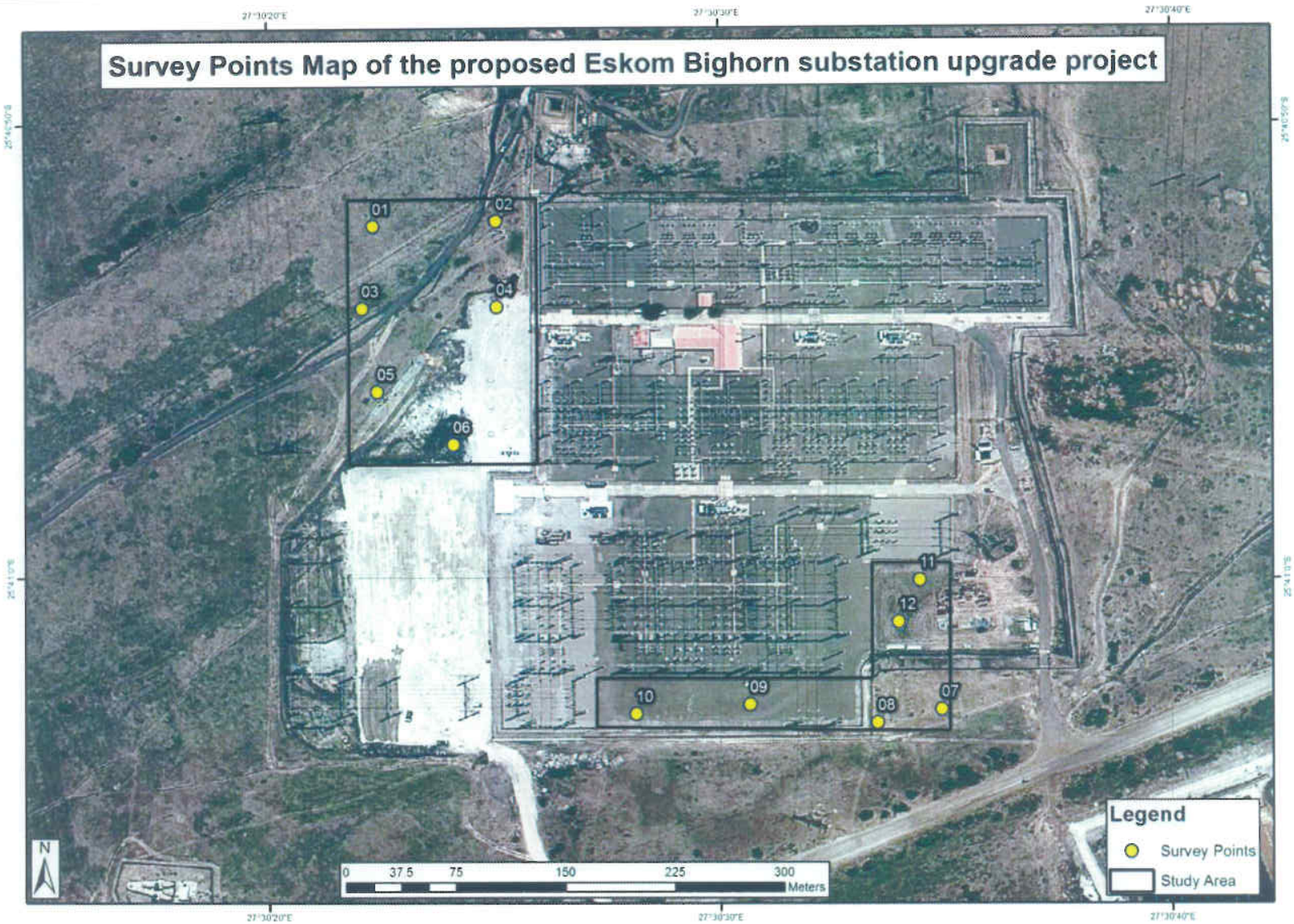

Figure 4: Survey points map for the proposed Eskom Bighorn Substation upgrade project

