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Terrestrial Ecosystems Assessment of proposed ash dump sites at Kusile Power Station

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REPORT

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Golder Associates

Executive Summary

Zitholele Consulting (Pty) Ltd appointed Golder Associates Africa (Pty) Ltd to undertake a terrestrial ecosystems assessment of the five proposed ash dump site alternatives and possible conveyor corridors at Kusile Power Station, in Mpumalanga Province, South Africa. This document presents the findings of the terrestrial ecosystems assessment.

The methodology used during the terrestrial ecosystems assessment consisted of three components, namely a literature review, field survey and impact assessment. The baseline characterisation of the study area identified seven vegetation communities, comprising three anthropogenically transformed units and four natural communities. The former category includes cultivated land, *Eragrostis* pastures and exotic woodlots. These units are highly disturbed and are of low ecological integrity and conservation importance.

The four natural communities include Dry mixed grassland, Moist grass and sedge community, *Acacia karroo – Acacia caffra* thickets and the Rocky scarp vegetation community. Although disturbances and degradation were noted in the natural communities at each of the proposed site alternatives, these areas provide important habitat for fauna and flora - a number of which are Red Data/protected species. Indeed, many natural areas in the study area form part of a larger habitat network linked to the Wilge River. The ecological importance of the Wilge River habitat network is recognised by the conservation plans of both Gauteng and Mpumalanga. The natural communities in the study area are thus of conservation importance and it is critical that their integrity be maintained.

Based on the nature and extent of natural vegetation communities at each site and in the proposed conveyor corridors, it was concluded that Site B and Site C will be the most negatively affected by habitat loss and fragmentation resulting from the proposed project. Accordingly, the Site A & F, Site A & G and Site F & G options are the preferred site alternatives from a terrestrial ecology perspective.

This notwithstanding, based on the findings of the combined assessments of all environmental studies associated with the project, and in conjunction with engineering and financial considerations and statements from the Department of Water Affairs, it was indicated that Site A and B should be carried forward and assessed as the preferred options.

The second part of the terrestrial ecosystems assessment therefore comprised a comparative assessment of Site A and B.

Comparative assessment of Site A and B

The terrestrial ecology comparative assessment of Site A and B noted that habitat loss and fragmentation will be the major negative environmental impacts associated with both proposed sites. The significance of these impacts however differs between Site A and B.

Site B has less natural habitat than Site A, but the conveyor corridor to Site B is substantially longer than the proposed conveyor corridor to Site A. The Site B conveyor corridor also traverses across a large stretch of important natural vegetation comprising numerous stream/wetlands and the Wilge River. The negative impacts of habitat fragmentation caused by the conveyor to Site B will thus be considerably greater than that for Site A, and are likely to severely reduce habitat connectivity, affecting fauna population dynamics in the area. The cumulative impacts associated with a Site B development also extend over a far larger area than those predicted for Site A. For these reasons, Site A is preferred over Site B as the location of the proposed 60 year ash dump.

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1.0 INTRODUCTION

Zitholele Consulting (Pty) Ltd appointed Golder Associates Africa (Pty) Ltd to undertake a terrestrial ecosystems assessment of the five proposed ash dump site alternatives and possible conveyor corridors at Kusile Power Station, in Mpumalanga Province, South Africa.

The study focused on describing the biodiversity and ecological characteristics of the proposed sites and associated conveyor corridors. These data were then used to inform an impact assessment of each site option, and to identify preferred sites from a terrestrial ecosystems perspective.

The preferred sites from a terrestrial ecosystem perspective were then considered as part of a broader multidisciplinary comparative analysis that took into account a suite of environmental studies, as well as engineering and financial considerations. Based on the outcomes of this comparative analysis, two preferred Sites (Site A & B) were put forward for a final comparative assessment.

This document presents the findings of the terrestrial ecosystems assessment.

2.0 OBJECTIVES

The objectives of the terrestrial ecosystems assessments are to:

- Present a description of the existing flora and fauna characteristics of each proposed site and the associated conveyor corridors (hereafter, collectively referred to as the study area);
- Identify species of conservation importance that occur, or potentially occur, in the study area;
- Confirm the presence of sensitive or important habitats, such ridges and natural wetlands;
- Identify and assess potential impacts of the proposed project, on flora, fauna and general habitat integrity and functioning at each site, but specifically the final preferred site/s; and
- Provide management recommendations to mitigate possible negative impacts at the preferred site.

3.0 METHODOLOGY

The methodology used during the terrestrial ecosystems assessment consists of three components, namely a literature review, field survey and impact assessment. These are briefly summarised below:

- Literature review – A literature review of existing reports, scientific studies, databases, reference works, guidelines and legislation relevant to the study area was conducted to establish a historical baseline condition of the site's ecology. Species lists of potential flora and fauna occurring in the study area, with specific emphasis on Red Data and protected species were also compiled (Refer to APPENDIX A for detailed methodology);
- Field survey – The field survey aimed at determining the general ecological characteristics and flora and fauna composition of the study area. Based on satellite imagery, vegetation communities within the study area were delineated. These vegetation communities were then sampled, by means of line and belt transects for flora. Fauna were sampled at specific sampling sites, by means of traps, spot counts, active searches and observations of their presence (burrows, faeces, tracks etc.). Based on the findings of the field survey, the ecological integrity, suitability as habitat for Red data and protected species and conservation importance of each vegetation community was determined (Refer to APPENDIX A for detailed methodology); and
- Impact assessment – With reference to the findings of the literature review and field survey, potential negative environmental impacts associated at each proposed site alternative were identified and assessed for significance. Based on this assessment, and after a broader multidisciplinary comparative analysis, a preferred site was selected and a suite of mitigation measures were recommended for inclusion into the project's environmental management programme (EMP) (refer to Section 5.0 for detailed impact assessment methodology).

Applicable legislation

The following national and provincial legislation were consulted during the terrestrial ecosystems assessment:

- The Constitution Act (No. 108 of 1996) – Section 24;
- National Environmental Management Act (No. 107 of 1998) (NEMA);
- National Environmental Management: Biodiversity Act (No. 10 of 2004) (NEMBA);
- Environmental Conservation Act (CARA) (No. 73 of 1989);
- Mpumalanga Nature Conservation Act (No. 10 of 1998); and
- National Forests Act (No. 84 of 1998).

4.0 ECOLOGICAL BASELINE CONDITIONS

4.1 Site Location

Kusile Power Station is located between the N4 and N12 national roads in the Nkangala District of Mpumalanga. Nearby towns include Bronkhorstspruit and eMalahleni, which are situated 22 km west and 25 km east of Kusile respectively (Figure 1).

The study area comprises five proposed site alternatives, each varying between 1500 ha and 2000 ha in extent and possible conveyor corridors, all located within a 15km radius of the Kusile Power Station.

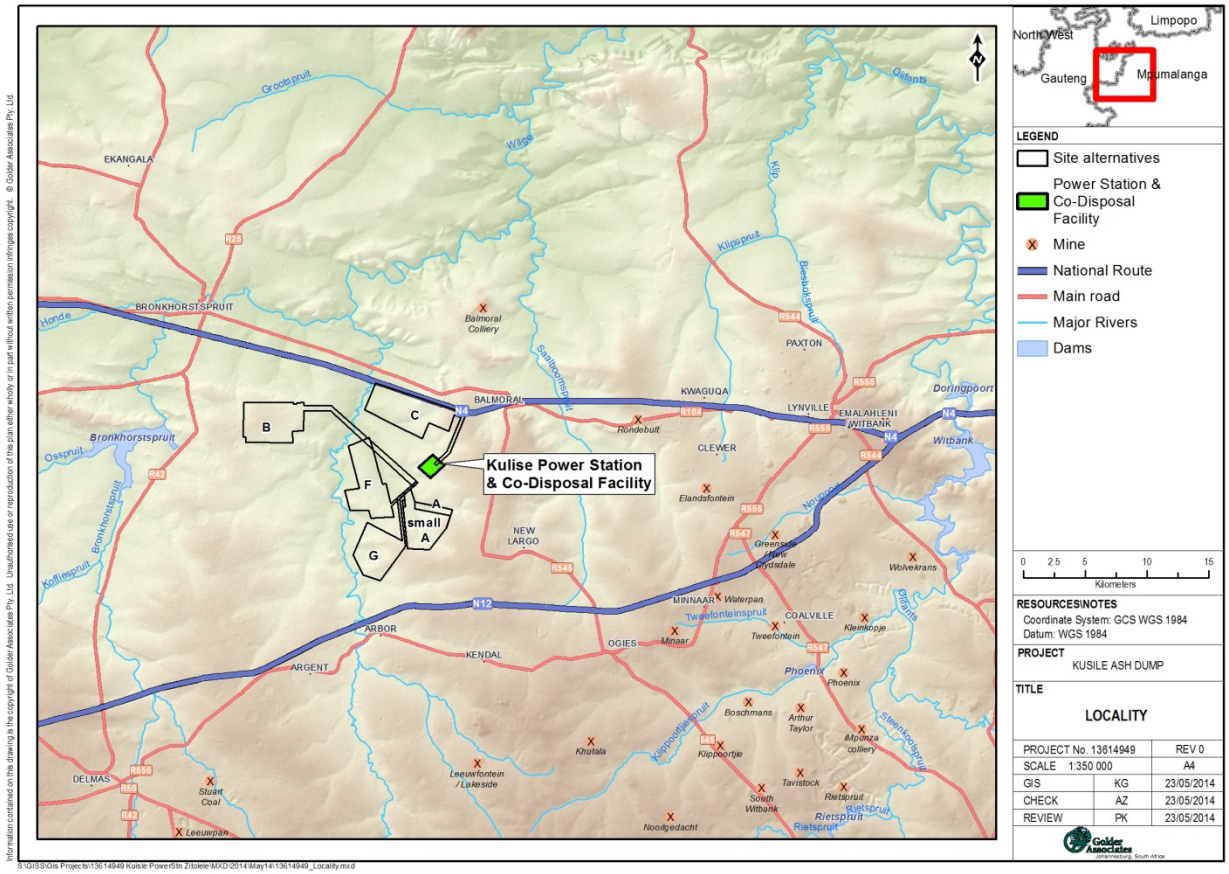

Figure 1: Regional location of the proposed ash dump sites at Kusile Power Station, Mpumalanga Province

4.2 General Biophysical Environment

The study area is located in the Eastern Highveld Grassland and Rand Highveld Grassland vegetation types of the grassland biome (Mucina & Rutherford, 2006) (Figure 2). The associated environmental characteristics of the grassland biome in general and Eastern Highveld Grassland and Rand Highveld Grassland are discussed below:

4.2.1 Grassland biome

The grassland biome covers approximately 28% of South Africa and is the dominant biome on the central plateau and inland areas of the eastern subcontinent (Manning, 2009). Grasslands are typically situated in moist, summer rainfall regions, which experience between 400 mm and 2000 mm of rainfall per year. Vegetation consists of a dominant ground layer comprising grass and herbaceous perennials with little- to no woody plant species present. According to Tainton (1999) the study area falls within 'fire climax grassland of potential savanna'. As this description suggests, these areas would probably succeed to savanna (co-dominance of woody and grass species) but are maintained in a grassland state by frequent fire.

4.2.2 Eastern Highveld Grassland

A broad band of Eastern Highveld Grassland extends to the south of Rand Highveld Grassland from Johannesburg in the east through to Bethel, Ermelo and Piet Retief in the west. This vegetation is dominated by elements of Acocks's (1953) Bakenveld and the North-Eastern Sandy Highveld and Moist Sand Highveld Grassland of Low & Robelo's (1996). Approximately 1 214 467 ha of Mpumalanga was originally covered by Eastern Highveld Grassland (Ferrar & Lötter 2007). The following notes sourced from Mucina & Rutherford (2006) summarise the characteristics of this vegetation type:

Vegetation and Landscape features

Eastern Highveld Grassland found on slightly to moderately undulating plains, low hills and wetland depressions. Grasses are typical Highveld species from the genera *Aristida*, Digitaria, *Eragrostis,* and *Tristachya*. Woody species are commonly found in rocky areas and include *Acacia caffra, Celtis africana, Protea caffra, Protea welwitschii, Diospyros lycioides* and *Rhus magalismontana* (Mucina & Rutherford, 2006).

Important Plant Taxa

Based on Mucina & Rutherford's (2006) vegetation classification, important plant taxa are those species that have a high abundance, a frequent occurrence (not being particularly abundant) or are prominent in the landscape within a particular vegetation type. They note the following species are important taxa in the Eastern Highveld Grassland vegetation type:

Shrubs: *Anthospermum rigidum* and *Stoebe plumosa.*

Graminiodes: *Aristida aequiglumis, Aristida congesta, Aristida junciformis, Cynodon dactylon, Digitaria monodactyla, Eragrostis chloromelas, Eragrostis curvula, Eragrostis plana, Eragrostis racemosa, Heteropogon contortus, Loudetia simplex, Setaria sphacelata, Sporobolus africanus, Themeda triandra, Alloteropsis semialata* and *Monocymbium ceresiiforme, inter alia.*

Herbs: *Berkheya setifera, Haplocarpha scaposa, Euryops gilfillanii, Euryops transvaalensis, Justicia anagalloides, Acalypha angusta, Chamaecrista mimosoides, Dicoma anomala, Kohautia amatymbica, Lactuca inermis, Gladiolus crassifolius, Haemanthus humilis* and *Selago densiflora.*

Endemic Taxon: The geophytic herbs *Agapanthus inapertus*, *Eucomis vandermerwei* and the succulent herb *Huernia insigniflora* are endemic to this region.

Conservation

Mucina & Rutherford (2006) classify Eastern Highveld Grassland at a regional scale as Endangered. According to Ferrar & Lötter (2007) within Mpumalanga this vegetation type has an ecological status of Endangered-high. Only a small fraction is currently conserved in statutory reserves such as Nooitgedacht Dam and Jericho Dam Nature Reserves. Approximately 44% of the Eastern Highveld Grassland has already

been transformed by cultivation, plantations, mines and urbanisation. Erosion of this vegetation type is low. (Mucina & Rutherford, 2006).

4.2.3 Rand Highveld Grassland

Rand Highveld Grassland extends in an east-west band from Stoffberg in Mpumalanga to the outskirts of Pretoria in Gauteng. This vegetation is dominated by elements of Acocks's (1953) Bakenveld and Low & Robelo's (1996) Rocky Highveld Grassland and Moist Sandy Highveld Grassland. According to Ferrar & Lötter (2007) this vegetation type originally covered 589 365 ha of Mpumalanga Province.

Vegetation and Landscape features

Rand Highveld Grassland is a highly variable landscape comprising elevated slopes and ridges and undulating grass plains. Vegetation ranges from species-rich sour grassland to sour shrub-land. Common taxa include grass species from the genera *Themeda, Eragrostis, Heteropogon* and *Elionurus* and herbs belonging to *Asteraceae*. Rocky areas are dominated by open woodlands of *Protea caffra, Protea welwitschii*, *Acacia caffra, Celtis africana* and *Searsia magalismontana* (Mucina & Rutherford, 2006).

Important Plant Taxa

Important taxa in the Rand Highveld Grassland vegetation type include:

Shrubs: *Anthospermum rigidum, Indigofera comosa, Rhus magalismontana* and *Stoebe plumose.*

Graminiodes: *Ctenium concinnum, Cynodon dactylon, Digitaria monodactyla, Diheteropogon amplectens, Eragrostis chloromelas, Heteropogon contortus, Loudetia simplex, Themeda triandra, Aristida aequiglumis, Aristida congesta* and *Monocymbium ceresiiforme, inter alia.*

Herbs: *Acanthospermum australe, Justicia anagalloides*, *Acalypha angusta, Chaemecrista mimosoides, Dicoma anomala, Kohautia amatymbica, Lactuca inermis* and *Selago densiflora.*

Endemic Taxon: The geophytic herbs *Agapanthus inapertus*, *Eucomis vandermaerwei* and the succulent herb *Huernia insigniflora* are endemic to this region.

Conservation

Based on Mucina & Rutherford (2006), regionally Rand Highveld Grassland is classified as Endangered. Within Mpumalanga, Ferrar & Lötter (2007) categorise Rand Highveld Grassland as having an ecological status of Endangered-low.

Although the target for conservation is 24%, only 1% of this vegetation type is currently under statutory conservation in reserves such as Kwaggavoetpad, Van Riebeck Park and Boskop Dam Nature Reserves. Cultivation, plantations and urbanisation have resulted in the transformation of large parts of Rand Highveld Grassland. Exotic invasive plants, particularly *Acacia mearnsii* are present. Only about 7% of this vegetation type has been subject to moderate to high erosion (Mucina & Rutherford, 2006).

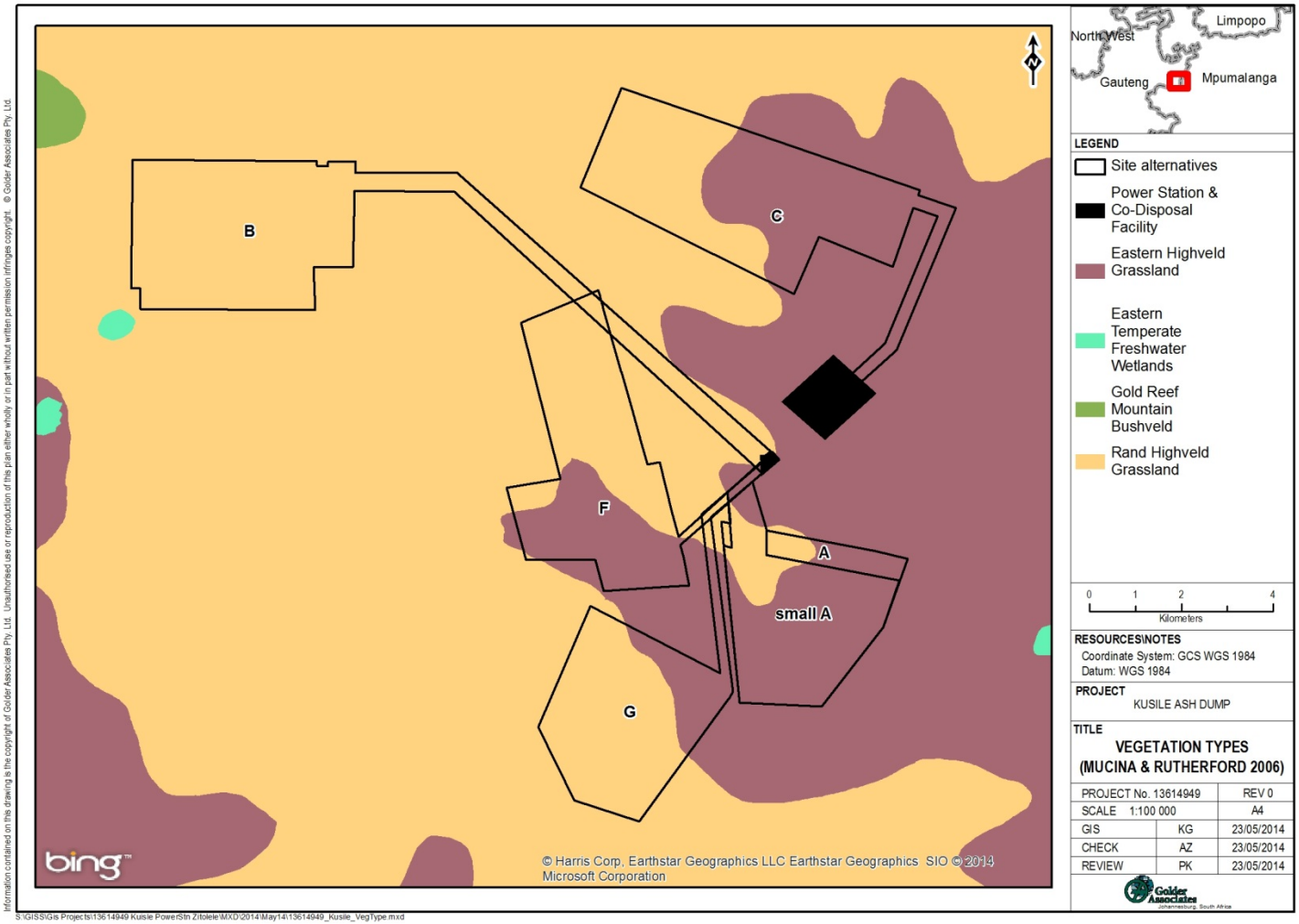

Figure 2: Location of site alternatives in relation to the regional vegetation types as described by Mucina & Rutherford (2006)

4.3 Provincial Conservation Plans

The study area straddles the Gauteng and Mpumalanga provincial boundary and therefore both the Gauteng Conservation Plan and the Mpumalanga Biodiversity Sector Plan are relevant.

