



REPORT



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Terrestrial Ecosystems Assessment of proposed Continuous and Emergency Ash Dumps at Kendal Power Station

Submitted to:
Zitholele Consulting Pty (Ltd)



Report Number. 13614982-11971-1

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Executive Summary

The terrestrial ecosystems assessment focused on describing the ecological characteristics of the sites of the proposed continuous ash dump, stream diversion, farm dam alterations and emergency dumping facility at Kendal Power Station.

Kendal Power Station is situated approximately 8 km south-west of Ogies in the Nkangala District of Mpumalanga. The surrounding landscape matrix is characterised by agriculture, mining and activities associated with power generation.

The site of the existing emergency dumping facility is located within the Kendal Power Station and is already transformed, with little to no natural habitat remaining. The site of the proposed continuous ash dump is located to the west of the power station, and will extend in a north-west direction from existing ash dump. The farm dam, additional proposed pollution and clean water dams, as well as the stream diversion are situated around the proposed Continuous ash dump facility.

Although large portions of the proposed development sites are characterised by cultivated fields, patches of semi-natural and natural grasslands are present and will be impacted on by the proposed project activities.

Based on the field survey, three semi-natural and natural vegetation communities were identified, namely *Themeda triandra* grasslands, *Hyparrhenia hirta* grasslands and the Moist grass and sedge community. All three communities provide important habitat for flora and fauna, some of which are species of conservation importance. Accordingly, the conservation importance of the vegetation communities are rated medium (*Hyparrhenia hirta* grasslands) and high (Moist grass and sedge community & *Themeda triandra* grasslands). Moreover, a section of the ash dump and stream diversion are located on land designated as CBA – Optimal by the Mpumalanga Biodiversity Sector Plan (2013).

Several negative environmental impacts have been identified and will need to be carefully managed during all phases of the project. The most prominent impact concerns the loss of natural habitat, particularly areas designated as CBA – Optimal. A suite of mitigation measures have been recommended in this report and it is important that these are integrated into the environmental management plan for the proposed project.



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1.0 INTRODUCTION

Zitholele Consulting (Pty) Ltd appointed Golder Associates Africa (Pty) Ltd to conduct a terrestrial ecosystems assessment of the sites associated with the proposed continuous ash disposal facility (ADF) project at Kendal Power Station, in Mpumalanga Province, South Africa. The study focused on describing the ecological characteristics of the proposed sites (hereafter, collectively referred to as the study area) with a view of identifying and assessing possible ecological impacts resulting from the proposed project.

1.1 Proposed activities

The proposed continuous ash disposal facility project comprises a continuation of the existing Kendal ADF in a north-westerly direction. The existing ADF is positioned between two streams. The stream to the east flows in a north-westerly direction, while the stream to the west flows in a northerly direction. Two main options, with various sub-options for the Continuous ADF, were considered. The main options are:

Option 1: Minimum Dump – The ADF is positioned between the two streams.

Option 2: Maximum Dump – The positioning of the ADF requires the northern stream to be diverted.

The sub-options included either staged or concurrent piggybacking of Options 1 and 2.

A trade-off study workshop was held during which the six alternatives were analysed using three broad criteria, namely: environmental influences, engineering influences and financial considerations. The findings of the trade-off study workshop indicated that Option 2A: Maximum Dump is the preferred alternative. Accordingly, the proposed footprint of the existing ash dump will extend across the northern stream. It has thus been proposed that this stream be diverted as part of the project to accommodate the expanded ash dump.

The project also considered possible alternatives for the storm water management system around the ADF. Based on the trade-off study workshop, Option 3B Scenario 2 is considered the preferred alternative. Amongst other components, this alternative includes:

- Two additional pollution dams (Dams 1 & 5);
- Three additional clean water dams (Dams 2, 3 & 4);
- Diversion of stream to the north of the proposed Continuous ADF; and
- Lowering of existing farm dam wall to reduce dam footprint.

This document presents the findings of the terrestrial ecosystems assessment of the proposed continuous ADF project at Kendal Power Station.

2.0 TERMS OF REFERENCE

The objectives of the terrestrial ecosystems assessments are to:

- Present a description of the study area's existing flora and fauna characteristics and identify species of conservation importance that occur, or potentially occur, in the study area;
- Confirm the presence of sensitive or important habitats, such aquatic ecosystems and/or natural wetlands;
- Identify and assess potential impacts of the various aspects of the proposed project on flora and fauna and general habitat integrity and functioning;
- Provide management recommendations to mitigate possible negative impacts; and
- Highlight the need and scope for additional ecological studies, if any.