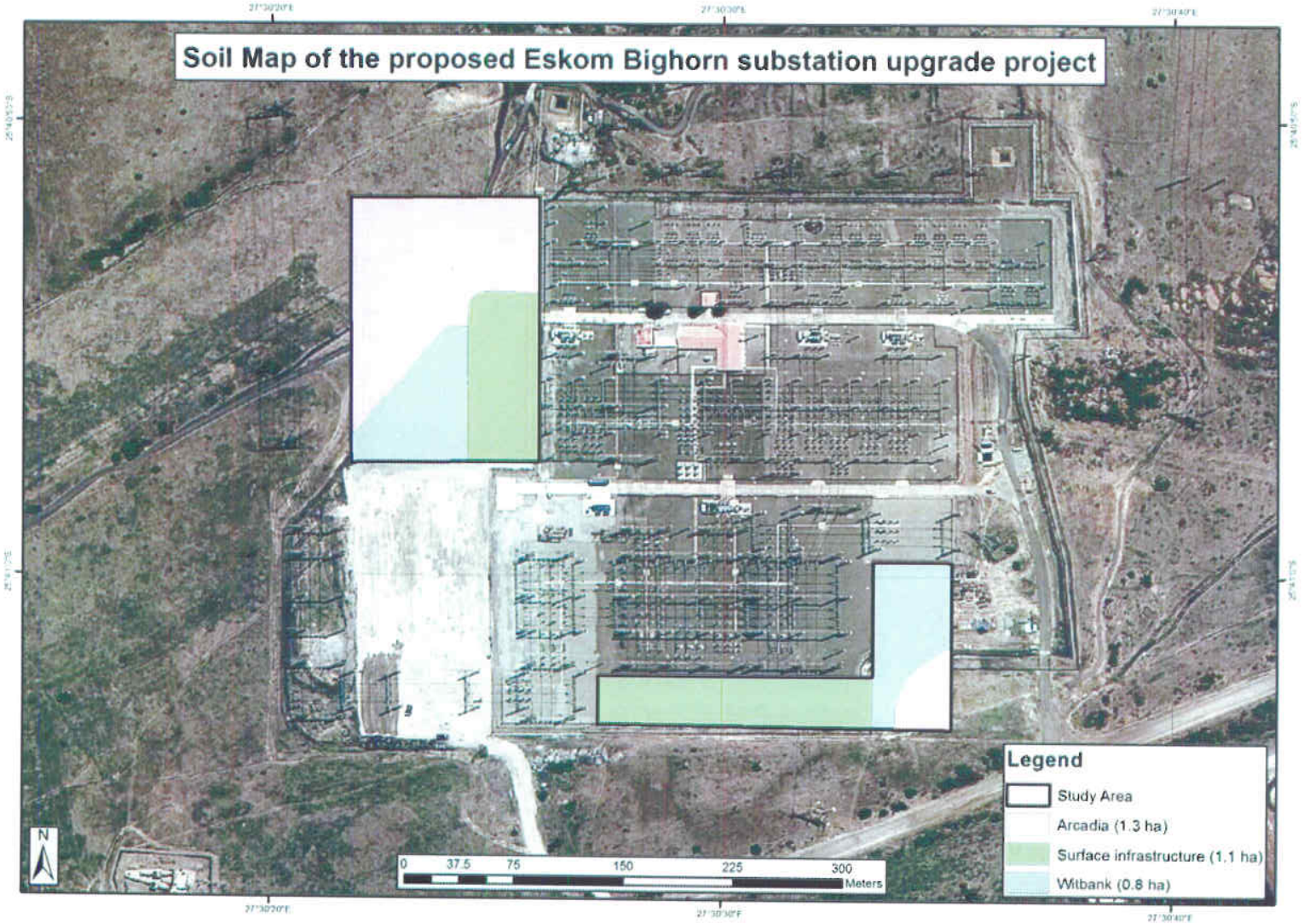

Figure 5: Soil map for the proposed Eskom Bighorn Substation upgrade project

10.3 Soil chemical characteristics and soil fertility

The chemical soil analysis of soil sampled from the survey site is discussed below. The points where the samples were taken is indicated as Points 1, 5 and 7 in Figure 4.