4.3.1 Mpumalanga Biodiversity Sector Plan

According to the Mpumalanga Biodiversity Sector Plan (MBSP) (2013) the study area consists of four of the province's biodiversity categories. These are listed and summarised in Table 1 and their distribution shown in Figure 3.

Table 1: Categories of the Mpumalanga Biodiversity Sector Plan (2013).

Category	Description and Motivation
Modified	Modified areas are those that have undergone a significant and often irreparable degree of transformation that has led to a near-complete loss of biodiversity and ecological functioning. Common agents of modification include mining, arable agriculture and infrastructure development.
Modified – Old lands	This sub-category of Modified relates to areas that have been altered by cultivation and other activities within the last 80 years and subsequently abandoned. The biodiversity and ecological functioning in such areas is compromised but may still play a role in the provision of ecosystem services.
Other natural areas	These are areas that have not been selected to meet biodiversity conservation targets, yet they are likely to provide habitat for flora and fauna species and a range of ecosystem services.
Critical Biodiversity Area (CBA) - Optimal	CBA – Optimal are areas selected to optimally meet biodiversity targets. Although these areas have a lower irreplaceability value than the CBA – Irreplaceable category, collectively they reflect the smallest area required to meet biodiversity conservation targets.
Critical Biodiversity Area (CBA) - Irreplaceable	CBA – Irreplaceable are critical areas required to meet biodiversity targets and ensure the persistence of species and continued ecosystem functioning. These areas typically have threatened species present or have high habitat connectivity.

4.3.2 Gauteng Conservation Plan

According to the Gauteng Conservation Plan (C-Plan) (Version 3.3, 2011) at a provincial level the Wilge River and associated tributaries, as well as various other natural areas in the Gauteng portion of the study area are designated as Irreplaceable, Important, or Ecological support areas – see Figure 3.

Areas designated as either Irreplaceable or Important are categorised as such based on the presence of one or a combination of Red Data plant habitat, Red Data fauna habitat, primary vegetation and/ or they are form part of a quaternary catchment. As the name suggests, sites delineated as Ecological support areas may not possess features of conservation concern themselves, but these areas are often adjacent to Irreplaceable or Important sites and are thus essential in maintaining the integrity and ecological processes of these important sites.

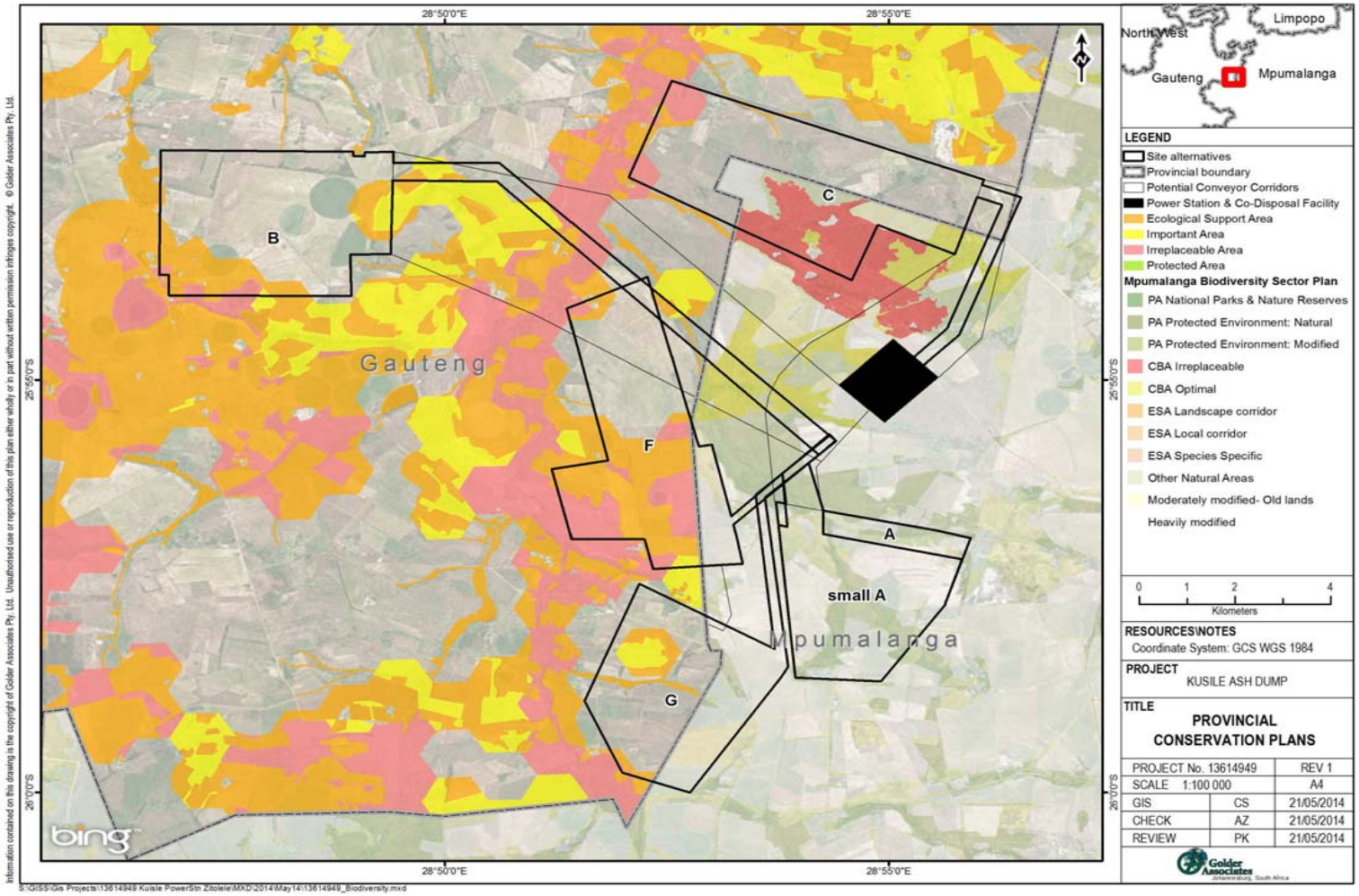

Figure 3: Site alternatives in relation to the Gauteng C-plan and the Mpumalanga Biodiversity Sector Plan.

4.4 Flora Assessment

4.4.1 Surrounding landscape matrix

The landscape matrix surrounding the study area is highly variable. The most dominate land uses are agriculture and livestock farming and consequently much of the surrounding land comprises either cultivated fields (mainly maize production) or natural/semi-natural grassland used to graze cattle.

Grassland habitats have varying levels of disturbance. Some areas are heavily degraded as a result of *inter alia*, erosion, artificial pasture maintenance, overgrazing and/or encroachment by exotic invasive species. Other natural areas, mostly associated with drainage features (wetlands & streams) and rocky soils, are in good ecological condition with low levels of disturbance.

Various anthropogenic developments and infrastructure are also present in the surrounding landscape and contribute to the overall levels of disturbance. These include *inter alia*, the Kusile Power Station, mining operations, roads (both gravel and tarred roads), farm fences, artificial dams, agricultural infrastructure (barns) and farms homesteads.

4.4.2 Study area characteristics

Seven vegetation communities, comprising three anthropogenic units and four natural communities were recognised in the study area during the 2013 field survey. These were recognised based on species composition, physiognomy, moisture regime, slope and disturbance characteristics. These include:

- Cultivated land (current and former);
- *Eragrostis* pastures;
- Exotic woodlots;
- Dry mixed grassland;
- Moist grass and sedge community;
- *Acacia karroo – Acacia caffra* thickets; and
- Rocky scarp vegetation community.

Although recorded as such, there is considerable variation within the natural communities as a result of current and historic anthropogenic disturbance and various natural influences. Transformed sites associated with anthropogenic developments (farmsteads, etc.) were noted, but were subject to no further investigation.

The characteristics of the seven vegetation communities are detailed in Sections 4.4.2.1 to 4.4.2.2. Table 2 reflects the approximate hectares of each vegetation community present in each of the site alternatives.

Refer to APPENDIX A for a list of flora species recorded in the study area during the 2013 field survey and a list of potential flora species according to the PRECIS database.

Table 2: Approximate area of the vegetation communities at site alternatives in the study area

Vegetation community	Approximate area (ha)				
	Site A	Site B	Site C	Site F	Site G
Cultivated land (current and former)	882	968	39	750	1175
Eragrostis pastures	0	194	55	117	0
Exotic woodlots	3	48	38	12	7
Dry mixed grassland	339	93	1300	326	323

Vegetation community	Approximate area (ha)				
	Site A	Site B	Site C	Site F	Site G
Moist grass and sedge community	253	24	48	24	167
Acacia karroo – Acacia caffra thickets	0	0	25	0	23
Rocky scarp vegetation community	0	0	22	71	165

4.4.2.1 Cultivated land (current and former)

Large portions of the study area comprise agriculture fields that are either in current use or left fallow. Currently cultivated lands are typically under maize (*Zea mays*) and potato (*Solanum tuberosum*) production and have no indigenous vegetation remaining. Lands that have been left fallow are heavily degraded and are dominated by ruderal, exotic species such as *Bidens pilosa, Campuloclinium macrocephalum, Conyza* species*, Cosmos bipinnata, Datura stramonium, Pseudognaphalium luteo-album, Tagetes minuta, Verbena bonariensis* and *Solanum sisymbriifolium*.

Sensitivity Aspects

These areas are either completely transformed with no natural habitat remaining or are highly degraded. Accordingly, areas of cultivated land, whether they are under current cultivation or not, are considered to have low ecological integrity. No endemic, Red Data or protected species were recorded in the cultivated lands and the probability of such species occurring in this vegetation community is considered low. As a result, the conservation importance of cultivated land is considered low (refer to Figure 12 and Figure 13).

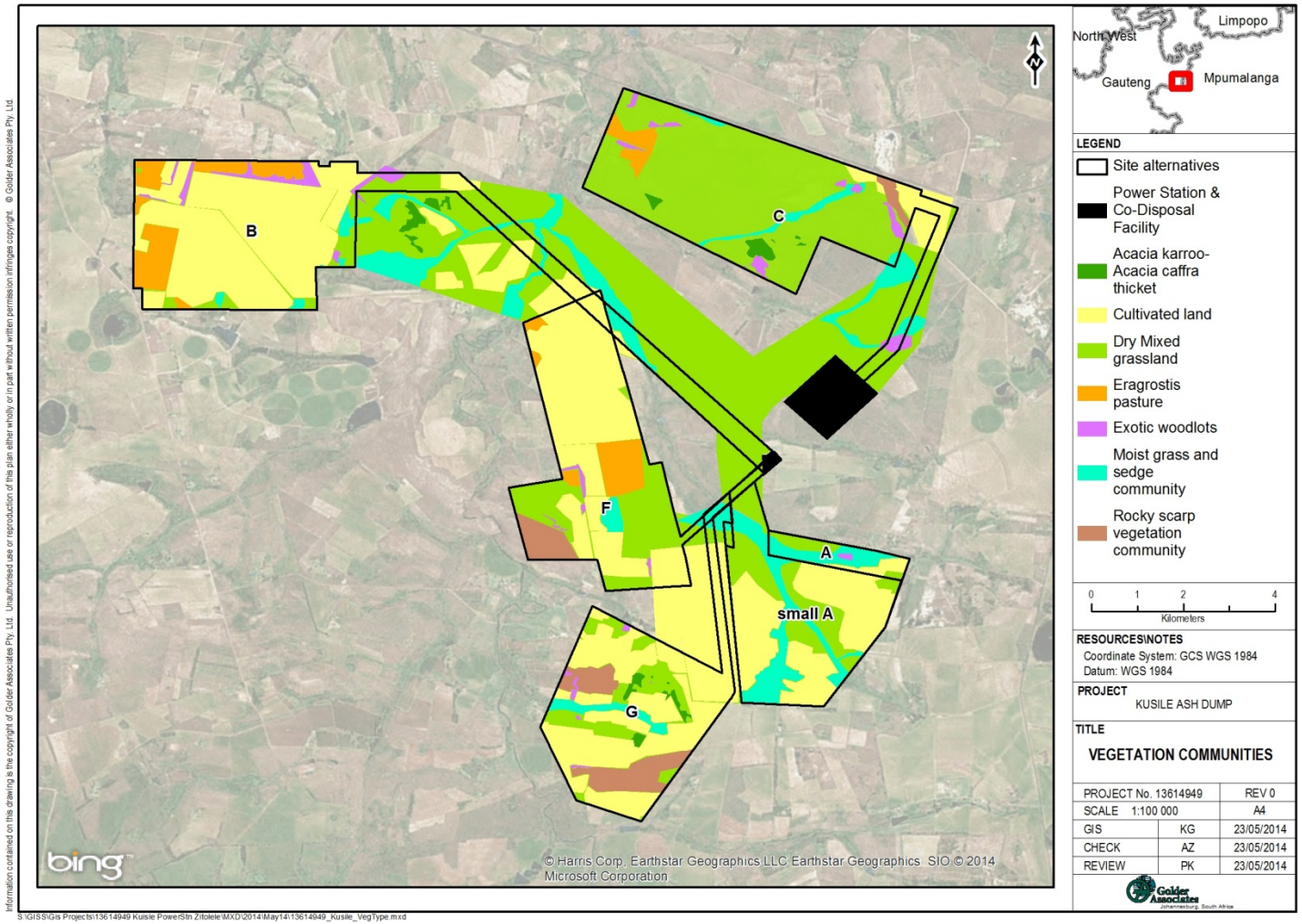

Figure 4: Vegetation communities identified in the study area

4.4.2.2 Exotic woodlots

Exotic woodlots are found in isolated patches throughout the study area. These areas are depauperate of indigenous vegetation and are dominated by the exotic trees, most typically *Eucalyptus* species, *Acacia baileyana, Acacia mearnsii* and *Populus x canescens* (Figure 5). Species present in the herbaceous layer include grasses such as *Hyparrhenia hirta*, *Sporobolus africana* and the exotic forbs *Bidens pilosa, Verbena bonariensis, Conyza bonariensis* and *Taraxacum officinale*.

In most instances it is likely that these woodlots have anthropogenic origins and are maintained as a ready supply of fuel wood by land users in the area. Although almost completely dominated by exotic, often invasive plant species, these woodlots contribute, albeit artificially, to the area's natural heterogeneity and provide roosting and nesting habitat for a variety of bird species. Indeed, Allan et al. (1997) note that anecdotal evidence suggests that grassland bird communities are often replaced by woodland bird assemblages in areas invaded by exotic plantations. This notwithstanding, these areas are disturbed and in the absence of fire, will encroach into adjacent wetland and grassland areas reducing biodiversity and ecological integrity of these communities.

Sensitivity aspects

This vegetation community is regarded as a highly disturbed, exotic vegetation community, with low floristic diversity and low ecological integrity. Furthermore the probability of endemic, Red Data or protected species occurring in this community is considered low. As such, the conservation importance of the Exotic woodlots is considered low (refer to Figure 12 and Figure 13).

Figure 5: Exotic woodlot, in this instance dominated by Acacia mearnsii

4.4.2.3 Eragrostis pastures

Eragrostis pastures are found at all site alternatives in the study area. These areas are actively managed for livestock production and are anthropogenically seeded, fertilised and often baled, to provide dry season forage for cattle. As a result of their anthropogenic origins and continued management *Eragrostis* pastures have low flora species richness. *Eragrostis curvula* is the dominant grass in most pastures, while less abundant species include *Eragrostis plana, Eragrostis racemosa* and *Eragrostis chloromelas.* Pastures seeded with *Digitaria eriantha* were also recorded and for parsimony are grouped under the *Eragrostis* pasture vegetation community (Figure 6).

Herbs recorded in this community are typically pioneer species such as *Bidens pilosa, Cirsium vulgare, Conyza species, Datura ferox, Helichrysum rugulosum, Hypochaeris radicata, Plantago lanceolata, Richardia brasiliensis, Taraxacum officinale, Tagetes minuta, Verbena bonariensis* and *Walafrida densiflora.*

Figure 6: Eragrostis pastures

Sensitivity Aspects

This vegetation community is artificial and subject to active management, which includes mowing and the application of fertiliser. Such areas have low floristic diversity and similarly low ecological integrity. Furthermore, the probability of endemic, Red Data or protected species occurring in this community is considered low. As such, the conservation importance of the *Eragrostis* pastures is considered low (refer to Figure 12 and Figure 13).

4.4.2.4 Dry mixed grassland

Areas comprising Dry mixed grassland are typically used for livestock production and are often associated with the edges of wetlands or where shallow, rocky soils preclude ploughing and cultivation. Where not disturbed, these areas typically have high flora species richness and are important wildlife habitat (Figure 7).

Common grass species include *Andropogon gayanus, Aristida congesta, Aristida congesta* subsp. *barbicollis, Bewsia biflora, Brachiaria serrata, Cymbopogon excavatus, Cynodon dactylon, Digitaria eriantha, Diheteropogon amplectens, Harpochloa falx, Heteropogon contortus, Eragrostis racemosa, Eragrostis chloromelas, Eragrostis curvula, Eragrostis gummiflua, Eragrostis superba, Elionurus muticus, Harpochloa falx, Hyparrhenia hirta, Melinis repens, Panicum natalense, Paspalum dilatatum, Paspalum notatum, Perotis patens, Setaria sphacelata, Sporobolus africana, Themeda triandra, Trachypogon spicatus* and *Tristachya leucothrix.*

Common herbs and shrubs include *Berkheya setifera, Berkheya radula, Boophane disticha, Chamaecrista comosa, Commelina africana, Crassula species, Cyperus sphaerocephalus, Dicoma zeyheri, Geigeria burkei, Gerbera ambigua, Gladiolus elliotii, Haplocarpha scaposa, Helichrysum aureonitens, Helichrysum pilosellum, Helichrysum nudifolium, Helichrysum rugulosum, Hypochaeris radicata, Hypoxis angustifolia, Hypoxis iridifolia, Ipomoea bathycolpos, Ipomoea crassipes, Ledebouria species, Lobelia erinus, Moraea elliotii, Oldenlandia larbacea, Pollichia campestris, Richardia brasiliensis, Scabiosa columbaria, Senecio inaequidens, Senecio harveianus, Senecio gregatus, Seriphium plumosum, Solanum sisymbriifolium, Thunbergia atriplicifolia, Tephrosia rhodesica, Thesium utile* and *Vernonia natalense.*

Figure 7: Dry mixed grassland

Woody species in the Dry mixed grassland vegetation community are rare and confined to scattered individual trees/shrubs occurring near natural thickets or exotic woodlots. Woody species recorded include *Acacia karroo*, *Acacia caffra* and *Rhus pyroides*, as well as the exotics *Acacia mearnsii, Acacia baileyana and Eucalyptus* species.

Large areas of Dry mixed grassland have been disturbed by historic and/or current anthropogenic activities such as overgrazing, frequent fires and cultivation. These areas have low flora species richness and are typically dominated by *Hyparrhenia hirta* – a tall robust grass (Figure 8).

Figure 8: Disturbed area of Dry mixed grassland dominated by Hyparrhenia hirta

Sensitivity Aspects

Although many areas comprising Dry mixed Grassland are negatively impacted by overgrazing, within the context of the broader landscape matrix, this vegetation community provides valuable and important natural grassland habitat. The ecological integrity of this vegetation community ranges from medium in disturbed areas (dominated by *Hyparrhenia hirta)* to high in less disturbed areas.