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 – A field survey was conducted from the 18-20th of February 2013 and aimed to determine 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 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 field sampling methodology); and
- Impact assessment – With reference to the findings of the literature review and field survey, potential negative environmental impacts associated with the proposed project were identified and assessed for significance. Based on the assessment, suitable mitigation measures have been recommended for inclusion into the project's environmental management programme (EMP) (Refer to Section 5.1 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

Kendal Power Station is located approximately 8 km south-west of Ogies in the Nkangala District of Mpumalanga. Nearby towns include Delmas and eMalahleni, which are situated 30 km south-west and 33 km north-east of Kendal, respectively (Figure 1).

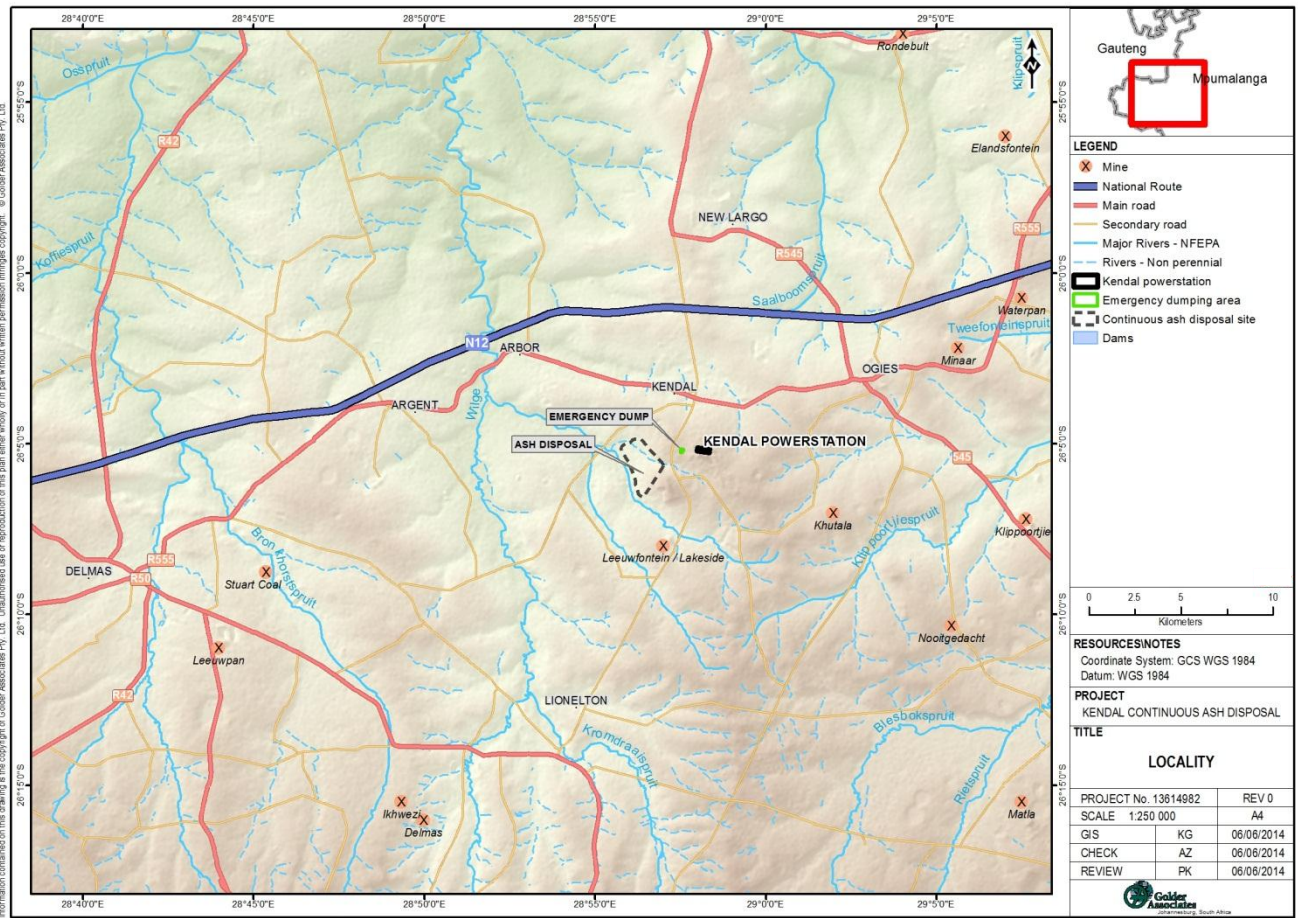


Figure 1: Regional location of study area

4.2 General Biophysical Environment

The study area is located in the Rand Highveld Grassland vegetation type on the border with the Eastern Highveld Grasslands in the grassland biome (Mucina & Rutherford, 2006) (Figure 2). The associated characteristics of the grassland biome and Rand Highveld Grasslands and Eastern Highveld Grasslands 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 or 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*.