Table 1 – Chemical soil analyses results

Soil Sample	Sample 1	Sample 2	Sample 3
Laboratory Reference	90575	90576	90577
Survey Points Map Reference	1	5	7
Soil Map Reference	Ar	Ar	Ar
pH (KCl)	4.6	5.9	5.2
CEC at pH7	5.52	29.10	21.71
P (Bray 1) (mg/kg)	4	13	16
K (mg/kg)	276	383	132
Mg (mg/kg)	152	900	645
Ca (mg/kg)	697	4110	3199
Na (mg/kg)	11	44	22
Ca : Mg	2.8	2.8	3.0
(Ca+Mg)/K	6.7	28.5	63.0
K%	12.9	3.4	1.6
Mg%	22.7	25.4	24.3
Ca%	63.6	70.6	73.7
Density	1.441	1.203	1.287

The pH of the analysed topsoil samples varies in the study area ranges from 4,6 to 5,9. Therefore soils found on the site can be described as very strongly acid to medium acid. For successful crop production, a pH of between 5.8 and 7.5 is optimum and crops produced in these soils may suffer aluminium (Al) toxicities and P deficiencies. All three P levels is as low as expected from natural South African field conditions. The cation exchange capacity of two of the three samples is as high as expected of a vertic soil with high base saturation. The high calcium, magnesium and potassium levels of the samples are also within range for these vertic soils.

9. LAND CAPABILITY

9.1. Introduction and methodology

Land capability classes were determined using the guidelines outlined in Section 7 of The Chamber of Mines Handbook of Guidelines for Environmental Protection (Volume 3, 1981), a summary of which follows (Table 9). The Chamber of Mines pre-mining / pre-construction land capability system was utilised, given that this is the dominant capability class classification system utilized in the mining and industrial fields.

Table 2: Pre-Construction Land Capability Requirements

Criteria for Wetland	➢ Land with organic soils or ➢ A horizon that is gleyed throughout more than 50 % of its volume and is significantly thick, occurring within 750mm of the surface.
Criteria for Arable Land	➢ Land, which does not qualify as a wetland, ➢ The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm, ➢ The soil has a pH value of between 4,0 and 8.4, ➢ The soil has a low salinity and SAR, ➢ The soil has a permeability of at least 1,5-mm per hour in the upper 500-mm of soil ➢ The soil has less than 10 % (by volume) rocks or pedocrete fragments larger than 100-mm in diameter in the upper 750-mm, ➢ Has a slope (in %) and erodibility factor (K) such that their product is <2.0, ➢ Occurs under a climatic regime, which facilitates crop yields that are at least equal to the current national average for these crops, or is currently being irrigated successfully.
Criteria for Grazing Land	➢ Land, which does not qualify as wetland or arable land, ➢ Has soil, or soil-like material, permeable to roots of native plants, that is more than 250-mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100-mm, ➢ Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants, utilizable by domesticated livestock or game animals on a commercial basis.
Criteria for Wilderness Land	➢ Land, which does not qualify as wetland, arable land or grazing land.

9.2. Baseline land capability of the study area

Following the classification system above, the soil and land types identified in the baseline study area could be classified into two land capability classes (Figures 6) i.e. land with

grazing land capability (1.3 ha) where the Arcadia soil form and the gravel road occurs as well as land with industrial/wilderness land capability (1.9 ha). Both these land capability classes are suitable for extensive grazing purposes by cattle, goats and/or game species except areas where the soil surface has permanently been covered by concrete.