Two protected flora species (*Boophane disticha* and *Hypoxis* species) were recorded in the Dry mixed grassland during the 2013 field survey and the suitability of this vegetation community as habitat for other Red Data and/or protected species is considered high. Accordingly, the conservation importance of areas of this vegetation community is also high (refer to Figure 12 and Figure 13).

4.4.2.5 Moist grass and sedge community

Areas comprising the moist grass and sedge community occur in streams and seep zones, and around pans and artificial dams in the study area (see Figure 9). This vegetation community is characterised by typical wetland grass species such *as Agrostis eriantha, Agrostis lachnantha, Andropogon eucomus, Andropogon huilensis, Aristida junciformis, Arundinella nepalensis, Ctenium concinnum, Imperata cylindrica, Eragrostis gummiflua, Eragrostis plana, Hemarthria altissima, Leersia hexandra, Paspalum dilatatum, Paspalum urvillei, Pennisetum sphacelatum, Phragmites australis, Schizachyrium sanguineum, Setaria sphacelata* and *Typha capensis.* Other grasses recorded include*, Cymbopogon excavatus, Cynodon dactylon, Digitaria eriantha, Sporobolus africana* and *Themeda triandra.*

Forbs and herbs recorded in the Moist mixed grasslands include many hydrophilic herb species, as well as common, terrestrial species such as *Berkheya radula, Chamaecrista comosa, Chironia purpurascens, Cirsium vulgare, Cotula anthemoides, Cucumis zeyheri, Cyperus longus, Cyperus marginatus, Dichondra micrantha, Floscopa glomerata, Haplocarpha lyrata, Haplocarpha scaposa, Helichrysum aureonitens, Helichrysum nudifolium, Helichrysum rugulosum, Hibiscus trionum, Hypericum lalandii, Hypochaeris radicata, Isolepis* spp.*, Juncus lomatophyllus, Juncus effusus, Kyllinga erecta, Limosella major, Lobelia flaccida, Ludwigia adscendens, Mariscus macrocarpus, Monopsis decipiens, Nasturtium officinale, Nidorella anomala, Plantago lanceolata, Pseudognaphalium luteo-album, Pycreus nitidus, Ranunculus meyeri, Richardia brasiliensis, Senecio gregatus, Seriphium plumosum, Sonchus nanus, Taraxacum officinale* and *Trifolium repens.*

Woody species are rare and typically include exotic, invasive such as *Salix babylonica, Acacia mearnsii,* and *Populus x canescens*.

Areas of this vegetation community that have been disturbed by overgrazing are often dominated by the dwarf, invader shrub *Seriphium plumosa*.

Figure 9: Moist grass and sedge community

Sensitivity Aspects

Areas characterised by the moist grass and sedge vegetation community play a critical ecological role in the purification and supply of water and are thus highly valuable hydrological features. Moreover, they also provide important breeding, feeding and dispersal habitat for a variety of fauna, some of which may be Red Data and protected fauna, as well as a threatened flora species such as *inter alia Eucomis autumnalis* and members of the genus *Gladiolus,* all potentially occur in this vegetation community. The ecological integrity of this vegetation community is therefore considered high and accordingly, the conservation importance of these areas is considered high (refer to Figure 12 and Figure 13).

4.4.2.6 Acacia karroo-Acacia caffra stands

Patches of indigenous woodland dominated by *Acacia karroo* and *Acacia caffra* occur throughout the study area. These areas are in close proximity to, and often invaded by exotic *Acacia* species such as *Acacia baileyana* and *Acacia mearnsii*. Other, less abundant woody species include *Rhus pyroides* and *Asparagus laricinus*. The herbaceous layer under the canopy of *Acacia karroo - Acacia caffra* stands has a low productivity and comprises grasses such as *Cynodon dactylon, Eragrostis racemosa* and *Panicum maximum*

Sensitivity Aspects

Stands of *Acacia karroo* and *Acacia caffra* are important natural woodland features within the grass dominated landscape. The ecological integrity of these areas is considered high and the probability of endemic, Red Data or protected species occurring in these areas is also regarded as being medium. Accordingly, the conservation importance of areas of *Acacia karroo-Acacia caffra* stands is high (refer to Figure 12 and Figure 13).

Figure 10: Acacia karroo-Acacia caffra thickets

4.4.2.7 Rocky scarp vegetation community

Rocky scarp vegetation occurs along ridges in the study area. This community is relatively rare and provides varied microhabitats that increase overall habitat heterogeneity within the overall landscape matrix (see Figure 11).

Indigenous woody species recorded in this community include, most commonly, *Diospyros austro-africana and Diospyros lycioides* subsp. *guerkei.*

Common and widespread grasses recorded in this vegetation community include *Andropogon schirensis, Brachiaria serrata, Ctenium concinnum, Digitaria brazzae, Diheteropogon amplectens, Elionurus muticus, Eragrostis chloromelas, Eragrostis racemosa, Hyparrhenia filipendula, Loudetia simplex, Melinis nerviglumis, Themeda triandra, Trachypogon spicatus* and *Tristachya leucothrix.*

The herbaceous layer consists of a variety of forbs including *Conyza bonariensis, Cyperus rupestris, Gomphrena fruticosa, Hypoxis iridifolia, Kyphocarpa angustifolia, Leonotis microphylla, Oldenlandia herbacea* var. *herbacea, Parinari capensis, Cyperus rupestris, Scabiosa columbaria, Senecio venosus, Tephrosia comosa* and *Xerophyta humilis.*

Sensitivity Aspects

Areas of rocky scarp vegetation are important heterogeneity features within the larger grassland matrix of the study area. Through the creation of varied microhabitats they provide unique niche habitat for a variety of flora and fauna species that are unlikely to occur in more homogenous grasslands. The ecological functioning of this community is considered high and the probability of endemic, Red Data or protected species occurring in these areas is also regarded as being high. Accordingly, the conservation importance of areas of Rocky scarp vegetation is high (refer to Figure 12 and Figure 13).

Figure 11: Rocky scarp vegetation community

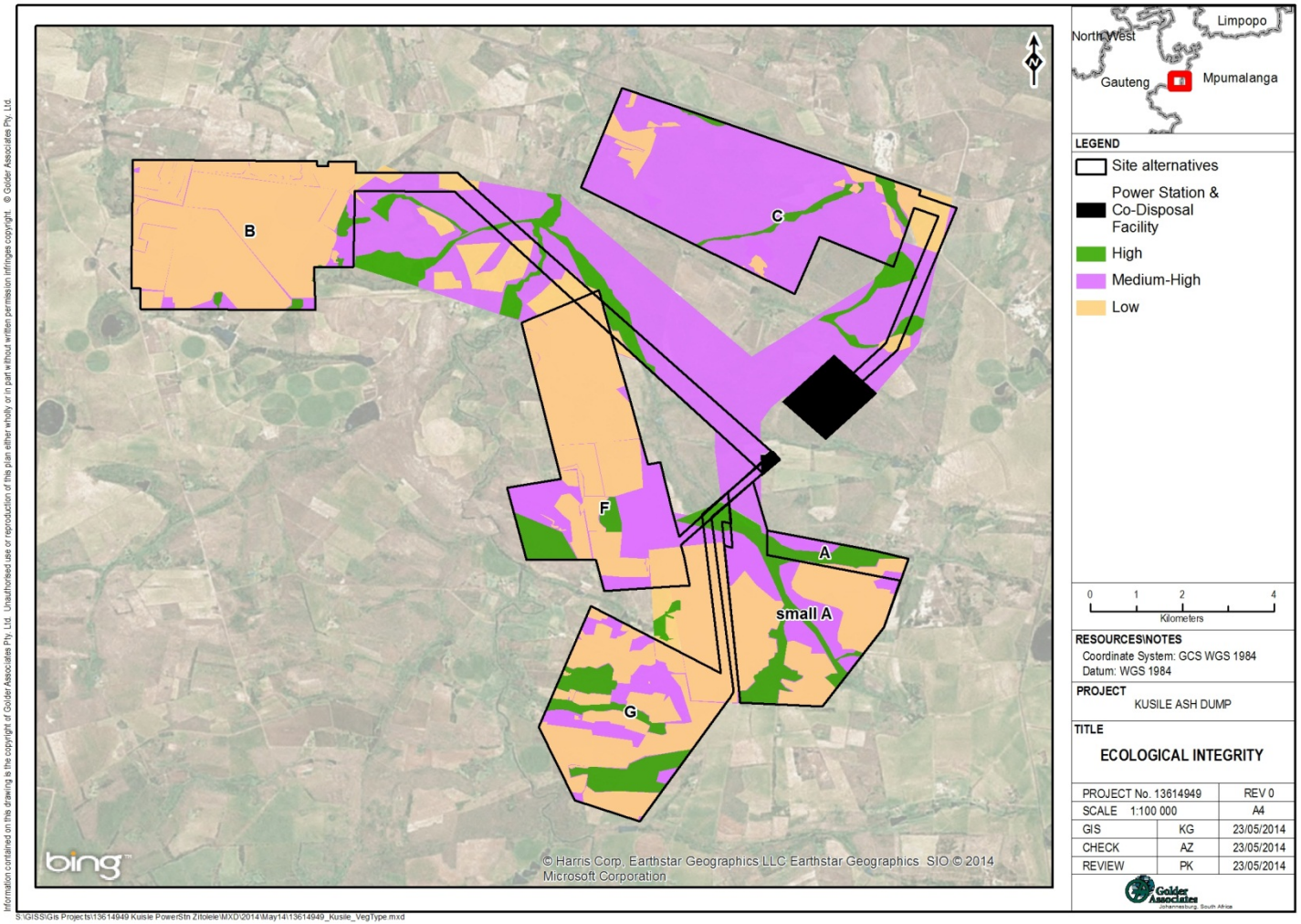

Figure 12: Ecological integrity of vegetation communities at each site alternative

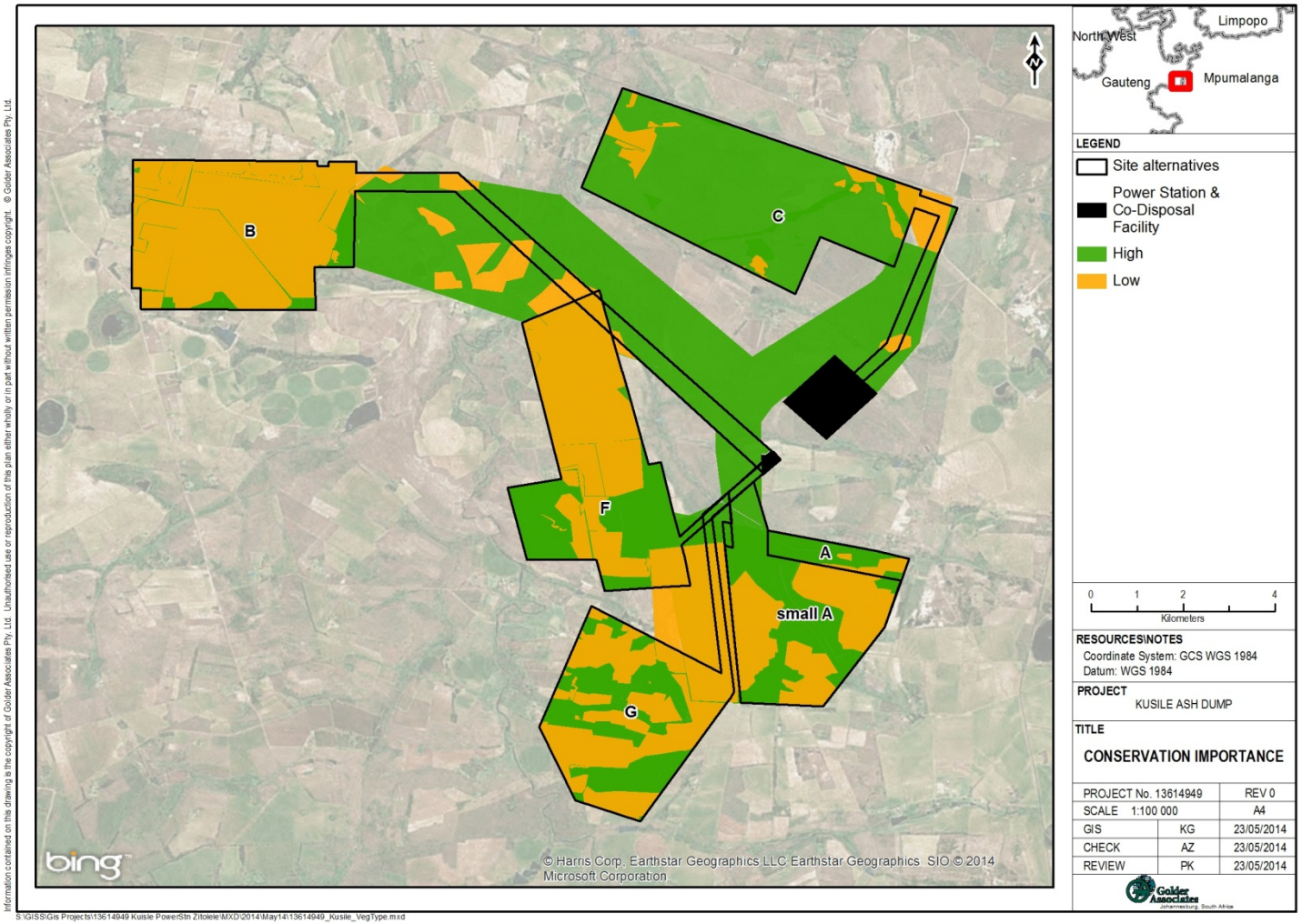

Figure 13: Conservation importance of vegetation communities at each site alternative

4.4.3 Flora species of conservation importance

Twenty five Red Data and/or protected plant species have historically been recorded in the general vicinity in which the study area is located according to the SANBI SIBIS database and data received from the Mpumalanga Tourism and Parks Agency. These are primarily from the families MESEMBRYANTHEMACEAE (5 species), IRIDACEAE (4 species), ORCHIDACEAE (4 species). All have a high probability of occurring in the study area. Plant species of conservation importance recorded in the study area include *Boophane disticha, Crinum bulbispermum, Hypoxis* sp. and *Gladiolus* sp. Refer to Table 3 for a list of Red Data and/or protected plant species.

Table 3: Red Data and protected plant species potentially occurring in study area

Family	Scientific name	Status		
		IUCN (2011)	NEMBA TOPS List (2007)	Mpumalanga Protected Species (1998)
AMARYLLIDACEAE	*Boophone disticha*	Declining	-	Protected
AMARYLLIDACEAE	*Crinum bulbispermum*	Declining	-	Protected
AMARYLLIDACEAE	*Cyrtanthus breviflorus*	-	-	Protected
MESEMBRYANTHEMACEAE	*Delosperma gautengense*	Vulnerable	-	-
MESEMBRYANTHEMACEAE	*Delosperma macellum*	Endangered	-	-
ZAMIACEAE	*Encephalartos lanatus*	Vulnerable	Protected	Protected
ZAMIACEAE	*Encephalartos middelburgensis*	Critically Endangered	Critically Endangered	Protected
HYACINTHACEAE	*Eucomis autumnalis*	Declining	-	Protected
ORCHIDACEAE	*Eulophia coddii*	Vulnerable	-	-
MESEMBRYANTHEMACEAE	*Frithia humilis*	Vulnerable	-	Protected
MESEMBRYANTHEMACEAE	*Frithia pulchra*	Rare	-	-
IRIDACEAE	*Gladiolus crassifolius*	-	-	Protected
IRIDACEAE	*Gladiolus elliotii*	-	-	Protected
IRIDACEAE	*Gladiolus papilio*	-	-	Protected
EUPHORBIACEAE	*Euphorbia clavarioides*	-	-	-
ORCHIDACEAE	*Habenaria clavata*	-	-	-
ORCHIDACEAE	*Habenaria mossii*	Endangered	-	-
ORCHIDACEAE	*Habenaria schlechteri* (*formerly Centrostigma schlechteri*)	-	-	Rare
HYPOXIDACEAE	*Hypoxis hemerocallidea*	Declining	-	Protected
AQUIFOLIACEAE	*Ilex mitis*	Declining	-	-
ISOETACEAE	*Isoetes transvaalensis*	Near Threatened	-	-
MESEMBRYANTHEMACEAE	*Khadia beswickii*	Vulnerable	-	-
LILIACEAE	*Kniphofia ensifolia*	Endangered	-	-
FABACEAE	*Melolobium subspicatum*	Vulnerable	-	-
PROTEACEAE	*Protea welwitschii*	-	-	Protected
IRIDACEAE	*Watsonia bella*	Least Concern	-	Protected

4.4.4 Declared weeds and invader plants

Regulations 15 and 16 of the Conservation of Agricultural Resources Act (CARA) (No. 43 of 1983)[1], as amended, are the only current, active regulations concerning exotic and invasive species in South Africa Although the National Environmental Management: Biodiversity Act (NEMBA) (No. 10 of 2004) does include provision for exotic invasive species management, this legislation has yet to be finalised and remains in draft format (ARC, 2010, internet).

The CARA recognises three categories of invasive plant, namely: Category 1 - Declared weeds, Category 2 - Declared invader plants with a commercial or utility value, and Category 3 - Ornamental plants. Where they occur outside biological control reserves and demarcated areas, Category 1 and 2 listed plants must be controlled.

The plants listed in Table 4 were recorded in the study area during the field survey and are declared weeds or invasive plants according to the CARA.

Table 4: CARA listed exotic species recorded in the study area

Scientific name	Common name	CARA Category	NEMBA Category (Proposed)	Vegetation community where recorded
Acacia species	Wattle	2	2	Dry mixed grassland Moist grass & sedge community *Acacia caffra – Acacia karroo* thickets
Campuloclinium macrocephalum	Pompom weed	1	1b	Cultivated land *Eragrostis* pastures Dry mixed grassland Moist grass & sedge community
Cirsium vulgare	Scottish thistle	1	1b	Cultivated land *Eragrostis* pastures Dry mixed grassland Moist grass & sedge community
Datura stramonium	Large thorn apple	1	1b	Exotic woodlots Dry mixed grassland Moist grass & sedge community
Eucalyptus species	Blue gum	2	1b	Exotic woodlots Dry mixed grassland Moist grass & sedge community
Solanum mauritianum	Bug weed	1	1b	Exotic woodlots
Populus x canescens	Popular trees	2	2	Exotic woodlots Moist grass & sedge community
Salix babylonica	Weeping willow	2	-	Moist grass & sedge community
Solanum sisymbriifolium	Dense-thorned bitter apple	1	1b	Exotic woodlots Cultivated land *Eragrostis* pastures Dry mixed grassland Moist grass & sedge community

[1] CARA is in the process of being revised.

4.5 Fauna Assessment

4.5.1 Mammals

Based on the 2013 field survey and previous studies (Golder 2007 Report no. 10613-5792-1 & Du Preez 2006), 16 mammal species have been recorded in, or adjacent to the study area Table 5. These range from small rodents to medium-sized ungulates, the majority of which are fairly-common, to common species with widespread distributions.

An additional 47 species are known to occur in the region in which the study area is located (refer to APPENDIX C for a list of species)

Table 5: Mammals recorded in study area

Scientific name	Common name
Aonyx capensis	Cape clawless otter
Atilax paludinosus	Water mongoose
Canis mesomelas	Black-backed jackal
Crocidura cyanea	Reddish grey musk shrew
Crocidura hirta	Lesser red musk shrew
Cynictis penicillata	Yellow mongoose
Damaliscus dorcas phillipsi	Blesbok
Dendromys mystacalis	Chestnut climbing mouse
Hystrix africaeaustralis	Porcupine
Lepus saxatilis	Scrub hare
Mastomys sp.	Multimammate mouse
Orycteropus afer	Aardvark
Otomys angoniensis	Angoni vlei rat
Phacochoerus africanus	Warthog
Rhabdomys pumilio	Striped mouse
Sylvicarpa grimmia	Common duiker

Red Data and protected mammals

Two Red Data/protected mammal species, namely the Aardvark (*Orycteropus afer)* and Cape clawless otter *(Aonyx capensis)* have been recorded in the study area. The Aardvark (*Orycteropus afer*) is Protected in terms of Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1997), while the Cape clawless otter *(Aonyx capensis)* is Protected according to the aforementioned Act, as well as the NEMBA TOPS list (2007).