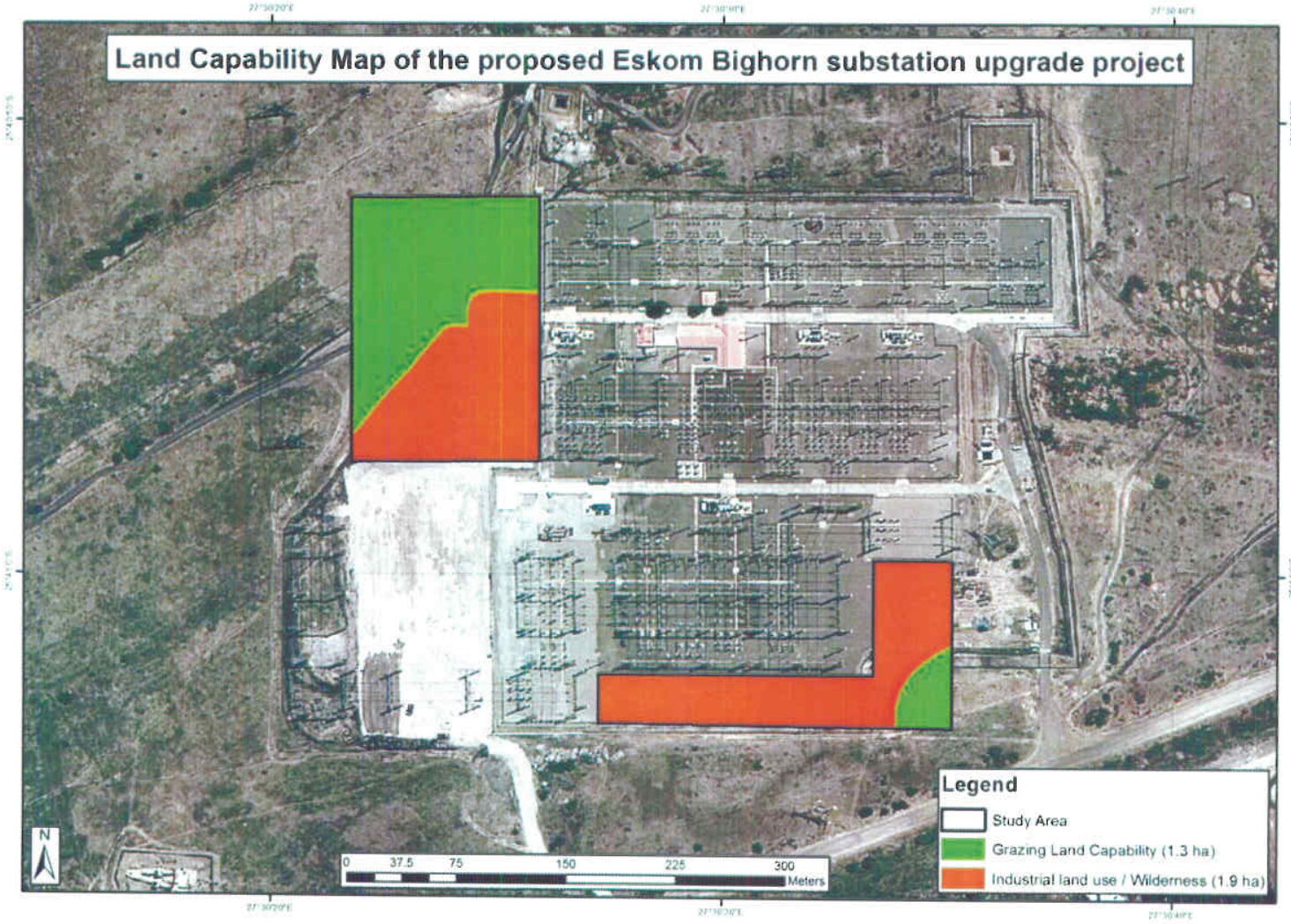

Figure 6: Land Capability Map of the proposed Eskom Bighorn substation upgrade project

10. CURRENT LAND USE ON THE PROPOSED SITE

The current land use on site is a combination of wilderness (where gravel is covering the soil surface) and industrial (where concrete slabs cover the soil surface) to grazing of the local community's goats where there is still vegetation on the undisturbed soil surfaces (**Figure 7**). No rainfed of irrigated crop production takes place on site.

11. SURROUNDING LAND USE AND ACTIVITIES

The study area is situated in an area where the main activity is platinum mining. Surrounding the area are informal settlements where the many of the mine workers reside. Many farms are fenced off with game fencing and these game farms are mainly used for tourism or hunting. Some farms in the area are still actively farming with citrus cultivars. The site is also close to the town of Marikana.