Twenty one Red Data and/or protected mammal species potentially occur in the study area. These, along with a probability of occurrence, are listed in Table 6.

Table 6: Red Data and protected mammals potentially occurring in the study area

Scientific name	Common name	Status			Probability of occurrence
		IUCN (2011)	NEMBA TOPS List (2007)	Mpumalanga Protected Species (1998)	
Chrysospalax villosus	Rough-haired golden mole	Critically Endangered	Critically Endangered	-	Moderate
Amblysomus robustus	Robust golden mole	Vulnerable	Endangered	-	Moderate
Amblysomus septentrionalis	Highveld golden mole	Near Threatened	-	-	High
Miniopterus schreibersii	Schreibers' long-fingered bat	Near Threatened	-	-	Low

Scientific name	Common name	Status			Probability of occurrence
		IUCN (2011)	NEMBA TOPS List (2007)	Mpumalanga Protected Species (1998)	
Dasymys incomtus	Water rat	Near Threatened	-	-	High
Vulpes chama	Cape fox	-	Protected	-	Low
Aonyx capensis	Cape-clawless otter	-	Protected	Protected	Recorded
Leptailurus serval	Serval	Near Threatened	Protected		High
Proteles cristatus	Aardwolf	-	-	Protected	High
Huaena burnea	Brown hyaena	Near Threatened	Protected	-	Low
Mellivora capensis	Honey badger	Near Threatened	Protected	Protected	Moderate
Ourebia ourebi	Oribi	-	Endangered	Protected	High
Raphicerus campestris	Steenbok	-	-	Protected	High
Pelea capreolus	Grey rhebok	-	-	Protected	High
Lutra maculicollis	Spotted-necked otter	Near Threatened	Protected	Protected	High
Felis nigripes	Black-footed cat	-	-	Protected	High
Atelerix frontalis	South African hedgehog	Near Threatened	Protected	Protected	High
Orycteropus afer	Aardvark	-	-	Protected	Recorded
Redunca fulvorufula	Mountain reedbuck	-	-	Protected	High

4.5.2 Birds

Forty one bird species were recorded in the study area during the 2013 field survey (Table 7). These are common and widespread species, typically associated with grassland and wetland habitats on the Highveld. Refer to APPENDIX D for a list of birds species potentially occurring in the study area.

Table 7: Birds recorded in the study area

Scientific name	Common Name
Alopochen aegyptiacus	Egyptian goose
Anas undulata	Yellow-billed Duck
Anhinga rufa	Darter
Ardea cinerea	Grey heron
Ardea melanocephala	Black-headed heron
Ardea purpurea	Purple heron
Asio capensis	Marsh owl
Bostrychia hagedash	Hadeda ibis
Bradypterus baboecala	African sedge warbler
Bubulcus ibis	Cattle egret
Burhinus capensis	Spotted thick knee
Calandrella cinerea	Redcapped lark
Chrysococcyx caprius	Diederik cuckoo
Cisticola fulvicapillus	Neddicky
Corvus albus	Pied crow
Cuculus solitarius	Red-chested cuckoo
Dendrocygna viduata	White-faced duck

Scientific name	Common Name
Elanus caeruleus	Black-shouldered kite
Euplectes afer	Golden bishop
Euplectes orix	Red bishop
Euplectus progne	Long-tailed widow
Hirundo rustica	European swallow
Falco amurensis	Eastern red-footed falcon
Francolinus swainsonii	Swainson's francolin
Fulica cristata	Red-knobbed coot
Hirundo albigularis	White throated swallow
Hirundo cucullata	Greater striped swallow
Lanius collaris	Fiscal shrike
Mirafra sabota	Sabota lark
Myrmecocich formicivora	Anteating chat
Passer melanurus	Cape sparrow
Phoenicopterus ruber	Greater flamingo
Platalea alba	African spoonbill
Plegadis falcinellus	Glossy ibis
Ploceus velatus	Masked weaver
Streptopelia capicola	Cape turtle dove
Streptopelia senegalensis	Laughing dove
Threskornis aethiopicus	Sacred ibis
Vanellus armatus	Blacksmith plover
Vanellus coronatus	Crowned plover
Vidua macroura	Pin-tailed whydah

Red Data and protected birds

According to Emery, Lotter and Williamson (2002) many of Mpumalanga's most threatened bird species are dependent on wetlands and the short, dense grasslands and tall grasslands in the province – all of which are found to some measure in the study area.

Several Greater flamingo's (*Phoenicopterus ruber*) were recorded in a pan immediately adjacent to Site B in the study area during the 2013 field survey (Co-ordinates 25°54,137' S 28°46,622' E). This species is listed as Near Threatened by the IUCN and inhabits shallow water bodies, such as pans and lakes where it feeds upon *inter alia*, small fish, aquatic insects and crustaceans.

An additional 15 Red data/protected species may occur in the study area. These, along with a probability of occurrence, are listed in Table 8:

Table 8: Red Data and protected bird species potentially occurring in the study area

Scientific name	Common name	Status			Probability of occurrence
		IUCN (2011)	NEMBA TOPS List (2007)	Mpumalanga Protected Species (1998)	
Anthropoides paradiseus	Blue crane	Vulnerable	Endangered	Protected	Low
Phoenicopterus minor	Lesser flamingo	Near threatened	-	Protected	High
Sagittarius serpentarius	Secretary bird	Near threatened	-	Protected	High
Falco peregrinus	Peregrine falcon	Near threatened	Vulnerable	Protected	Moderate
Eupodotis caerulescens	Blue korhaan	Near threatened	Vulnerable	Protected	Moderate
Eupodotis senegalensis	White-belled korhaan	Vulnerable	-	Protected	Low
Charadrius pallidus	Chestnut-banded plover	Near threatened	-	Protected	Moderate
Glareola nordmanni	Black-winged pratincole	Near threatened	-	Protected	Moderate
Alcedo semitorquata	Half-collared kingfisher	Near threatened	-	Protected	Moderate
Mirafra cheniana	Melodious lark	Near threatened	-	Protected	Moderate
Phoenicopterus ruber	Greater flamingo	Near Threatened		Protected	Recorded
Falco naumanni	Lesser Kestrel	Vulnerable	Vulnerable	Protected	High
Falco biarmicus	Lanner falcon	Near Threatened		Protected	High
Circus ranivorus	African marsh harrier	Vulnerable	Protected	Protected	High
Tyto capensis	African grass owl	Vulnerable	Vulnerable	Protected	High
Geronticus calvus	Southern bald ibis	Vulnerable	Vulnerable	Protected	High

4.5.3 Herpetofauna

Seventeen species of herpetofauna have been recorded in the study area and its immediate surrounds (Table 9) (Golder 2007 Report no. 10613-5792-1 & Du Preez 2006). These include ten reptile and seven amphibian species. All recorded species are common and not restricted in terms range or habitat.

Refer to APPENDIX D for a list of all herpetofauna species potentially occurring in the study area.

Table 9: Herpetofauna recorded in and adjacent to the study area

Biological Name	Common Name
Reptiles	
Bitis arietans	Puff adder
Dasypeltis scabra	Rhombic egg eater
Hemachatus heamachatus	Rinkhals
Lamprophis fuliginosus	Brown house snake
Pelomedusa subrufa	Marsh terrapin
Philothamnus hoplogaster	Green water snake
Psammophylax tritaenIatus	Striped skaapsteker
Mabuya varia	Variable skink
Mabuya striata punctatissima	Striped skink
Varanus niloticus	Water monitor
Amphibians	
Afrana angolensis	Common river frog
Afrana fuscigula	Cape river frog
Bufo gutturalis	Guttural toad

Biological Name	Common Name
Kassina senegalensis	Bubbling kassina
Schismaderma carens	African red toad
Tomopterna cryptotis	Tremolo sand frog
Xenopus laevis	Common platanna

Red Data and protected herpetofauna

According to Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1997), all species of reptile excluding both monitor species (*Varanus exanthematicus* and *Varanus niloticus*) and all snakes, are listed as Protected. This notwithstanding, the Spotted Harlequin snake (*Homoroselaps lacteus)* which may potentially occur in the study area, has been categorized by provincial authorities as Near-threatened, while two other species which may also occur in the study area, the Breyer's long-tailed seps (*Tetradactylus breyeri*) and the Striped Harlequin snake *(Homoroselaps dorsalis*), are listed by the IUCN as Vulnerable and Near Threatened, respectively. The probability that these species occur in the study area is considered moderate.

In terms of amphibians, the Giant bullfrog (*Pyxicephalus adspersus*) is the only listed amphibian that may potentially occur in the study area. According to Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1997) this species is Protected, while the NEMBA TOPS List (2007) and IUCN categorise it as Near Threatened. The probability of Giant bullfrog (*Pyxicephalus adspersus*) occurring in the Moist grass and sedge vegetation community in the study area is considered high.

4.5.4 Arthropoda

Ninety five arthropod taxa have been recorded in, and/or adjacent to the study area. These are all common and widespread species. Refer to APPENDIX F for a list of arthopoda recorded during the 2013 survey and previous surveys.

Red Data and protected arthropods

The Marsh sylph (*Metisella meninx*) has a high probability of occurring in the study area. This species is listed as Vulnerable according to Henning et al. (2009) and favours wetland and marsh habitats on the Highveld. Within the study area this species potentially occurs in undisturbed sites comprising the Moist grass and sedge vegetation community.

Other arthropods of conservation importance that potentially occur in the study area include members of the *CTENIZIDAE* (trapdoor spiders) and *THERAPHOSIDAE* families (Baboon spiders). These spiders usually live in burrows or silk-lined retreats, none of which were observed in the study area. That said, on-site habitat is suitable for these species and the probability that they are present is considered moderate.

The following scorpions may occur in the area and are of conservation importance; *Opistacanthus validus* and *Opistophthalmus glabrifrons*. Although these were not recorded in the study area, the probability that they are present is also considered high, particularly in areas of Rocky scarp.

5.0 IMPACT ASSESSMENT

5.1 IMPACT ASSESSMENT METHODOLOGY

The impacts must be rated according to the methodology described below. Where possible, mitigation measures must be provided to manage impacts. In order to ensure uniformity, a standard impact assessment methodology was utilised so that a wide range of impacts can be compared with each other. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology is used to describe impacts for each of the aforementioned assessment criteria. A more detailed description of each of the assessment criteria is given in the following sections.

5.1.1 Significance Assessment

Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these since their importance in the rating scale is very relative. A more detailed description of the impact significance rating scale is given in Table 10.

Table 10: Description of the significance rating scale

Rating		Description
7	Severe	Impact most substantive, no mitigation.
6	Very high	Impact substantive, mitigation difficult/expensive.
5	High	Impact substantive, mitigation possible and easier to implement.
4	Moderate-High	Impact real, mitigation difficult/expensive.
3	Moderate-Low	Impact real, mitigation easy, cost-effective and/or quick to implement.
2	Low	Impact negligible, with mitigation.
1	Very low	Impact negligible, no mitigation required.
0	No impact	There is no impact at all – not even a very low impact on a party or system.

5.1.2 Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at small (study area) or large (provincial or national) scale. The spatial assessment scale is described in more detail in Table 11.

Table 11: Description of the spatial scale

Rating		Description
7	National	The maximum extent of any impact.
6	Provincial	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a provincial scale.
5	District	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a district scale.

Rating		Description
4	Local	The impact will affect an area up to 5 km from the proposed development.
3	Adjacent	The impact will affect the development footprint and a 500 m buffer around the proposed development.
2	Study Area	The impact occurring within the development footprint.
1	Isolated Sites	The impact will affect isolated sites in the development foorprint

5.1.3 Duration Scale

In order to accurately describe the impact it is necessary to understand the duration and persistence of an impact in the environment. The temporal scale is rated according to criteria set out in Table 12.

Table 12: Description of the temporal rating scale

Rating		Description
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium term	The environmental impact identified will operate for the duration of life of facility.
4	Long term	The environmental impact identified will operate beyond the life of operation.
5	Permanent	The environmental impact will be permanent.

5.1.4 Degree of Probability

Probability or likelihood of an impact occurring is described as shown in Table 13.

Table 13: Description of the degree of probability of an impact occurring

Rating	Description
1	Practically impossible
2	Unlikely
3	Could happen
4	Very Likely
5	It's going to happen / has occurred

5.1.5 Degree of Certainty

As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used as discussed in Table 14. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 14: Description of the degree of certainty rating scale

Rating	Description
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact, or of the likelihood of an impact occurring.

Rating	Description
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

5.1.6 Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale as described below:

Impact Risk = ((SIGNIFICANCE **+** *Spatial* **+** Temporal) ÷ 2.714) **X** (Probability ÷ 5)

Table 15: Impact Risk Classes

Rating	Impact class	Significance
0.1-1.0	1	VERY LOW
1.1-2.0	2	LOW
2.1-3.0	3	MODERATE-LOW
3.1-4.0	4	MODERATE-HIGH
4.1-5.0	5	HIGH
5.1-6.0	6	VERY HIGH
6.1-7.0	7	SEVERE

5.2 Direct Impacts

Several potential negative ecological impacts have been identified. These are relevant to each of the proposed site alternatives and are listed in Table 16 and broadly characterised in Section 5.3.

Table 16: Potential ecological impacts resulting from the proposed project

Impact	Phase
Principle Impacts	
Habitat loss and degradation through vegetation clearing	Construction
Habitat fragmentation through loss of habitat and erection of artificial barriers (fences, conveyors, roads etc.)	Construction
Secondary Impacts	
Increase in erosion and possible sedimentation of drainage features	Construction Operational Closure
Increased dust generation	Construction Operational Closure
Increased exotic and/or declared Category 1, 2 & 3 invader species	Construction Operational Closure
Killing or injuring of fauna in the study area	Construction
Loss of species of conservation importance	Construction

5.3 Impact characterisation

5.3.1 Habitat loss and degradation associated with vegetation clearing

Nature of impact

Habitat loss refers to the removal of natural habitat. In terrestrial ecosystems habitat loss occurs primarily through the clearing of indigenous vegetation or through the homogenisation of available habitat. This results not only in the immediate destruction of individual plants and some fauna species, but may lead to a loss of biodiversity and a contingent breakdown in ecosystem functioning.

Habitat degradation refers to an extreme form of ecosystem disturbance. In such instances much of the original ecosystem processes have been disrupted and many of the original species have been excluded (Begon *et al*. 2002).

Although habitat loss and degradation are normally associated with the immediate vegetation clearing and earth works that precede construction activities, the impacts can be long term, persisting throughout the operational and closure phases. In certain instances, these impacts can be ameliorated by successful rehabilitation of the site.

5.3.2 Habitat fragmentation

Nature of impact

Habitat fragmentation refers to the partitioning and breakup of natural habitat into smaller less viable habitat patches. Habitat fragmentation leads to changes in habitat configuration which manifest as a decrease in patch size and connectivity and an increase in patch number and isolation (Fahrig, 2003). These alterations change the ecological properties of remaining habitat which can affect species diversity and system function (Fahrig, 2003). Linear developments such as fences, pipelines, roads and conveyors are primary causes of habitat fragmentation.

In terms of ecological functioning, one of the primary outcomes of habitat fragmentation is an increase in habitat edge effect. Edge effect refers to changes in microclimate near the edge (boundary) of habitat patches that not only reduce the effective size of viable, interior habitat, but may also create parameter conditions that are more conducive to predators, parasites and exotic species invasion (Begon *et al*. 2002). In addition, patch isolation can negatively affect the ability of fauna to disperse and move across the landscape thereby affecting fauna population abundance and distribution (Begon *et al*. 2002).

Habitat fragmentation initially occurs during vegetation clearing, but may persist throughout the remaining phases if linear barriers (pipelines, fences conveyors and roads) are constructed.

5.3.3 Increase in erosion and possible sedimentation of drainage features

Nature of impact

Although in many instances soil erosion is a natural process, where it is initiated or accelerated by anthropogenic activities such as vegetation clearing and/or soil disturbances, it can lead to severe habitat degradation. Degradation may occur both at the point of erosion itself, as well as in areas where eroded material collects such as drainage lines, rivers and streams.

5.3.4 Dust generation

Nature of impact

The clearing of vegetation for construction and mining, coupled with increased vehicular traffic and the establishment of top soil and waste stockpiles, will result in the increased potential for dust entrainment. Dust settling on plant material can affect photosynthesis, respiration, transpiration rates, and allow for the penetration of phototoxic gaseous pollutants into plant tissue (Farmer, 1993). These impacts can result in decreased plant productivity which may lead to alterations in plant community structure and composition, and consequent changes in herbivore diversity and abundance (Farmer, 1993).

Moreover, dust may directly affect fauna. In arthropods for example, exposure to dust may lead to the smothering of adults and larvae and the disrupting of chemical cues used for mating (Talley et al. 2006), while mammals exposed to dust may show respiratory afflictions (Borm & Tran, 2002).

5.3.5 Increases in exotic and / or declared invader species

Nature of impact

Clearing of natural vegetation may create conditions conducive to the establishment and colonisation of exotic and/or declared CARA Category 1, 2 & 3 invader plants. Most exotic, invasive species if left uncontrolled will suppress or replace indigenous plants leading to a concomitant reduction in fauna species diversity and abundance (Bromilow, 2010). Moreover, certain common invasive plants, such as the exotic *Acacias* (Wattle trees), are highly flammable and can increase the frequency and intensity of fires which may further alter ecosystem structure and functioning.

Facilitated by indigenous vegetation clearing, encroachment by exotic invasive species may initially occur during the construction phase. However, if not controlled, the scale and magnitude of infestation will rapidly increase and may persist for the entire lifecycle of the project.

5.3.6 Killing or injuring of fauna in the study area

Nature of impact

Grassland areas in South Africa provide habitat for a number of fauna species. It is likely that upon commencement of construction activates many larger and more agile species will move-off to avoid disturbance. A number of smaller and less mobile species however, may be trapped and killed /injured during all phases of the project. Common causes include:

- Injury and death during vegetation clearing and earth works;
- Vehicle–wildlife collisions;
- Trapping of wildlife in infrastructure (fences, excavations, etc.).

5.3.7 Loss of species of conservation importance

Nature of impact

During initial vegetation clearing and earth works, flora and fauna species of conservation importance, such as Red Data and protected species may be killed, injured or damaged. Moreover, habitat loss, fragmentation and degradation may result in sensitive species populations becoming unsustainable leading to local extinctions. A number of species of conservation importance occur, or potentially occur in the study area. Elements of concern *viz.* the proposed project are:

- The presence of fauna species of concern such as Greater flamingo (*Phoenicopterus ruber*), Aardvark (*Orycteropus afer)* and Cape clawless otter *(Aonyx capensis)* have been recorded in, or near the study area; and
- A number of protected plants occur in the grassland and wetland habitats surrounding Kusile Power Station. These include *inter alia, Boophane disticha, Crinum bulbispermum, Hypoxis* sp., and *Gladiolus* sp.

6.0 COMPARATIVE SITE SELECTION EVALUATION

Within a landscape dominated by *inter alia* agriculture and mining activities, areas of natural vegetation are ecologically important and many are designated of conservation importance by provincial conservation plans. In terms of the proposed ash dump project, despite the fact that some mitigation measures can be implemented, the loss and fragmentation of natural habitat will occur at all proposed site alternatives. The severity of these impacts differs between sites based on the extent of natural vegetation at each site and within the proposed conveyor corridors. Other secondary environmental impacts, as listed above, are also

likely to occur to at all site alternatives. These can be mitigated through the implementation of suitable management measures.

Selection of a preferred ash dump site/s is therefore based on minimising the loss of important natural habitat and reducing the potential disruption of local ecological processes. As such, the preferred site for the proposed ash dump should ideally be dominated by land of low ecological integrity and conservation importance and where disturbances, most notably habitat fragmentation from the proposed conveyor, will be minimal. Table 17 provides percentage estimates of the relative contributions of land of medium-high and high ecological integrity, and of high conservation importance at each site and was used as a guide to determine the degree of potential negative impacts associated with each proposed site alternative.

Table 17: Approximate percentage of land with medium-high & high ecological integrity, and high conservation importance

Site alternative	Medium-high ecological integrity	High ecological integrity	High conservation importance
Site A	22	17	40
Site B	6	1	7
Site C	86.6	4.4	92
Site F	25	23.5	33
Site G	18.2	18	37

Site A

Although Site A is situated in close proximity to Kusile Power Station and comprises large areas of cultivated land, the site is characterised by important natural habitat consisting of the moist grass and sedge community and adjacent dry mixed grassland. These areas provide important habitat and dispersal routes for a variety of fauna and flora, some of which maybe Red Data/protected species. The wetland areas are also of hydrological importance.

The conveyor corridor linking Site A to Kusile Power Station is short in comparison to other site options, and will run adjacent to an existing tarred road. In conjunction with the proposed ash facility it will cause habitat fragmentation preventing fauna movement and dispersal. When compared to the other site alternatives, Site A as a whole is therefore not a preferred site option from a terrestrial ecosystems perspective (Refer to Section 7.0 for detailed discussion concerning Site A).

Site B

The majority (approximately 90%) of Site B is already transformed and degraded by cultivation. Vegetation clearing at this site will not result in severe habitat loss, although small habitat patches on the periphery of the site are designated as being of conservation importance according to the Gauteng C-plan. Be that as it may, this site is the furthest from Kusile Power Station and the proposed conveyor cross a number of wetlands, streams and the Wilge River in order to reach the site. This will cause considerable habitat fragmentation which will negatively affect local fauna populations. The Gauteng C-plan has designated a large portion of the natural habitat along the Wilge River of conservation importance. Site B is therefore not a preferred option from a terrestrial ecosystems perspective (Refer to Section 7.0 for detailed discussion concerning Site B).

Site C

As with Site A, Site C is in close proximity to Kusile Power Station and the impacts of the conveyor corridor will not be major. However, the majority of this site comprises natural vegetation (primarily Dry mixed grassland) which is important habitat for fauna and flora and designated by MBSP (2013) as CBA – Irreplaceable. Moreover, selection of this site will necessitate the establishment of a borrow pit on a portion of Site A, which will increase the total footprint of habitat loss and degradation beyond Site C. From a terrestrial ecosystems perspective Site C is therefore not a preferred option.

Site A & F

Site F is dominated by cultivated land and *Eragrostis* pastures (approximately 67% combined). In these areas vegetation clearing will have minimal negative impacts on terrestrial ecology. A portion of land comprising Rocky scarp vegetation and Dry mixed grassland, as well as a small pan (used by Flamingo's) are present and are of conservation importance, as recognised by the Gauteng C-Plan.

In this option, only a portion of Site A is included, leaving much of the Moist grass and sedge community in the north of Site A intact. However, the proposed conveyor routes feeding these two sites will lead to habitat fragmentation, as it crosses the wetland area to the south of Kusile. Be that as it may, this site is considered one of the preferred options from a terrestrial ecosystems perspective, but only if the area of Rocky scarp vegetation can be excluded from the project footprint.

Site A & G

Site G is characterised by all seven vegetation communities, the majority of which consists of the cultivated land, *Eragrostis* pastures and Exotic woodlots vegetation types (approximately 67% combined). As with the Site A & F option, only a portion of Site A is included. Much of the proposed conveyor route for this option will run parallel to the existing road yet some fragmentation will occur where the conveyor crosses wetland areas. This site is therefore also considered one of the preferred options from a terrestrial ecosystems perspective.

Site F & G

Based on the ecological characteristics of Site F and Site G, as mentioned above, the Site F & G option is considered one of the preferred options from a terrestrial ecosystems perspective.

6.1 Conclusions

Terrestrial ecology comparative site evaluation

Seven vegetation communities were identified in the study area, comprising three anthropogenically transformed communities and four natural communities. The former category includes cultivated land, *Eragrostis* pastures and Exotic woods. These areas are highly disturbed and are of low ecological integrity and conservation importance. Although varying disturbances were noted in the four natural vegetation communities on each site alternative, it is recognised that these communities provide important natural habitat for fauna and flora, some of which may be Red Data/protected species. Indeed, a number of these areas are designated as being of conservation importance at a provincial level. Consequently, in terms of the proposed project these communities have a high conservation importance and should ideally remain undisturbed.

The major impact associated with the proposed project is the loss and degradation of habitat. This will occur at all site alternatives to varying degrees based on the area of natural and semi-natural vegetation present. From a terrestrial ecosystems perspective, selection of a preferred ash dump site is therefore based on minimising the loss of important natural habitat and reducing the potential disruption of ecological processes. As such, the preferred site for the ash dump should ideally be dominated by land of low ecological integrity and conservation importance (i.e. areas of cultivated land, Exotic woodlots and *Eragrostis* pastures) and where disturbance from the proposed conveyor will be minimal.

The terrestrial ecosystems assessment indicates that Site A & F, Site A & G and Site F & G are the preferred site alternatives.

7.0 SITE A AND B COMPARATIVE EVALUATION

The findings of the combined assessments of **all** environmental disciplines associated with the Kusile 60 years Ash Dump Project, in conjunction with engineering and financial considerations, indicated that Site A is the preferred option. However, after consultation with the Department of Water Affairs, the project team was asked to include an assessment of Site B as the site option. Section 7.0 thus provides a comparative impact assessment of Site A and Site B form a terrestrial ecology perspective.

7.1 Status Quo

Site A

Site A is situated in close proximity to Kusile Power Station and is mostly characterised by cultivated land under maize production. Natural habitat occurs in the form of the moist grass and sedge community associated with on-site wetlands, and the adjacent dry mixed grasslands. These areas are important habitat for fauna and flora, some of which maybe Red Data/protected species. These natural areas are part of a larger habitat network that connects with the Wilge River riparian area.

The Kusile Power Station construction site is located immediately north of the Site A, while the proposed New Largo Colliery is located to the west. The site is thus largely surrounded by transformed or highly disturbed land. The proposed conveyor corridor link from Site A to Kusile Power Station is relatively short and will run adjacent to the existing tarred road and the Kusile co-disposal facility.

Site B

The majority (approximately 90%) of Site B is transformed or degraded, with cultivation, exotic woodlots and planted *Eragrostis* pastures being the dominant vegetation communities/units. The majority of the site therefore does not comprise important or critical natural habitat for flora and fauna.

Site B is however, the furthest from Kusile Power Station and the land between the two sites is characterised by a large stretch of natural habitat, comprising wetlands/streams and dry mixed grasslands. At a landscape level, this area is considered highly important as it forms part of a larger, almost contiguous habitat network connecting natural areas along the Wilge River with those of its tributaries and adjacent grasslands, wooded thickets and ridges.

This habitat network is likely to play an important role in maintaining local fauna population dynamics by facilitating dispersal and foraging movements. Certainly, it is expected that species such as Serval (*Leptailurus serval*) and Cape clawless otter (*Aonyx capensis*) which are of conservation importance, will depend considerably on the Wilge River habitat network. The importance of the Wilge River habitat network is emphasised by the conservation plans of both Gauteng and Mpumalanga (see Figure 14), and it is important that, as far as possible, the integrity of this area be maintained and even enhanced.

Figure 14 shows the study area in relation to areas designated by provincial conservation authorities as important for biodiversity conservation. Potential faunal dispersal and movement routes along the natural areas comprising the Wilge River habitat network are shown with arrows.

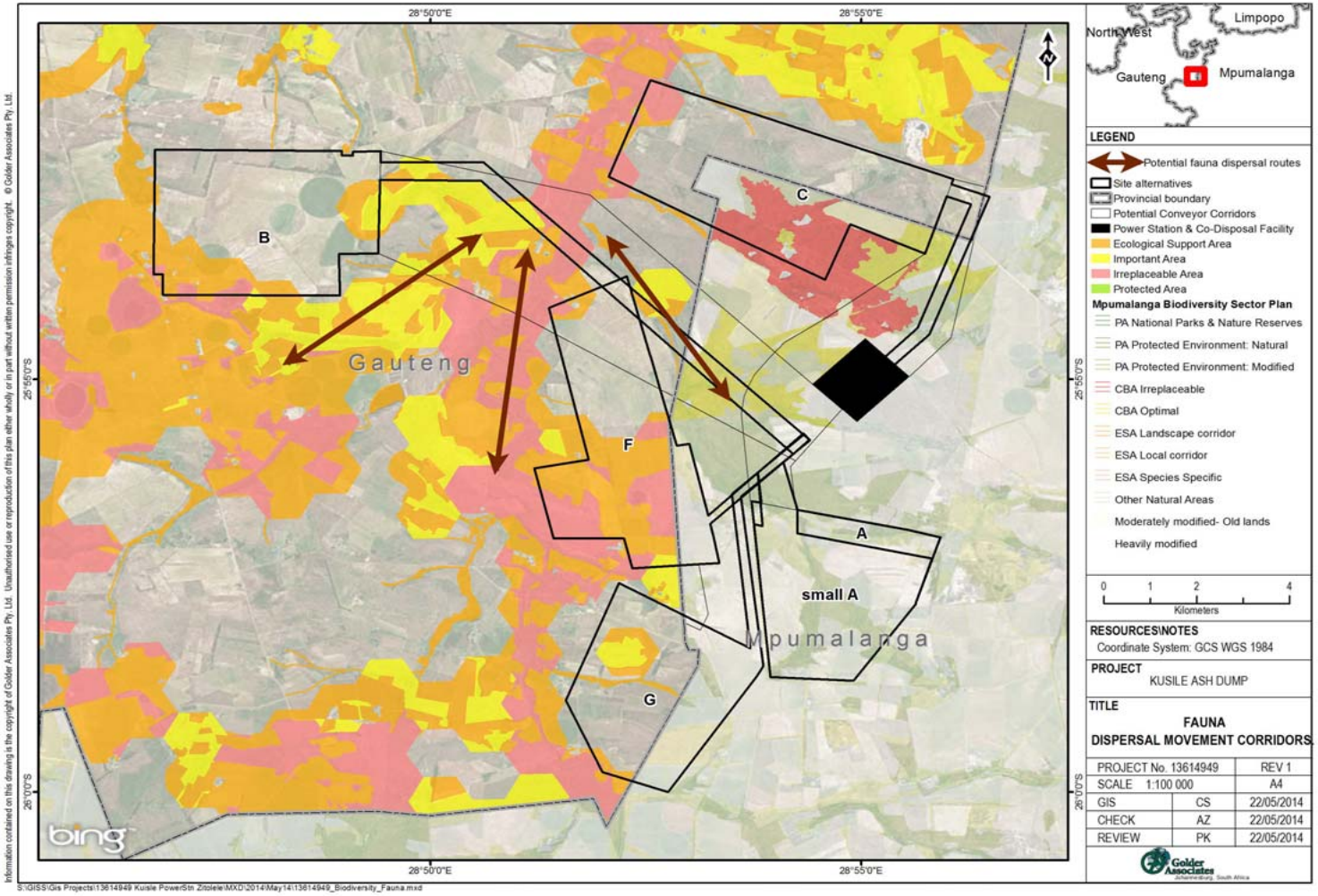

Figure 14: Potential fauna dispersal and movement routes in the Wilge River habitat network between Kusile Power Station and Site B.

7.2 Site A and B Impact Comparison

The potential ecological impacts identified in Section 5.3 of this report are discussed in the context of Site A and Site B below. For the impact rating tables refer to APPENDIX G.

7.2.1 Principle environmental impacts

As construction of the proposed ash dump progresses, natural habitat within the development footprint of the chosen site alternative will be subject to vegetation clearing and earth works causing direct habitat loss and fragmentation. The construction of the conveyor between Kusile Power Station and the selected site will also lead to habitat loss and habitat fragmentation. These impacts will commence during the construction phase and will persist throughout the entire life of the facility. Habitat loss and habitat fragmentation are thus the principle environmental impacts of concern and will affect both Site A and Site B, albeit to varying degrees. These impacts are discussed below:

7.2.1.1 Habitat loss

Approximately 339 ha of Dry mixed grassland and 253 ha Moist grass and sedge community will be lost at Site A, compared to 93 ha and 24 ha of the same vegetation communities cleared at Site B (refer to Table 18). Accordingly, direct habitat loss resulting from vegetation clearing will be greatest at Site A. Conversely, the proposed conveyor to Site B is substantially longer than it is to Site A resulting more vegetation clearing in the Site B conveyor corridor. Refer to Section 7.2.1.2 for more detail concerning impacts of the proposed conveyor.

Mitigation potential

Considering the nature of the proposed project, mitigating habitat loss is difficult as vegetation clearing is inevitable. Measures that can be implemented include prohibiting vegetation clearing outside of the immediate development footprint, and where possible, avoiding clearing in areas designated as sensitive or of conservation importance. The latter measure may be possible at Site B as areas of conservation importance are located on the periphery of the proposed ash dump footprint. However, at Site A areas of natural habitat extend down the middle of the site and it will not be possible avoid losing these areas. For more detailed mitigation measures refer to Table 19.

Table 18: Approximate extent of vegetation communities to be cleared on Site A and B

Vegetation Community	Approximate area (ha)	
	Site A	Site B
Cultivated land (current and former)	882	968
Eragrostis pastures	0	194
Exotic woodlots	3	48
Dry mixed grassland	339	93
Moist grass and sedge community	253	24
Acacia karroo – Acacia caffra thickets	0	0
Rocky scarp vegetation community	0	0

7.2.1.2 Habitat fragmentation

The proposed conveyor will be a major cause of habitat fragmentation. The conveyor corridor from Kusile Power Station to Site A will be routed along an existing tarred road and will be approximately 3 km long. Although it crosses a wetland, a large portion of the land between the power station and Site A is already transformed by the Kusile ash stack.

The conveyor corridor between Kusile Power Station and Site B is approximately 9 km long and will traverse across a large stretch of natural vegetation comprising numerous stream/wetlands and the Wilge River. The effects of habitat fragmentation caused by the conveyor to Site B will thus be considerably greater than that

for Site A. It will reduce habitat connectivity and prevent or severely restrict fauna movement and dispersal throughout the area. This may significantly affect local fauna populations.

Mitigation potential

Possible measures to mitigate the habitat fragmentation effects of the proposed conveyor include:

a) Aligning the conveyor with existing linear infrastructure (this is only really possible for the Site A option);

b) Routing the conveyor across the narrowest point of important and/or sensitive habitats, such as wetland areas; and

c) Constructing regular culverts or 'through-passages' along the conveyor to increase habitat connectivity and allow fauna to move across the barrier.

Although these measures can be implemented to some degree at both sites, the negative ecological impacts of the proposed corridor to Site B remain significant. For more detailed mitigation measures refer to Table 19.

7.2.2 Secondary impacts

Secondary impacts relevant to both Site A and B include:

d) Increased erosion and sedimentation of downstream drainage features;

e) Increased dust entrainment that typically accompanies vegetation clearing, earth works, exposed stockpiles and increased vehicle activity;

f) Potential increase in exotic invasive plant species encroachment as a consequence of vegetation disturbance;

g) Fauna species occurring at Site A may be disturbed, injured or even killed during the construction and operational phases, when vegetation clearing and earth works are initiated; and

h) A number of species of conservation importance occur, or potentially occur at Site A. These may be negatively impacted on by one or a combination of the above impacts.

All listed secondary impacts are equally likely to occur at both site options. Yet considering the length of the proposed Site B conveyor corridor and the number of potential stream/wetland crossings it will make, the potential incidences of erosion and exotic species encroachment will probably be far higher for this option.

Recommended mitigation measures for secondary impacts of concern are listed in Table 19.

7.3 Cumulative Impacts

Large portions of land immediately surrounding Site A are already transformed or will be transformed in the near future. Kusile Power station and its associated facilities have transformed the land to the north, while the proposed New Largo above-ground mining operation will transform the land to the east of Site A.

From a terrestrial perspective, the possible development of Site A will expand this cumulative transformation footprint around Kusile. It is worth noting however that, when compared to Site B, this cumulative transformation footprint is spatially concentrated around Kusile.

Conversely, the cumulative transformation footprint related to the development of Site B is extensive - crossing a provincial boundary, a number of streams and wetlands, and spanning different water catchments. The potential for negative environmental impacts to affect a far larger area is thus greater for Site B than it is for Site A.

7.4 Mitigation measures

Management and monitoring measures recommended to mitigate potential environmental impacts are listed in Table 19. Refer to APPENDIX H for the proposed management work plan sheets.

Table 19: Impacts and recommended mitigation/monitoring measures

Impact	Proposed mitigation measure
Habitat loss and degradation through vegetation clearing.	■ Vegetation clearing should be restricted to the proposed development footprints only, with no unnecessary clearing permitted outside of these areas. ■ Areas to be cleared should be marked/taped-off to prevent unnecessary clearing outside of these demarcated sites. ■ A nursery should be established to house species of conservation significance removed during site clearing. Alternatively conservation significant species should be taken to an existing nursery to temporarily house the plants. Only species known to successfully relocate should be moved. ■ Removed topsoil should be stockpiled and used to rehabilitate disturbed areas. Topsoil should ideally not be stockpiled for greater than 12 months and stockpiles should not exceed two metres in height. ■ It is recommended that an environmental control officer (ECO) be appointed during construction to oversee the vegetation clearing process. ■ A suitable rehabilitation programme should be developed and implemented in all disturbed areas post-construction. The ECO should be responsible for overseeing the rehabilitation programme. ■ It is recommended that monitoring of rehabilitated areas be undertaken to ensure successful stabilisation and revegetation of disturbed areas.
Habitat fragmentation through loss of habitat or the erection of artificial barriers.	■ Where possible, proposed linear infrastructure should be aligned with existing linear infrastructure or routed through already transformed / degraded areas. ■ Linear infrastructure should be routed across the narrowest point of important and/or sensitive habitats, such as wetland areas. ■ In order to prevent the obstruction of surface and subterranean water flow in wetland and aquatic environments, linear infrastructure should be raised above ground level and the footprint area required for foundation infrastructure should be kept to an absolute minimum. ■ To prevent the obstruction of fauna dispersal and movement patterns, culverts should be installed at regular intervals along conveyor routes, fences and access roads to allow easy access across the barrier.
Increase in erosion and possible sedimentation of drainage features.	■ Construct berms and sediment traps in construction areas where surface water run-off is likely. ■ Regularly inspect existing erosion sites or those potentially susceptible to erosion. ■ All sites displaying incidence of erosion must be actively stabilised and re-vegetated.
Increased dust generation.	■ All topsoil stockpiles and cleared areas should be re-vegetated, covered or kept moist to prevent dust generation. ■ Dust suppression through the use of water bowsers should be implemented on all exposed areas including roads, parking zones and lay down areas. Water spraying on high use roads should be prioritised. ■ All disturbed areas should be re-vegetated with indigenous species as per an approved rehabilitation plan.

Impact	Proposed mitigation measure
	■ All onsite traffic can be restricted to specific designated roads. Off-road travel can only be authorized on a case-by-case basis (e.g. access to a remote monitoring well, etc.). Traffic speed can also be restricted to an appropriate level on all designated roads.
Increased exotic and/or declared Category 1, 2 & 3 invader species.	■ An exotic species control programme, including monitoring, must be developed and implemented to reduce the encroachment of exotic invasive species. ■ It is recommended that the ECO be responsible for monitoring the nature and extent of on-site exotic, invasive plants.
Killing or injuring of fauna in the study area.	■ An ECO should be on-site during all construction activities to monitoring for and manage any wildlife-human interactions. ■ A low speed limited should be enforced on site to reduce wildlife-collisions. ■ Employees and contractors should be made aware of the presence of, and rules regarding fauna through suitable induction training and on-site signage.
Loss of species of conservation importance.	■ Prior to construction, all areas designated for vegetation clearing should be clearly marked and surveyed for Red Data/protected flora and fauna species. It is advised that an ECO be appointed to oversee this process; ■ Where possible, development footprints should be sited so as to exclude areas where Red Data/protected flora occur. ■ In the event that Red Data/protected flora are identified within the designated construction footprints and require relocation, rescue permits must be obtained from the provincial or relevant authority, and a suitable ex-situ, and/or in-situ conservation plan developed. The conservation plan must be approved by the provincial authority and overseen by the ECO.