12. AGRICULTURAL POTENTIAL

Although the larger area has the potential for permanent and irrigated crop production under good management measures, the proposed site for the Bighorn Upgrade project is so small and already changed to an extent by previous anthropogenic activities that it does not contribute at all to food production in the region. The development of the 3.2 ha of land will have no negative impact on agricultural production in the region.

13. SOIL, LAND USE AND LAND CAPABILITY IMPACT ASSESSMENT

13.1 Soil impacts

13.1.1 Loss of fertile topsoil layer

Environmental significance:

The fertile layer of topsoil containing the seedbed for the natural vegetation will be stripped during pre-construction and construction phases. This will result in the loss of the soil carbon content. The effect of this will be localised within the site boundary but will have a long term effect that would stretch beyond closure of the project and will ultimately lead to the irretrievable commitment of this resource. The significance of this potential impact is considered to be medium. The measurable effect of the construction and operational phase on this resource and the likeliness of preventing or reducing the effect by utilizing mitigation measures are negligible.

Significance of implementation of mitigation measures:

The significance of mitigation to preserve the fertile layer of topsoil containing the seedbed for the natural vegetation will only be effective in areas where the rehabilitation can be done in a very short time after disturbance such as open areas where no buildings will be erected. Therefore the effect will be localised within the site boundary but will have a long term effect on the larger part of the area where the permanent structures will be erected and will still stretch beyond closure of the project thus total loss of topsoil cannot really be prevented through implementing mitigation. The significance of this potential impact, after mitigation, is considered to be medium.

13.1.2 Soil compaction

Environmental significance:

Soil compaction due to unnatural load in the area will change soil structure. Soil compaction will increase because of the increase in activity. The effect of this will largely be within the site boundary and will continue during the operational phase. If probable mitigating measures are not implemented the effect of the compaction will affect soil structure of soils on the site. The significance of this potential impact is considered to be medium.

Significance of implementation of mitigation measures:

The significance of suggested mitigation measures will only be moderate due to the nature and long-term duration of the project. The most effective mitigation will be the minimization of the construction footprint and by ensuring minimal infrastructure being built in the area the affect can be detained to a certain degree. Therefore the effect of compaction mitigation will be localised within the area and will only have an effect during the construction and operational years. The significance of this potential impact, after mitigation, is considered to be low to medium.

13.1.3 Soil erosion

Environmental significance:

Soil will be prone to erosion because the vegetation layer will be removed that prevent wind erosion and erosion by the impact of water flow. Erosion will be localised within the site boundary but will have a long term effect that would stretch beyond closure of the project and will ultimately lead to the irretrievable commitment of this resource. The measurable effect of reducing erosion by utilizing mitigation measures will be effective if implemented correctly. The significance of this potential impact is considered to be medium.

Significance of implementation of mitigation measures:

The application of the suggested mitigation measures to prevent erosion effectively will cause the effect of soil erosion to be localised within the site boundary and will therefore only have a low significant impact on the proposed sites.

13.1.4 Chemical soil pollution

Environmental significance:

The mixing and using of cement on site as well as other building-related chemicals such as paint and paint cleaners as well as the possible spillage of hydrocarbon products such as oil and fuel from vehicles on site can result in possible chemical soil pollution. The effect can stretch beyond the site boundaries and the significance of this potential impact is considered to be medium.

Significance of implementation of mitigation measures:

Soil pollution within and outside the site boundary can be prevented through mitigation the anticipated impact can be reduced from medium to low. The significance of this potential impact, after mitigation, is considered to be low.

13.1.5 Changes in natural soil profile (soil landscape)

Environmental significance:

The original soil landscape will be disturbed by earthworks, infrastructure, pipelines, roads, etc. The change in natural landscape will have a long term affect and will stretch beyond the decommissioning of the project. The significance of this potential impact is considered to be low.

Significance of implementation of mitigation measures:

By reducing the construction footprint the significance of the impact can be mitigated to be even lower. The significance of this potential impact, after mitigation, is considered to be very low.

13.2 Land use impacts

- A very small area currently used for communal grazing by goats will change to industrial. The area is so small that it is considered an insignificant impact.