7.5 Conclusions

Based on the comparative evaluation of Site A and B, the potential negative impacts on terrestrial ecology related to the developed of Site B are greater than that of Site A. It is therefore recommended, from a terrestrial ecology perspective, that Site A be the preferred option.

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Please note reference books, field guides and guidelines not necessarily referenced in the text but used in the field work and in the compilation of this report have also been included in the above reference list.

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APPENDIX A

Detailed Methodology

May 2014
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Literature Review Component

Vegetation

Flora species lists for the 2528DD grid squares were obtained from the PRECIS (National Herbarium Pretoria Computer Information System) database (SIBIS: South African Biodiversity Information Facility, 2009, internet) and the Plants of South Africa database (Plants of Southern Africa, 2009, internet). In addition, Mucina & Rutherford (2006) was consulted, as were the flora species lists detailed in previous reports related various aspects of the Kusile Power Station development. These include Du Preez (2006), Golder Report No. 10613-5792-1 (2007) and various monitoring reports.

Information relating to specific areas and species of concern for the study area and its surrounds was obtained from the Mpumalanga Tourism and Parks Agency and the Mpumalanga Biodiversity Conservation Plan (MBCP) (2006) online resource.

Mammals

A list of expected mammal species was compiled by consultation of a number of literature sources including Skinner & Smithers (1990), Stuart & Stuart (2007), Du Preez (2006) and Golder Report No. 10613-5792-1 (2007).

Birds

A list of expected bird species was compiled by consultation of a number of literature sources relevant to the study area, including the SANBI's SIBIS database (SIBIS: SABIF, 2009, internet), Sinclair *et al.* (2002), Du Preez (2006) and Golder Report No. 10613-5792-1 (2007).

Herpetofauna (reptiles and amphibians)

Expected reptile and amphibian species lists were compiled by consultation of various field guides and previous reports, including Golder Report No. 10613-5792-1 (2007), Branch (1994) and Alexander & Marais (2010) for reptiles, while Carruthers (2001) were used for amphibian species.

Red Data and protected flora and fauna

In order to assess the Red Data and / or protected status of species in the study area, the following sources were consulted:

- National Environmental Management: Biodiversity Act (No. 10 of 2004) – Lists of critically endangered, endangered, vulnerable and protected species (NEMBA TOPS List 2007);
- International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (2012);
- National Forests Act (No. 84 of 1998) – List of Protected Tree Species;
- Mpumalanga Nature Conservation Act (No. 10 of 1998):
  - Schedule 2: Protected Game;
  - Schedule 4: Protected Wild Animals;
  - Schedule 7: Protected Invertebrates;
  - Schedule 11: Protected Plants; and
  - Schedule 12: Specially Protected Plants.

Field Sampling Methodology

Vegetation sampling

As a first approximation, plant communities within the study area were roughly delineated based on satellite imagery. In order to study the vegetation in greater detail, relevés were selected according to on-site characteristics. These were surveyed during the wet/growing season from the 10-14th of January 2013.

Relevé data was collected in the field by means of point transects (for species occurring in the herbaceous layer) and belt transects (for tree and shrub species).

Species that were not identified in the field were photographed for identification at a later stage by consulting additional literature sources. Identification of plant species was undertaken using Germishuizen (1982), Van Wyk & Van Wyk (1997), Van Wyk & Malan (1998), Gerber et al. (2004), Pooley (2005), Bromilow (2010), Schmidt et al. 2002 and Van Oudtshoorn (1999) where applicable.

Fauna surveys

Fauna surveys were conducted from the 10-14th of January 2013.

Mammals

Small mammals were trapped by means of Sherman traps and Cage traps placed in a single grid at each of the fauna survey sites. Data collected from the Sherman and Cage trapping were augmented by actual visual sightings and/or observations of mammal tracks, faeces, burrows, feedings signs, as well as anecdotal evidence provided by local residents and land users. As required, Stuart & Stuart (2007) was used to identify mammals in the study area.

Birds

Bird surveys were conducted by means of point counts of 15 min each (Bibby *et al*. 1998) at each of the fauna survey sites. During the survey, bird species were identified either visually or through bird calls. Where necessary, identifications were verified using Sinclair *et al*. (2002). Particular attention was paid to suitable roosting, foraging and nesting habitats for Red Data and protected species.

Herpetofauna (Reptiles and Amphibians)

Active searching was conducted at each of the fauna survey sites. Active searching was conducted on foot and included searching all suitable habitats (rocks, logs, artificial cover, leaf litter, artificial litter, bark, pools and streams etc.), and scanning basking sites and places where specimens were likely to be found. Pitfall traps were also placed at each of the fauna survey sites. Branch (1994) was used to identify observed reptile species, while Carruthers (2001) was used to identify any amphibians found in the study area.

Arthropoda

Active searching, pitfall traps and sweep netting for arthropods were conducted at each of the fauna survey sites. Active searching was conducted on foot and included searching suitable habitats (rocks, logs, artificial cover, leaf litter, bark, leaf axils, etc.), and scanning sites where specimens were likely to be found. Migdoll (1994), Filmer (1995), Leeming (2003), Leroy & Leroy (2003) and Picker *et al* (2004) were used to identify species were applicable. Identification was done to the lowest possible taxonomic level.

Floristic Sensitivities Analysis

Floristic sensitivity analysis was determined by subjectively assessing the ecological integrity and conservation importance of the vegetation, as defined in the below.

Rating of ecological integrity and conservation importance

	Ecological integrity	**Conservation importance**
High	Sensitive ecosystems with either low inherent resistance or resilience towards disturbance factors or highly dynamic systems considered to be stable and important for the maintenance of ecosystems integrity (e.g. pristine grasslands, pristine wetlands and pristine ridges).	Ecosystems with high species richness and usually provide suitable habitat for a number of threatened species. Usually termed ‘no-go’ areas and unsuitable for development, and should be protected.
Moderate	Relatively important ecosystems at gradients of intermediate disturbances. An area may be	Ecosystems with intermediate levels of species diversity without any threatened

	Ecological integrity	Conservation importance
	considered of moderate ecological function if it is directly adjacent to sensitive/pristine ecosystem.	species. Low-density development may be allowed, provided the current species diversity is conserved.
Low	Degraded and highly disturbed systems with little or no ecological function.	Areas with little or no conservation potential and usually species poor (most species are usually exotic).

Red Data Assessment

Based on the potential Red Data species lists compiled during the literature review and on the findings of the field survey, the probability of occurrence of Red Data species in the study area were determined for each relevant taxon. The following parameters were used in the assessment:

Habitat requirements (HR): Most Red Data species have very specific habitat requirements and the presence of these habitat characteristics in the study area was evaluated.

Habitat status (HS): The status or ecological condition of available habitat in the area was assessed. Often a high level of habitat degradation prevalent in a specific habitat will negate the potential presence of Red Data species (this is especially evident in wetland habitats).

Habitat linkage (HL): Movement between areas for breeding and feeding forms an essential part of the existence of many species. Connectivity of the study area to surrounding habitat and the adequacy of these linkages are evaluated for the ecological functioning of Red Data species within the study area.

Probability of occurrence is presented in four categories, namely:

- Low;
- Moderate;
- High; and
- Recorded.

APPENDIX B

Plant species previously recorded in the 2528DD Quarter Degree Square

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Family	Scientific name
AGYRIACEAE	*Trapeliopsis parilis*
AMARANTHACEAE	*Aerva leucura*
AMARYLLIDACEAE	*Boophone disticha*
ANACARDIACEAE	*Rhus magalismontana subsp. magalismontana*
ANACARDIACEAE	*Sclerocarya birrea subsp. caffra*
ANACARDIACEAE	*Searsia magalismontana subsp. magalismontana*
APIACEAE	*Afrosciadium magalismontanum*
APIACEAE	*Heteromorpha arborescens var. abyssinica*
APOCYNACEAE	*Asclepias aurea*
APOCYNACEAE	*Asclepias brevipes*
APOCYNACEAE	*Asclepias fallax*
APOCYNACEAE	*Asclepias gibba var. gibba*
APOCYNACEAE	*Asclepias stellifera*
APOCYNACEAE	*Brachystelma rubellum*
APOCYNACEAE	*Catharanthus roseus*
APOCYNACEAE	*Cryptolepis oblongifolia*
APOCYNACEAE	*Gomphocarpus glaucophyllus*
APOCYNACEAE	*Pachycarpus schinzianus*
APOCYNACEAE	*Parapodium costatum*
APOCYNACEAE	*Raphionacme galpinii*
APOCYNACEAE	*Raphionacme hirsuta*
APOCYNACEAE	*Raphionacme velutina*
APONOGETONACEAE	*Aponogeton natalensis*
AQUIFOLIACEAE	*Ilex mitis var. mitis*
ASPARAGACEAE	*Asparagus flavicaulis subsp. flavicaulis*
ASPARAGACEAE	*Asparagus laricinus*
ASPHODELACEAE	*Aloe zebrina*
ASPHODELACEAE	*Chortolirion angolense*
ASPHODELACEAE	*Kniphofia ensifolia Baker subsp. ensifolia*
ASPHODELACEAE	*Kniphofia ensifolia subsp. ensifolia*
ASTERACEAE	*Acanthospermum australe*
ASTERACEAE	*Berkheya insignis*
ASTERACEAE	*Berkheya onopordifolia var. onopordifolia*
ASTERACEAE	*Callilepis laureola*
ASTERACEAE	*Crassocephalum x picridifolium*
ASTERACEAE	*Dicoma anomala subsp. anomala*
ASTERACEAE	*Dicoma macrocephala*
ASTERACEAE	*Felicia muricata subsp. cinerascens*
ASTERACEAE	*Helichrysum aureonitens*

Family	Scientific name
ASTERACEAE	*Helichrysum caespititium*
ASTERACEAE	*Helichrysum cerastioides var. cerastioides*
ASTERACEAE	*Helichrysum nudifolium var. nudifolium*
ASTERACEAE	*Helichrysum rugulosum*
ASTERACEAE	*Helichrysum setosum*
ASTERACEAE	*Helichrysum splendidum*
ASTERACEAE	*Lactuca inermis*
ASTERACEAE	*Macledium zeyheri subsp. argyrophyllum*
ASTERACEAE	*Nidorella hottentotica*
ASTERACEAE	*Schistostephium crataegifolium*
ASTERACEAE	*Senecio burchellii*
ASTERACEAE	*Senecio coronatus*
ASTERACEAE	*Senecio latifolius*
ASTERACEAE	*Seriphium plumosum*
ASTERACEAE	*Vernonia oligocephala*
ASTERACEAE	*Vernonia poskeana subsp. botswanica*
BRYACEAE	*Bryum argenteum*
CAPPARACEAE	*Maerua cafra*
CARYOPHYLLACEAE	*Corrigiola litoralis subsp. litoralis var. perennans*
CARYOPHYLLACEAE	*Dianthus mooiensis subsp. mooiensis var. mooiensis*
CARYOPHYLLACEAE	*Dianthus transvaalensis*
CELASTRACEAE	*Gymnosporia tenuispina*
COMMELINACEAE	*Cyanotis speciosa*
CONVOLVULACEAE	*Ipomoea crassipes var. crassipes*
CONVOLVULACEAE	*Ipomoea magnusiana*
CONVOLVULACEAE	*Ipomoea oenotherae*
CRASSULACEAE	*Crassula capitella. subsp. nodulosa*
CRASSULACEAE	*Crassula setulosa var. setulosa forma setulosa*
CRASSULACEAE	*Kalanchoe thyrsiflora*
CYPERACEAE	*Bulbostylis burchellii*
CYPERACEAE	*Bulbostylis densa subsp. afromontana*
CYPERACEAE	*Bulbostylis hispidula subsp. pyriformis*
CYPERACEAE	*Cyperus obtusiflorus var. obtusiflorus*
CYPERACEAE	*Fuirena stricta*
CYPERACEAE	*Lipocarpha nana*
CYPERACEAE	*Pycreus pumilus*
CYPERACEAE	*Schoenoplectus corymbosus*
CYPERACEAE	*Scirpoides burkei*
DICRANACEAE	*Campylopus savannarum*

Family	Scientific name
DIPSACACEAE	*Cephalaria decurrens*
ERICACEAE	*Erica drakensbergensis*
ERIOCAULACEAE	*Eriocaulon abyssinicum*
EUPHORBIACEAE	*Acalypha angustata*
EUPHORBIACEAE	*Euphorbia clavarioides var. clavarioides*
EUPHORBIACEAE	*Euphorbia inaequilatera var. inaequilatera*
EXORMOTHECACEAE	*Exormotheca holstii*
FABACEAE	*Chamaecrista mimosoides*
FABACEAE	*Dichrostachys cinerea subsp. nyassana*
FABACEAE	*Eriosema psoraleoides*
FABACEAE	*Indigofera arrecta*
FABACEAE	*Indigofera cryptantha var. cryptantha*
FABACEAE	*Indigofera hilaris var. hilaris*
FABACEAE	*Indigofera oxytropis*
FABACEAE	*Indigofera zeyheri*
FABACEAE	*Leobordea foliosa*
FABACEAE	*Neorautanenia ficifolia*
FABACEAE	*Pearsonia sessilifolia subsp. filifolia*
FABACEAE	*Rhynchosia monophylla*
FABACEAE	*Rhynchosia nervosa var. nervosa*
FABACEAE	*Sphenostylis angustifolia*
FABACEAE	*Tephrosia elongata var. elongata*
FABACEAE	*Virgilia divaricata*
FABACEAE	*Virgilia divaricata*
FABACEAE	*Zornia milneana*
FOSSOMBRONIACEAE	*Fossombronia gemmifera*
HALORAGACEAE	*Myriophyllum aquaticum*
HALORAGACEAE	*Myriophyllum spicatum*
HYACINTHACEAE	*Albuca setosa*
HYACINTHACEAE	*Schizocarphus nervosus*
HYPOXIDACEAE	*Hypoxis filiformis*
HYPOXIDACEAE	*Hypoxis filiformis Baker*
HYPOXIDACEAE	*Hypoxis hemerocallidea*
HYPOXIDACEAE	*Hypoxis rigidula var. pilosissima*
IRIDACEAE	*Gladiolus crassifolius*
IRIDACEAE	*Lapeirousia sandersonii*
ISOETACEAE	*Isoetes transvaalensis*
LAMIACEAE	*Mentha aquatica*
LAMIACEAE	*Ocimum angustifolium*

Family	Scientific name
LAMIACEAE	*Pycnostachys reticulata*
LENTIBULARIACEAE	*Utricularia stellaris*
MALPIGHIACEAE	*Triaspis hypericoides subsp. nelsonii*
MALVACEAE	*Hermannia geniculata*
MALVACEAE	*Hermannia sp.*
MALVACEAE	*Pavonia transvaalensis*
MALVACEAE	*Triumfetta obtusicornis*
MENYANTHACEAE	*Nymphoides thunbergiana*
MESEMBRYANTHEMACEAE	*Delosperma sp.*
MESEMBRYANTHEMACEAE	*Frithia humilis*
MESEMBRYANTHEMACEAE	*Mossia intervallaris*
MOLLUGINACEAE	*Limeum viscosum subsp. viscosum var. glomeratum*
MORACEAE	*Ficus abutilifolia*
MORACEAE	*Ficus salicifolia*
NYMPHAEACEAE	*Nymphaea nouchali var. caerulea*
OCHNACEAE	*Ochna gamostigmata*
ONAGRACEAE	*Epilobium hirsutum*
ONAGRACEAE	*Epilobium hirsutum*
ORCHIDACEAE	*Centrostigma occultans*
ORCHIDACEAE	*Habenaria clavata*
ORCHIDACEAE	*Satyrium hallackii subsp. ocellatum*
OROBANCHACEAE	*Striga gesnerioides*
PALLAVICINIACEAE	*Symphyogyna brasiliensis*
PANNARIACEAE	*Psoroma sp.*
PARMELIACEAE	*Canoparmelia pustulescens*
PEDALIACEAE	*Dicerocaryum senecioides*
PHYLLANTHACEAE	*Phyllanthus maderaspatensis*
POACEAE	*Alloteropsis semialata subsp. eckloniana*
POACEAE	*Andropogon eucomus*
POACEAE	*Andropogon schirensis*
POACEAE	*Andropogon schirensis*
POACEAE	*Aristida aequiglumis*
POACEAE	*Aristida congesta subsp. barbicollis*
POACEAE	*Aristida junciformis subsp. galpinii*
POACEAE	*Aristida stipitata subsp. graciliflora*
POACEAE	*Bewsia biflora*
POACEAE	*Brachiaria serrata*
POACEAE	*Calamagrostis epigejos var. capensis*
POACEAE	*Ctenium concinnum*

Family	Scientific name
POACEAE	*Cymbopogon caesius*
POACEAE	*Cynodon dactylon*
POACEAE	*Digitaria brazzae*
POACEAE	*Digitaria monodactyla*
POACEAE	*Digitaria tricholaenoides*
POACEAE	*Diheteropogon amplectens var. amplectens*
POACEAE	*Diheteropogon amplectens var. amplectens*
POACEAE	*Echinochloa jubata*
POACEAE	*Elionurus muticus*
POACEAE	*Eragrostis capensis*
POACEAE	*Eragrostis chloromelas*
POACEAE	*Eragrostis curvula*
POACEAE	*Eragrostis gummiflua*
POACEAE	*Eragrostis hierniana*
POACEAE	*Eragrostis inamoena*
POACEAE	*Eragrostis plana*
POACEAE	*Eragrostis racemosa*
POACEAE	*Eragrostis sclerantha subsp. sclerantha*
POACEAE	*Eragrostis tef*
POACEAE	*Heteropogon contortus*
POACEAE	*Hyparrhenia hirta*
POACEAE	*Hyparrhenia quarrei*
POACEAE	*Hyparrhenia tamba*
POACEAE	*Hyperthelia dissoluta*
POACEAE	*Loudetia simplex*
POACEAE	*Melinis nerviglumis*
POACEAE	*Melinis repens subsp. repens*
POACEAE	*Microchloa caffra*
POACEAE	*Miscanthus junceus*
POACEAE	*Monocymbium ceresiiforme*
POACEAE	*Panicum natalense*
POACEAE	*Paspalum scrobiculatum*
POACEAE	*Paspalum urvillei*
POACEAE	*Perotis patens*
POACEAE	*Pogonarthria squarrosa*
POACEAE	*Schizachyrium sanguineum*
POACEAE	*Schizachyrium ursulus*
POACEAE	*Setaria nigrirostris*
POACEAE	*Setaria sphacelata var. sphacelata*

Family	Scientific name
POACEAE	*Setaria sphacelata var. torta*
POACEAE	*Sporobolus africanus*
POACEAE	*Sporobolus pectinatus*
POACEAE	*Sporobolus stapfianus*
POACEAE	*Themeda triandra*
POACEAE	*Trichoneura grandiglumis*
POACEAE	*Tristachya biseriata*
POACEAE	*Tristachya leucothrix*
POACEAE	*Tristachya rehmannii*
POACEAE	*Urelytrum agropyroides*
POACEAE	*Urochloa brachyura*
POLYGALACEAE	*Polygala ohlendorfiana*
POLYGALACEAE	*Polygala transvaalensis subsp. transvaalensis*
PORTULACACEAE	*Anacampseros subnuda*
PORTULACACEAE	*Portulaca hereroensis*
PORTULACACEAE	*Portulaca quadrifida*
POTAMOGETONACEAE	*Potamogeton schweinfurthii*
PROTEACEAE	*Protea caffra subsp. caffra*
PROTEACEAE	*Protea welwitschii*
RANUNCULACEAE	*Ranunculus meyeri*
RICCIACEAE	*Riccia atropurpurea*
RICCIACEAE	*Riccia okahandjana*
RICCIACEAE	*Riccia volkii*
RUBIACEAE	*Kohautia cynanchica*
RUBIACEAE	*Pentanisia prunelloides subsp. latifolia*
RUBIACEAE	*Richardia scabra*
SALICACEAE	*Populus sp.*
SANTALACEAE	*Thesium transvaalense*
SCROPHULARIACEAE	*Chaenostoma leve*
SCROPHULARIACEAE	*Hebenstretia angolensis*
SCROPHULARIACEAE	*Hebenstretia angolensis*
SCROPHULARIACEAE	*Nemesia sp.*
SCROPHULARIACEAE	*Selago densiflora*
SELAGINELLACEAE	*Selaginella dregei*
SINOPTERIDACEAE	*Cheilanthes viridis var. glauca*
THELYPTERIDACEAE	*Thelypteris confluens*
THYMELAEACEAE	*Gnidia sericocephala*
VELLOZIACEAE	*Xerophyta retinervis*
VERBENACEAE	*Lippia javanica*

Family	Scientific name
VERBENACEAE	*Verbena bonariensis*
XYRIDACEAE	*Xyris capensis*
ZAMIACEAE	*Encephalartos lanatus*

Sources: Plants of Southern Africa (Internet, Accessed: January 2013) and SIBIS South African Biodiversity Facility (Internet, Accessed: January 2013)

APPENDIX C

Mammals potentially occurring in the study area

May 2014
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Scientific name	Common name
Aethomys ineptus	Tete veld rat
Amblysomus robustus	Robust golden mole
Amblysomus septentrionalis	Highveld golden mole
Antidorcas marsupialis	Springbok
Aonyx capensis	Cape Clawless otter
Atelerix frontalis	South African Hedgehog
Atilax paludinosus	Water mongoose
Canis adustus	Side-striped jackal
Canis mesomelas	Black-backed jackal
Caracal caracal	Caracal
Chrysospalax villosus	Rough-haired golden mole
Crocidura cyanea	Reddish-grey musk shrew
Crocidura flavescens	Greater Musk Shrew
Crocidura mariquensis	Swamp musk shrew
Crocidura silacea	Lesser Grey-brown musk shrew
Cryptomys hottentotus	Common molerat
Cynictis penicillata	Yellow mongoose
Damaliscus pygargus phillipsi	Blesbok
Dasymys incomtus	Water rat
Dendromus mesomelas	Brant's climbing mouse
Elephantulus myurus	Rock Elephant-shrew
Felis nigripes	Black-footed cat
Felis sylvestris	African wild cat
Galerella sanguinea	Slender mongoose
Genetta tigrina	Large-spotted genet
Georychus capensis	Cape molerat
Huaena burnea	Brown Hyaena
Hystrix africaeaustralis	Porcupine
Ichneumia albicauda	White-tailed mongoose
Ictonyx striatus	Striped polecat
Leptailurus serval	Serval
Lepus capensis	Cape hare
Lepus saxatilis	Scrub hare
Lutra maculicollis	Spotted-necked Otter
Mastomys coucha	Multimammate mouse
Mellivora capensis	Honey Badger
Micaelamys namaquensis	Namaqua rock mouse
Miniopterus natalensis	Natal long-fingered bat
Mus minutoides	Pygmy mouse
Myosorex cafer	Dark-footed Forest Shrew
Myosorex varius	Forest Shrew
Neoromicia capensis	Cape serotine bat
Orycteropus afer	Aardvark
Otomys angoniensis	Angoni vlei rat
Otomys irroratus	Vlei rat

Scientific name	Common name
Ourebia ourebi	Oribi
Pelea capreolus	Grey Rhebok
Poecilogale albinucha	African Striped weasel
Potamochoerus procus	Bush Pig
Procavia capensis	Rock Hyrax
Proteles cristatus	Aardwolf
Raphicerus campestris	Steenbok
Redunca fulvorufula	Mountain Reedbuck
Rhabdomys pumilio	Striped mouse
Rhinolophus clivosus	Geoffroy's horseshoe bat
Steatomys pratensis	Fat mouse
Suncus varilla	Lesser Dwarf Shrew
Suricata suricatta	Suricate
Sylvicapra grimmia	Common duiker
Tadarida aegyptiaca	Egyptian free-tailed bat
Tatera brantsii	Highveld gerbil
Thryonomys swinderianus	Greater Cane Rat
Vulpes chama	Cape fox

Source: Stuart & Stuart (1997)

APPENDIX D

Bird species potentially occurring in the study area

May 2014
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Scientific name	Common name
Accipiter melanoleucus	Black Sparrowhawk
Accipiter minullus	Little Sparrowhawk
Accipiter ovampensis	Ovambo Sparrowhawk
Accipiter rufiventris	Redbreated sparrow hawk
Acridotheres tristis	Indian Myna
Acrocephalus arundinaceus	Greet reed Warlber
Acrocephalus baeticatus	African Marsh Wabler
Acrocephalus gracilirostris	Cape Reed Warbler
Actitis hypoleucos	Common Sandpiper
Alcedo cristata	Malachite Kingfisher
Alcedo semitorquata	Halfcollared Barbet
Alopochen aegyptiaca	Egyptian Goose
Amadina erythrocephala	Redheaded finch
Amadina fasciata	Cuthroat Finch
Amandava subflava	Organe breasted waxbill
Amaurornis flavirostris	Black crake
Amblyospiza albifrons	Thick-billed weaver
Anaplectes rubriceps	Red-headed weaver
Anas capensis	Cape Teal
Anas erythrorhyncha	Red-billed teal
Anas hottentota	Hottentot Teal
Anas smithii	Cape Shoveller
Anas sparsa	African Black Duck
Anas undulata	Yellow-billed Duck
Andropadus importunus	Sombre bulbul
Anhinga rufa	Darter
Anomalospiza imberbis	Cuckoofinch
Anthropoides paradiseus	Blue Crane
Anthus chloris	Yellow-breasted Pipit
Anthus cinnamomeus	Grassveld pipit
Anthus leucophrys	Plain backed Pipit
Anthus similis	Long billed Pipit
Anthus vaalensis	Buffy pipit
Apalis thoracica	Black throated Apalis
Apus affinis	Little Swift
Apus barbatus	Black Swift
Apus caffer	White rumped Swift
Apus horus	Horus Swift
Ardea cinerea	Grey Heron

Scientific name	Common name
Ardea goliath	Goliath Heron
Ardea melanocephala	Blackheaded Heron
Ardea purpurea	Purple Heron
Ardeola ralloides	Squacco Heron
Asio capensis	Marsh Owl
Aviceda cuculoides	Cuckoo Hawk
Balearica regulorum	Crowned Crane
Batis capensis	Cape Batis
Batis molitor	Chinspot Batis
Bostrychia hagedash	Hadeda Ibis
Bradypterus baboecala	African Sedge warbler
Bubo africanus	Spotted Eagle Owl
Bubo capensis	Cape Eagle Owl
Bubulcus ibis	Cattle Egret
Bugeranus carunculatus	Wattled Crane
Burhinus capensis	Spotted Thick-knee
Buteo rufofuscus	Jackal Buzzard
Buteo vulpinus	Steppe Buzzard
Butorides striata	Greenbacked Heron
Calandrella cinerea	Red capped lark
Calendulauda sabota	Sabota Lark
Calidris ferruginea	Curlew Sandpiper
Calidris minuta	Little Stint
Caprimulgus europaeus	Eurasian Nightjar
Caprimulgus tristigma	Freckled Nightjar
Centropus burchelli	Burchell's Coucal
Cercomela familiaris	Familiar Chat
Cercotrichas leucophrys	White-browed Scrub Robin
Certhilauda curvirostris	Long-billed Lark
Ceryle rudis	Pied Kingfisher
Chalcomitra amethystina	Black Sunbird
Charadrius hiaticula	Ringed Lapwing
Charadrius pecuarius	Kittlitz's Lapwing
Charadrius tricollaris	Three-banded Lapwing
Chersomanes albofasciata	Spike heeled Lark
Chlidonias hybrida	Whiskered Tern
Chlidonias leucopterus	White winged tern
Chloropeta natalensis	Yellow Warbler
Chrysococcyx caprius	Diederik's Cuckoo

Scientific name	Common name
Chrysococcyx klaas	Klaas's Cuckoo
Ciconia abdimii	Adbims' Stork
Ciconia ciconia	White Stork
Ciconia nigra	Black Stork
Cinnyricinclus leucogaster	Plum collared Starling
Cinnyris afer	Greater Double-collared Sunbird
Cinnyris mariquensis	Marico Sunbird
Cinnyris talatala	White bellied Sunbird
Circaetus cinereus	Brown Snake Eagle
Circaetus pectoralis	Black breasted snake Eagle
Circus ranivorus	African Marsh Harrier
Cisticola aberrans	Lazy Cisticola
Cisticola aridulus	Desert Cisticola
Cisticola ayresii	Ayre's Cisticola
Cisticola chiniana	Rattling Cisticola
Cisticola fulvicapilla	Neddicky
Cisticola juncidis	Fantailed Cisticola
Cisticola lais	Wailing Cisticola
Cisticola textrix	Cloud Cisticola
Cisticola tinniens	Levaillant's Cisticola
Clamator jacobinus	Jacobin's Cuckoo
Coccopygia melanotis	Swee Waxbill
Colius striatus	Speckled Mousebird
Columba arquatrix	Rameron Pigeon
Columba guinea	Rock Pigeon
Columba livia	Feral pigeon
Coracias caudatus	Lilac-breasted Roller
Coracias garrulous	Eurasian Roller
Corvus albus	Pied Crow
Corvus capensis	Black Crow
Corythaixoides concolor	Grey Lourie
Cossypha caffra	Cape Robin
Cossypha humeralis	White throated robin
Coturnix coturnix	Common Quail
Coturnix delegorguei	Harlequin Quail
Creatophora cinerea	Wattled Starling
Crithagra atrogularis	Black-throated Canary
Crithagra gularis	African Cuckoo
Crithagra mozambicus	Yellow-fronted Canary

Scientific name	Common name
Cuculus solitarius	Red-chested Cuckoo
Cursorius temminckii	Temminck's Courser
Cypsiurus parvus	Palm Swift
Delichon urbicum	House Martin
Dendrocygna viduata	White-faced Duck
Dendroperdix sephaena	Crested Francolin
Dendropicos fuscescens	Cardinal Woodpecker
Dicrurus adsimilis	Fork tailed Drongo
Dryoscopus cubla	Puffback
Egretta alba	Great White Egret
Egretta ardesiaca	Black Egret
Egretta garzetta	Little Egret
Egretta intermedia	Yellowbilled Egret
Elanus caeruleus	Blackshouldered Kite
Emberiza capensis	Cape Bunting
Emberiza flaviventris	Golden breasted Bunting
Emberiza tahapisi	Rock Bunting
Eremopterix leucotis	Chestnut-backed Sparrow-lark
Estrilda astrild	Common Waxbill
Euplectes afer	Golden Bishop
Euplectes albonotatus	White winged Widow
Euplectes ardens	Red-collared Widow
Euplectes axillaris	Red-shouldered Widow
Euplectes capensis	Yellow-rumped Widow
Euplectes orix	Red Bishop
Euplectes progne	Longtailed Widow
Eupodotis afra	Southern Black Korhaan
Eupodotis caerulescens	Blue Korhaan
Eupodotis senegalensis	White-bellied Korhaan
Falco amurensis	Eastern Red-footed Kestrel
Falco rupicolis	Rock Kestrel
Falco rupicoloides	Greater Kestrel
Fulica cristata	Red-knobbed Coot
Gallinago nigripennis	Ethiopian Snipe
Gallinula chloropus	Common Moorhen
Geronticus calvus	Bald Ibis
Glareola nordmanni	Blackwinged Pratincole
Glaucidium perlatum	Pearl Spotted Owl
Granatina granatina	Violet eared Waxbill

Scientific name	Common name
Halcyon albiventris	Brown hooded Kingfisher
Halcyon senegalensis	Woodland Kingfisher
Haliaetus vocifer	African Fish Eagle
Himantopus himantopus	Black winged Stilt
Hirundo abyssinica	Lesser Striped Swallow
Hirundo cucullata	Greater Striped Swallow
Hirundo dimidiata	Pearl-breasted Swallow
Hirundo fuligula	Rock Martin
Hirundo rustica	Eurasian Swallow
Hirundo semirufa	Red-breasted Swallow
Hirundo spilodera	South African Cliff Swallow
Indicator indicator	Greater Honeyguide
Indicator minor	Lesser Honeyguide
Ixobrychus minutus	Little Bittern
Jynx ruficollis	Red throated Wryneck
Lagonosticta rhodopareia	Jameson's Firefinch
Lagonosticta rubricata	Blue billed Firefinch
Lagonosticta senegala	Redbilled Firefinch
Lamprotornis nitens	Glossy Starling
Laniarius atrococcineus	Crimson breasted Shrike
Laniarius ferrugineus	Southern Boubou
Lanius collaris	Fiscal Shrike
Lanius collurio	Red-backed Shrike
Lanius minor	Lesser Grey Shrike
Larus cirrocephalus	Greyheaded Gull
Lissotis melanogaster	Black-bellied Korhaan
Locustella fluviatilis	Riber Wabbler
Lybius torquatus	Black collared Barbet
Macronyx capensis	Orange throated Longclaw
Malaconotus blanchoti	Greyheaded Bush Shrike
Megaceryle maximus	Giant Kingfisher
Melaenornis pammelaina	Black Flycatcher
Merops apiaster	Eurasian Bee-eater
Merops bullockoides	White fronted Bee-eater
Merops pusillus	Little Bee-eater
Milvus migrans	Black Kite
Mirafra africana	Rufousnaped Lark
Mirafra apiata	Cape clapper Lark
Mirafra rufocinnamomea	Flappet Lark

Scientific name	Common name
Monticola explorator	Sentinel Rockthrush
Motacilla aguimp	African Pied Wagtail
Motacilla capensis	Cape Wagtail
Muscicapa striata	Spotted Flycatcher
Myrmecocichla formicivora	Ant-eating Chat
Nectarinia famosa	Malachite Sunbird
Neoscona moreli	Malachite Sunbird
Neotis denhami	Stanley's Bustard
Netta erythrophthalma	Southern Pochard
Nilaus afer	Brubru
Numida meleagris	Helmeted Guineafowl
Nycticorax nycticorax	Black-crowned Night Heron
Oena capensis	Namaqua Dove
Oenanthe bifasciata	Buff-streaked Chat
Oenanthe monticola	Mountain Chat
Oenanthe pileata	Capped Wheatear
Onychognathus morio	Red-winged Starling
Oriolus larvatus	Blackheaded Oriole
Ortygospiza atricollis	Quail Finch
Oxyura maccoa	Maccoa Duck
Parisoma subcaeruleum	Titbabbler
Parus niger	Southern Black Tit
Passer diffusus	Southern Greyheaded Sparrow
Passer domesticus	House Sparrow
Passer melanurus	Cape Sparrow
Peliperdix coqui	Coqui Francolin
Petronia superciliaris	Yellow-throated Sparrow
Phalacrocorax africanus	Reed Cormorant
Phalacrocorax lucidus	White-breasted Cormorant
Phoenicopterus minor	Lesser Flamingo
Phoenicopterus ruber	Greater Flamingo
Phoeniculus purpureus	Red-billed Woodhoopoe
Phylloscopus trochilus	Willow Warbler
Platalea alba	African Spoonbill
Plectropterus gambensis	Spurwinged Goose
Plegadis falcinellus	Glossy Ibis
Plocepasser mahali	White-browed Sparrowweaver
Ploceus capensis	Cape Weaver
Ploceus cucullatus	Spotted-backed Weaver

Scientific name	Common name
Ploceus intermedius	Lesser Masked Weaver
Ploceus ocularis	Spectacled Weaver
Ploceus velatus	Masked Weaver
Ploceus xanthops	Golden Weaver
Podica senegalensis	African Finfoot
Podiceps cristatus	Great Crested Grebe
Podiceps nigricollis	Blacknecked Grebe
Pogoniulus chrysoconus	Yellow-fronted Tinker Barbet
Polyboroides typus	Gymnogene
Porphyrio madagascariensis	Purple Gallinule
Prinia flavicans	Black-chested Prinia
Prinia hypoxantha	Spotted Prinia
Prinia subflava	Tawny-flanked Prinia
Prionops plumatus	White Helmetshrike
Psophocichla litsipsirupa	Groundscraper Thrush
Pternistis natalensis	Natal Francolin
Pternistis swainsonii	Swainson's Francolin
Pycnonotus tricolor	Blackeyed Bulbul
Pytilia melba	Melba Finch
Quelea quelea	Redbilled Quelea
Rallus caerulescens	African Rail
Recurvirostra avosetta	Pied Avocet
Riparia cincta	Banded Martin
Riparia paludicola	Brown-throated Martin
Sagittarius serpentarius	Secretarybird
Sarkidiornis melanotos	Knobbilled Duck
Saxicola torquatus	Stonechat
Scleroptila levaillantii	Redwing Francolin
Scleroptila shelleyi	Shelley's Francolin
Scopus umbretta	Hamerkop
Serinus canicollis	Cape Canary
Sphenoeacus afer	Grassbird
Spizocorys conirostris	Pink-billed Lark
Spreo bicolor	Pied Starling
Streptopelia capicola	Cape Turtle Dove
Streptopelia semitorquata	Red-eyed Dove
Streptopelia senegalensis	Laughing Dove
Struthio camelus	Ostrich
Sylvia borin	Garden Warbler

Scientific name	Common name
Sylvietta rufescens	Long-billed Crombec
Tachybaptus ruficollis	Dabchick
Tachymarptis melba	Alpine Swift
Tchagra australis	Three-streaked Tchagra
Tchagra senegalus	Black-crowned Tchagra
Telophorus zeylonus	Bokmakierie
Terpsiphone viridis	Paradise Flycatcher
Thalassornis leuconotus	White-backed Duck
Thamnolaea cinnamomeiventris	Mocking Chat
Threskiornis aethiopicus	Sacred Ibis
Tockus nasutus	African grey Hornbill
Trachyphonus vaillantii	Crested Barbet
Treron calvus	African Green Pigeon
Tricholaema leucomelas	Pied Barbet
Tringa glareola	Wood Sandpiper
Tringa nebularia	Greenshank
Tringa stagnatilis	Marsh Sandpiper
Turdoides jardineii	Arrow-marked Babbler
Turdus libonyanus	Kurrichane Thrush
Turdus olivaceus	Olive Thrush
Turnix sylvaticus	Kurrichane Buttonquail
Turtur chalcospilos	Green-spotted Wood Dove
Tyto alba	Barn Owl
Tyto capensis	Grass Owl
Upupa africana	African Hoopoe
Uraeginthus angolensis	Blue Waxbill
Urocolius indicus	Red-faced Mousebird
Vanellus armatus	Blacksmith Lapwing
Vanellus coronatus	Crowned Lapwing
Vanellus melanopterus	Black-winged Lapwing
Vanellus senegallus	Wattled Lapwing
Vidua funerea	Black Widowfinch
Vidua macroura	Pintailed Whydah
Zosterops pallidus	Cape White-eye

Source: PRECIS Database - SIBIS South African Biodiversity Facility (Internet, Accessed: September 2011)

APPENDIX E

Herpetofauna potentially occurring in the study area

May 2014
Report No. 13614949-11847-1

Scientific name	Common name
Reptiles	
Agama aculeata	Ground agama
Aparallactus capensis	Cape centipede eater
Bitis arietans	Puff adder
Causus rhombeatus	Rhombic night adder
Chammaesaura aenea	Transvaal grass lizard
Ichnotropis squamulosa	Common Rough-scaled Lizard
Nucras taeniolata	Ornate Sandveld Lizard
Cordylus vittifer	Transvaal Girdled Lizard
Crotaphopeltis hotamboeia	Red-lipped snake
Dasypeltis scabra	Rhombic egg eater
Duberria lutrix	Common slug eater
Elapsoidea sundevallii	Sundevall's garter snake
Gerrhosaurus flavigularis	Yellow-throated plated lizard
Hemachatus heamachatus	Rinkhals
Homoroselaps dorsalis	Striped harlequin snake
Homoroselaps lacteus	Spotted harlequin snake
Lamprophis aurora	Aurora house snake
Lamprophis fuliginosus	Brown house snake
Leptotyphlops conjunctus	Cape thread snake
Leptotyphlops distanti	Distant’s Thread Snake
Leptotyphlops scutifrons	Peter's thread snake
Lycodonomorphus rufulus	Common brown water snake
Lycophidion capense	Cape wolf snake
Naja haje	Egyptian Cobra
Naja mossambica	Mozambique spitting cobra
Philothamnus hoplogaster	Green water snake
Philothamnus natalensis	Natal green snake
Psammophis crucifer	Montane grass snake
Psammophylax rhombeatus	Rhombic skaapsteker
Panaspis wahlbergii	Wahlberg’s Snake-eyed skink
Pseudaspis cana	Mole snake
Tetradactylus breyeri	Breyer’s Long-tailed Seps
Typhlops bibronii	Bibron's blind snake
Typhlops lalandei	Delalandes blind snake
Varanus exanthematicus	Rock monitor
Varanus niloticus	Water monitor
Kinixys belliana	Bell’s Hinged Tortoise
Typhlops schlegelii	Schlegel’s Blind Snake
Leptotyphlops nigricans	Black Thread Snake
Psammophylas tritaeniatus	Striped Skaapsteker
Atractaspis bibronii	Southern Burrowing Asp
Philothamnus semivariegatus	Spotted Bush Snake
Pedioplanis lineoocellata	Spotted Sand Snake
Mabuya capensis	Cape skink
Mabuya striata	Striped skink
Mabuya varia	Variable skink
Acontias gracilicauda	Thin-tailed Legless skink
Pachydactylus capensis	Cape thick-toed gecko