13.3 Land capability impacts

- Although the land capability of 1.3 hectare of the site will change from grazing to industrial, it is so small that it is considered an insignificant impact.

13.4 Impact rating

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
		M	D	S	P	TOTAL	SP		M	D	S	P	TOTAL	SP
Issues related to SOILS, LAND USE and LAND CAPABILITY														
Construction Phase: Footprint Clearance														
Dilution of fertile topsoil component	Vegetation removal	1	5	8	4	56	M	Keep as much original land-cover as possible	1	5	6	4	48	M
Soil compaction	Movement of vehicles over soil surface	2	4	6	4	48	M	Keep infrastructure localized to reduce footprint	2	4	4	2	20	L
Construction Phase: Establishment of Infrastructure														
Loss of fertile topsoil layer	Construction of power station and associated infrastructure	1	5	8	4	56	M	Preserve as large a area as possible/strip if possible	1	5	6	4	48	M
Soil compaction	Construction of infrastructure	2	4	6	4	48	M	Keep infrastructure localized to reduce footprint	2	4	4	2	20	L
Soil erosion	Vegetation removal during construction and operations	1	5	8	4	56	M	Keep as much original land-cover as possible	1	3	4	2	16	L
Chemical soil pollution	Spillage and seepage of wastewater	2	4	8	4	56	M	Proper chemical waste management	1	3	4	2	16	L
Change in natural landscape	Ground clearance and waste disposal	1	5	6	2	24	L	Keep infrastructure to a minimum to reduce footprint	1	5	4	2	20	L
Operational Phase: Waste Generation and Handling of waste														
Chemical soil pollution	Spillage and seepage of wastewater	2	5	6	4	52	M	Proper chemical waste management	1	3	4	2	16	L
Closure & Decommissioning: NO DECOMMISSIONING ANTICIPATED														

13.5 Summary of soil management measures

The following mitigation measures are recommended:

- The construction footprint should be kept as small as possible. This mitigation measure should already be addressed during the pre-construction (design) phase.
- Stripping of topsoil should not be conducted earlier than required (maintain grass cover for as long as possible) in order to prevent the erosion (wind and water) of organic matter, clay and silt.
- When stripping machinery is used for stripping, stockpiling and 'topsoiling' operations, it should operate when the soil moisture content is below approximately 8 % (during the dry winter months) in order to limit soil compaction and machinery getting stuck.
- For use on site, tracked vehicles are more desirable than wheeled vehicles due to their lower point loading and slip, while vehicle speed should be maintained in order to reduce the duration of applied pressure, thereby minimizing compaction.
- The majority of stripped soils should be stockpiled as a berm upslope surrounding the disturbed area.
- Soil stockpiles must be sampled, ameliorated (fertilized) and re-vegetated as soon after construction as possible. This is in order to limit raindrop and wind energy, as well as to slow and trap runoff, thereby reducing soil erosion. Grassland and shrub species indigenous to the area are preferred, given both their hardy nature as well as their lower maintenance requirements.
- An intercept drain should be constructed upslope of the construction and operational areas, in order to re-direct clean water away from the area to avoid soil chemical pollution to clean groundwater resources.
- An intercept drain should possibly be constructed downslope of the construction and operational areas, in order to drain potentially polluted water into a pollution control dam.
- The soils stripped for levelling purposes must be stockpiled as a berm along the entire length of haul roads (upslope).
- Erosion control measures such as intercept drains and toe berms must be constructed where necessary.
- The width of the levelled or disturbed area for haul roads must be minimised as much as possible. Unnecessary dirt tracks (outside of the area to be disturbed) should not be formed during the construction of the haul road.
- Gravel roads must be well drained in order to limit soil erosion.

- The gravel haul road drainage system and surface must be well maintained in order to limit soil erosion.
- Provided that the drains and intercept drains are maintained and continue to redirect clean water away from the footprint area, and to convey any potentially polluted water to a potential pollution control dam, then soil pollution is not likely to be an issue.
- Routine monitoring will be required in and around the sites to prevent any additional impacts on the sites during the operational phase as far as possible.
- Wetting of the road surface is recommended, in order to limit the amount of dust fallout in the surrounding area.

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