Scientific name	Common name
Pelomedusa subrufa	Marsh terrapin
Chamaeleo dilepis	Flap-neck Chameleon

Amphibians

Bufo gutturalis	Guttural Toad
Bufo garmani	Eastern olive Toad
Bufo rangeri	Raucous Toad
Schismaderma carens	Red Toad
Kassina senegalensis	Bubbling Kassina
Semnodactylus wealii	Rattling Frog
Breviceps adspersus	Bushveld rain Frog
Breviceps mossambicus	Mozambique rain Frog
Xenopus laevis	Common Platanna
Cacosternum boettgeri	Common Caco
Phrynobatrachus natalensis	Snoring puddle Frog
Afrana angolensis	Common river Frog
Afrana fuscigula	Cape river Frog
Ptychadena porosissima	Striped grass frog
Pyxicephalus adspersus	Giant Bullfrog
Strongylopus fasciatus	Striped stream Frog
Strongylopus grayii	Clicking stream Frog
Tomopterna cryptotis	Tremelo sand Frog
Tomopterna natalensis	Natal sand Frog

Sources: Branch (1994) & Carruthers (2001)

APPENDIX F

Arthopoda taxa recorded in and near the study area

May 2014
Report No. 13614949-11847-1

Family	Genus
Coenagrionidae	*Ceriagron glabrum*
	Pseudagrion hageni
Gomphidae	*Ictinogomphus ferox*
Aeshnidae	*Aeshna miniscula*
	Anax imperator
Libellulidae	*Nothiothemis jonesi*
	Trithemis stictica
	Trithemis annulata
	Brachythemis leucosticta
	Crocothemis sanguinolenta
Blattidae	*Deropeltis erythrocephala*
	Periplenata americana
Blatellidae	*Blatella germanica*
Blaberidae	*Derocalymma*
Pseudophyllodromiidae	*Supella dimidiata*
Termitidae	*Macrotermes natalensis*
Hymenopodidae	*Harpagomantis tricolor*
Mantidae	*Sphodromantis gastrica*
	Miomantis sp.
Empusidae	*Empusa guttula*
Libiduridae	*Euborellia annuplipes*
Anostostomatidae	*Onosandrus sp.*
Bradyporidae	*Hetrodes pupus*
Danainae	*Danaus chrysippus aegyptius*
Tettigonidae	*Phaneroptera sp.*
	Eurycorypha sp.
	Phaneroptera sp.
Gryllidae	*Gryllus bimaculatus*
	Gryllotalpidae sp.
Pamphagidae	*Hoplolopha sp.*
Pyrgomorphidae	*Zonocerus elegans*
Lentulidae	*Lentula sp.*
Acrididae	*Acrida acuminata*
	Truxaloides sp.
	Cyrtacnthacris aeruginosa
	Locustana pardalina
	Acanthacris ruficornis
	Sphigonotus scabriculus
	Rhachitopis sp.
Phasmatidae	*Palophus reyi*
Miridae	*Deraeocoris sp.*
Tingidae	*Phyllontochila walbergi*
Reduviidae	*Etrichodia crux*
	Glymmatophora
	Lopodytes grassator

Family	Genus
Plataspidae	*Solenostethium lilligerum*
Alydidae	*Mirperus faculus*
Pentatomidae	*Nezara viridula*
Scarabidae	*Gymnopleurus humanus*
	Anachalcos convexus
	Copris mesacanthus
Cerambycidae	*Prosopocera lactator*
	Macrotoma palmata
	Acanthophorus confinis
Carabidae	*Passalidius fortipes*
	Acanthoscelis ruficornis
	Anthia maxillosa
Melirydae	*Melyris sp.*
Tennebrionidae	*Psammodes striatus*
	Stenocara dentata
	Dichtha incantatoris
Meloidae	*Actenoidia curtula*
Curculionidae	*Prionorhinus canus*
	Brachycerus ornatus
Myrmeleontidae	*Centroclisi sp.*
	Cymothales sp.
	Hagenomyia tristis
Tabanidae	*Philoliche rostrata*
Culicidae	*Aedes sp.*
	Culex sp.
Bombyliidae	*Exoprosopa sp.*
Calliphoridae	*Chrysomya chloropyga*
Saturniidae	*Bunaea alcinoe*
Pieridae	*Eurema brigitta*
Nymphalidae	*Hamanumida daedalus*
	Precis hierta
	Precis oenone
	Junonia cebrene
	Junonia orithya madagascariensis
Lycaenidae	*Species 1*
	Danaus chrysippus
Vespidae	*Ropalidia sp.*
	Belonogaster dubia
Apidae	*Apis mellifera*
Formicidae	*Solenopsis sp.*
	Anoplolepis custodiens
	Messor sp.
	Camponotus sp.
Buthidae	*Uroplectes olivaceus*
	Uroplectes formosus

Family	Genus
	Parabuthus ganulatus
Arachnidae	*Species 1*
Araneidae	*Argiope australis*
	Gasteracanthus sanguinolenta
	Isoxya sp.

Source: 2013 field survey & Golder (2007) Report no. 10613-5792-1

APPENDIX G

Impact rating tables for Site A and B.

Site A

Rated By: Andrew Zinn	*Terrestrial Ecology*	Site A						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnitude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	CONSTRUCTION							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Habitat loss and degradation through vegetation clearing	Negative	Definite	7 SEV	2 DEV	5 PERM	5 OCCUR	-5.2 VHIGH
Project Impact 2	Habitat fragmentation through loss of habitat and erection of artificial barriers (fences, conveyors, roads)	Negative	Probable	6 VHIGH	4 LOC	4 LONG	4 VLIKE	-4.1 HIGH
Project Impact 3	Increase in erosion and possible sedimentation of drainage features	Negative	Possible	4 MODH	4 LOC	4 LONG	4 VLIKE	-3.5 MODH
Project Impact 4	Increased dust generation	Negative	Probable	4 MODH	4 LOC	3 MED	5 OCCUR	-4.1 HIGH
Project Impact 5	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Possible	3 MODL	3 ADJ	4 LONG	4 VLIKE	-2.9 MODL
Project Impact 6	Killing or injuring of fauna in the study area	Negative	Possible	3 MODL	3 ADJ	2 SHORT	4 VLIKE	-2.4 MODL
Project Impact 7	Loss of species of conservation importance	Negative	Probable	4 MODH	2 DEV	2 SHORT	4 VLIKE	-2.4 MODL
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Probable	7 SEV	4 LOC	5 PERM	5 OCCUR	-5.9 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	6 VHIGH	4 LOC	5 PERM	5 OCCUR	-5.5 VHIGH

Rated By: Andrew Zinn		Site A						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	OPERATIONAL							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Habitat fragmentation through loss of habitat and erection of artificial barriers (fences, conveyors, roads)	Negative	Definite	6 VHIGH	4 LOC	4 LONG	4 VLIKE	-4.1 HIGH
Project Impact 2	Increase in erosion and possible sedimentation of drainage features	Negative	Probable	4 MODH	4 LOC	4 LONG	3 LIKE	-2.7 MODL
Project Impact 3	Increased dust generation	Negative	Possible	4 MODH	4 LOC	3 MED	5 OCCUR	-4.1 HIGH
Project Impact 4	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Probable	3 MODL	3 ADJ	4 LONG	3 LIKE	-2.2 MODL
Project Impact 5	Killing or injuring of fauna in the study area	Negative	Possible	3 MODL	3 ADJ	2 SHORT	3 LIKE	-1.8 LOW
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Probable	7 SEV	4 LOC	5 PERM	5 OCCUR	-5.9 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	6 VHIGH	4 LOC	4 LONG	4 VLIKE	-4.1 HIGH

Rated By: Andrew Zinn		Site A						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	CLOSURE							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Increase in erosion and possible sedimentation of drainage features	Negative	Possible	3 MODL	4 LOC	4 LONG	3 LIKE	-2.4 MODL
Project Impact 2	Increased dust generation	Negative	Probable	3 MODL	4 LOC	4 LONG	4 VLIKE	-3.2 MODH
Project Impact 3	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Probable	3 MODL	3 ADJ	4 LONG	4 VLIKE	-2.9 MODL
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Definite	5 HIGH	4 LOC	5 PERM	5 OCCUR	-5.2 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	5 HIGH	4 LOC	4 LONG	3 LIKE	-2.9 MODL

Rated By: Andrew Zinn		Site A						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	POST CLOSURE							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Increase in erosion and possible sedimentation of drainage features	Negative	Possible	3 MODL	4 LOC	4 LONG	3 LIKE	-2.4 MODL
Project Impact 2	Increased dust generation	Negative	Probable	3 MODL	4 LOC	4 LONG	4 VLIKE	-3.2 MODH
Project Impact 3	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Probable	3 MODL	3 ADJ	4 LONG	4 VLIKE	-2.9 MODL
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Definite	5 HIGH	4 LOC	5 PERM	5 OCCUR	-5.2 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	5 HIGH	4 LOC	4 LONG	3 LIKE	-2.9 MODL

Site B

Rated By: Andrew Zinn		Site B						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	CONSTRUCTION							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Habitat loss and degradation through vegetation clearing	Negative	Definite	7 SEV	2 DEV	5 PERM	5 OCCUR	-5.2 VHIGH
Project Impact 2	Habitat fragmentation through loss of habitat and erection of artificial barriers (fences, conveyors, roads)	Negative	Probable	7 SEV	4 LOC	4 LONG	5 OCCUR	-5.5 VHIGH
Project Impact 3	Increase in erosion and possible sedimentation of drainage features	Negative	Possible	5 HIGH	4 LOC	4 LONG	4 VLIKE	-3.8 MODH
Project Impact 4	Increased dust generation	Negative	Probable	4 MODH	4 LOC	3 MED	5 OCCUR	-4.1 HIGH
Project Impact 5	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Possible	4 MODH	3 ADJ	4 LONG	4 VLIKE	-3.2 MODH
Project Impact 6	Killing or injuring of fauna in the study area	Negative	Possible	4 MODH	3 ADJ	2 SHORT	4 VLIKE	-2.7 MODL
Project Impact 7	Loss of species of conservation importance	Negative	Probable	4 MODH	2 DEV	2 SHORT	4 VLIKE	-2.4 MODL
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Probable	7 SEV	4 LOC	5 PERM	5 OCCUR	-5.9 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	6 VHIGH	4 LOC	5 PERM	5 OCCUR	-5.5 VHIGH

Rated By: Andrew Zinn		Site B						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	OPERATIONAL							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Habitat fragmentation through loss of habitat and erection of artificial barriers (fences, conveyors, roads)	Negative	Definite	7 SEV	4 LOC	4 LONG	5 OCCUR	-5.5 VHIGH
Project Impact 2	Increase in erosion and possible sedimentation of drainage features	Negative	Probable	4 MODH	4 LOC	4 LONG	3 LIKE	-2.7 MODL
Project Impact 3	Increased dust generation	Negative	Possible	4 MODH	4 LOC	3 MED	5 OCCUR	-4.1 HIGH
Project Impact 4	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Probable	3 MODL	3 ADJ	4 LONG	3 LIKE	-2.2 MODL
Project Impact 5	Killing or injuring of fauna in the study area	Negative	Possible	3 MODL	3 ADJ	2 SHORT	3 LIKE	-1.8 LOW
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Probable	7 SEV	4 LOC	5 PERM	5 OCCUR	-5.9 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	6 VHIGH	4 LOC	4 LONG	4 VLIKE	-4.1 HIGH

Rated By: Andrew Zinn		Site B						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	OPERATIONAL							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Increase in erosion and possible sedimentation of drainage features	Negative	Possible	3 MODL	4 LOC	4 LONG	3 LIKE	-2.4 MODL
Project Impact 2	Increased dust generation	Negative	Probable	3 MODL	4 LOC	4 LONG	4 VLIKE	-3.2 MODH
Project Impact 3	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Probable	3 MODL	3 ADJ	4 LONG	4 VLIKE	-2.9 MODL
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Probable	5 HIGH	4 LOC	5 PERM	5 OCCUR	-5.2 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	5 HIGH	4 LOC	4 LONG	3 LIKE	-2.9 MODL

Rated By: Andrew Zinn		Site B						
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	*Phase*							
	POST CLOSURE							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	5 HIGH	2 DEV	4 LONG	5 OCCUR	-4.1 HIGH
Project Impact 1	Increase in erosion and possible sedimentation of drainage features	Negative	Possible	3 MODL	4 LOC	4 LONG	3 LIKE	-2.4 MODL
Project Impact 2	Increased dust generation	Negative	Probable	3 MODL	4 LOC	4 LONG	4 VLIKE	-3.2 MODH
Project Impact 3	Increased exotic and/or declared Category 1, 2 & 3 invader species	Negative	Probable	3 MODL	3 ADJ	4 LONG	4 VLIKE	-2.9 MODL
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, BEFORE MITIGATION	Negative	Definite	5 HIGH	4 LOC	5 PERM	5 OCCUR	-5.2 VHIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, AFTER MITIGATION	Negative	Probable	5 HIGH	4 LOC	4 LONG	3 LIKE	-2.9 MODL

APPENDIX H

Environmental Management Planning

May 2014
Report No. 13614949-11847-1

Management / Environmental Component:	**EMPr Reference Code:**		
Habitat loss and degradation through vegetation clearing			
Primary Objective:			
Limit extent and severity of vegetation clearing			
Ensure that successful rehabilitation is carried out			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
■ Vegetation clearing should be restricted to the proposed development footprints only, with no unnecessary clearing permitted outside of these areas.	Project Manager		Ongoing
■ Areas to be cleared should be marked/taped-off to prevent unnecessary clearing outside of these demarcated sites.	Project Manager		Ongoing
■ Removed topsoil should be stockpiled and used to rehabilitate disturbed areas. Topsoil should ideally not be stockpiled for greater than 12 months and stockpiles should not exceed two metres in height.	Project Manager		Monthly
■ It is recommended that an environmental control officer (ECO) be appointed during construction to oversee the vegetation clearing process.	Environmental Manager		Ongoing
■ A suitable rehabilitation programme should be developed and implemented in all disturbed areas post-construction. The ECO should be responsible for overseeing the rehabilitation programme.	Environmental Manager		Ongoing
■ It is recommended that monitoring of rehabilitated areas be undertaken to ensure successful stabilisation and revegetation of disturbed areas.	Environmental Manager		Monthly
Existing management plans / procedures:			

Management / Environmental Component:	**EMPr Reference Code:**		
Habitat fragmentation through loss of habitat and erection of artificial barriers (fences, conveyors, roads)			
Primary Objective:			
Prevent or minimise additional habitat fragmentation			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
■ Where possible, proposed linear infrastructure should be aligned with existing linear infrastructure or routed through already transformed / degraded areas.	Project Manager		Pre-Construction
■ Linear infrastructure should be routed across the narrowest point of important and/or sensitive habitats, such as wetland areas.	Project Manager		Pre-Construction
■ In order to prevent the obstruction of surface and subterranean water flow in wetland and aquatic environments, linear infrastructure should be raised above ground level and the footprint area required for foundation infrastructure should be kept to an absolute minimum.	Project Manager		Pre-Construction
■ To prevent the obstruction of fauna dispersal and movement patterns, culverts should be installed at regular intervals along conveyor routes, fences and access roads to allow easy access across the barrier.	Project Manager		Pre-Construction
Existing management plans / procedures:			

Management / Environmental Component:	**EMPr Reference Code:**		
Increase in erosion and possible sedimentation of drainage features			
Primary Objective:			
Prevent erosion and reduce sediment entering into drainage features			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
■ Construct berms and sediment traps in construction areas where surface water run-off is likely.	Environmental Manager		Monthly
■ Regularly inspect existing erosion sites or those potentially susceptible to erosion.	Environmental Manager		Monthly
■ All sites displaying incidence of erosion must be actively stabilised and re-vegetated with indigenous plants. It is recommended that a seedmix comprising locally present species be used. Suggested species include *inter alia*, *Aristida congesta, Cynodon dactylon, Eragrostis curvula, Eragrostis chloromelas, Eragrostis racemosa, Heteropogon contortus & Sporobolus africana.*	Environmental Manager		Monthly
Existing management plans / procedures:			

Management / Environmental Component:	**EMPr Reference Code:**		
Increased dust generation			
Primary Objective:			
Reduce dust generation			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
■ All topsoil stockpiles and cleared areas should be re-vegetated, covered or kept moist to prevent dust generation.	Environmental Manager		Ongoing
■ Dust suppression through the use of water bowsers should be implemented on all exposed areas including roads, parking zones and lay down areas. Water spraying on high use roads should be prioritised.	Environmental Manager		Ongoing
■ All disturbed areas should be re-vegetated with indigenous species as per an approved rehabilitation plan.	Environmental Manager		Ongoing
■ All onsite traffic can be restricted to specific designated roads. Off-road travel can only be authorized on a case-by-case basis (e.g. access to a remote monitoring well, etc.). Traffic speed can also be restricted to an appropriate level on all designated roads.	Project Manager		Ongoing
Existing management plans / procedures:			

Management / Environmental Component:	**EMPr Reference Code:**		
Increased exotic and/or declared Category 1, 2 & 3 invader species			
Primary Objective:			
Prevent spread of exotic invasive plant species			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
■ An exotic species control programme including monitoring, must be developed and implemented to reduce the encroachment of exotic invasive species.	Environmental Manager		Pre-construction
■ It is recommended that the ECO be responsible for monitoring the nature and extent of on-site exotic	Environmental Manager		Monthly
Existing management plans / procedures:			

Management / Environmental Component:	**EMPr Reference Code:**		
Killing or injuring of fauna in the study area			
Primary Objective:			
Prevent the killing or injuring of fauna			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
■ An ECO should be on-site during all construction activities to monitoring for and manage any wildlife-human interactions.	Environmental Manager		Ongoing
■ A low speed limited should be enforced on site to reduce wildlife-collisions.	Project Manager		Ongoing
■ Employees and contractors should be made aware of the presence of, and rules regarding fauna through suitable induction training and on-site signage.	Environmental Manager		Ongoing
Existing management plans / procedures:			

Management / Environmental Component:	**EMPr Reference Code:**		
Loss of species of conservation importance			
Primary Objective:			
Prevent loss of species of Red Data / protected flora and fauna			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
■ Prior to construction, all areas designated for vegetation clearing should be clearly marked and surveyed for Red Data/protected flora and fauna species. It is advised that an ECO be appointed to oversee this process.	Environmental Manager		Pre-construction
■ Where possible, development footprints should be sited so as to exclude areas where Red Data/protected flora occur.	Project Manager		Pre-construction
■ In the event that Red Data/protected flora are identified within the designated construction footprints and require relocation, rescue permits must be obtained from the provincial or relevant authority, and a suitable ex-situ, and/or in-situ conservation plan developed. The conservation plan must be approved by the provincial authority and overseen by the ECO.	Environmental Manager		Ongoing
Existing management plans / procedures:			

APPENDIX I

Document Limitations

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