Graminoids: *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 anagaloides*, *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

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 Rand Highveld Grassland vegetation type:



TERRESTRIAL ECOSYSTEMS ASSESSMENT

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

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

Herbs: *Acanthospermum australe*, *Justicia anagalloides*, *Acalypha angusta*, *Chamaecrista 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).

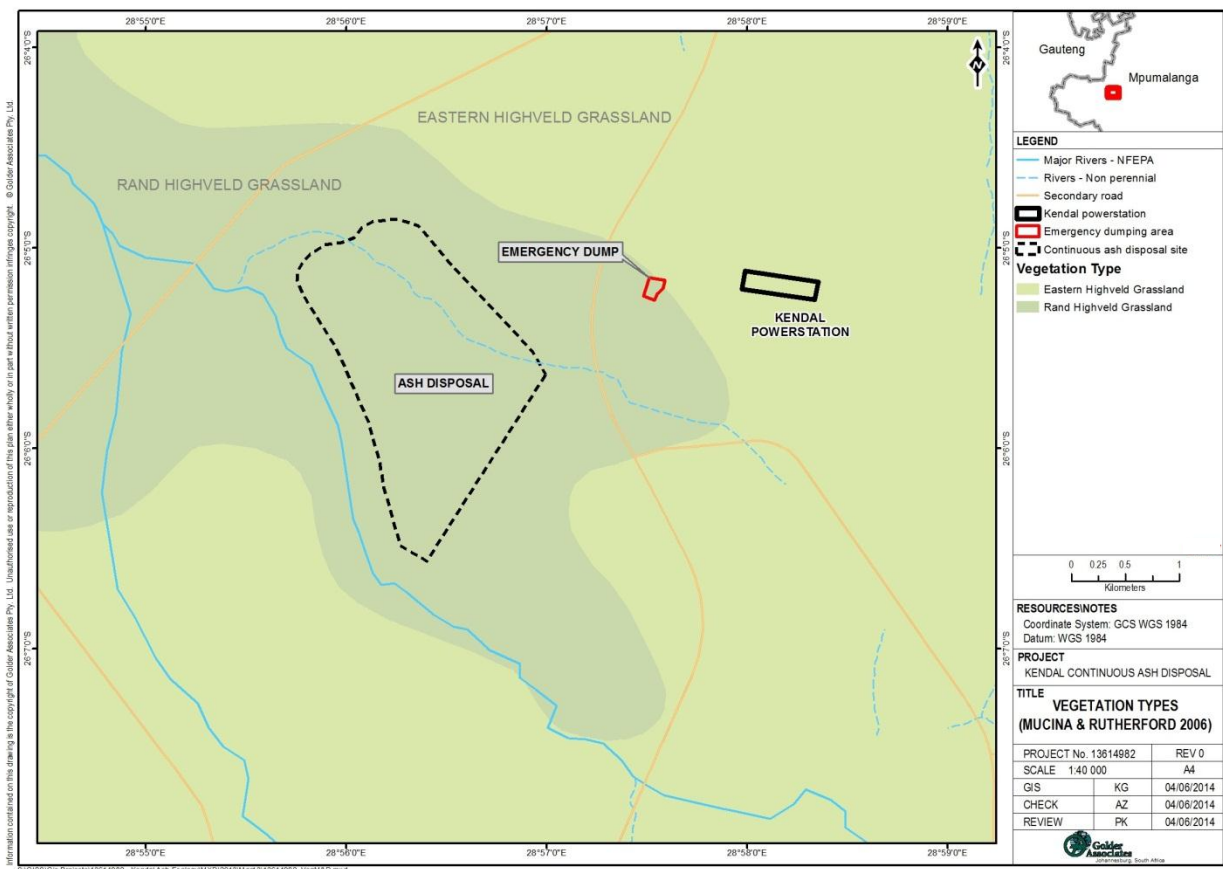


Figure 2: Locality of study area in relation to the regional vegetation types, as described by Mucina & Rutherford (2006)



4.3 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. Part of the proposed continuous ash dump footprint as well as the proposed stream diversion stretch over land designated as CBA – Optimal – see Figure 3.



TERRESTRIAL ECOSYSTEMS ASSESSMENT

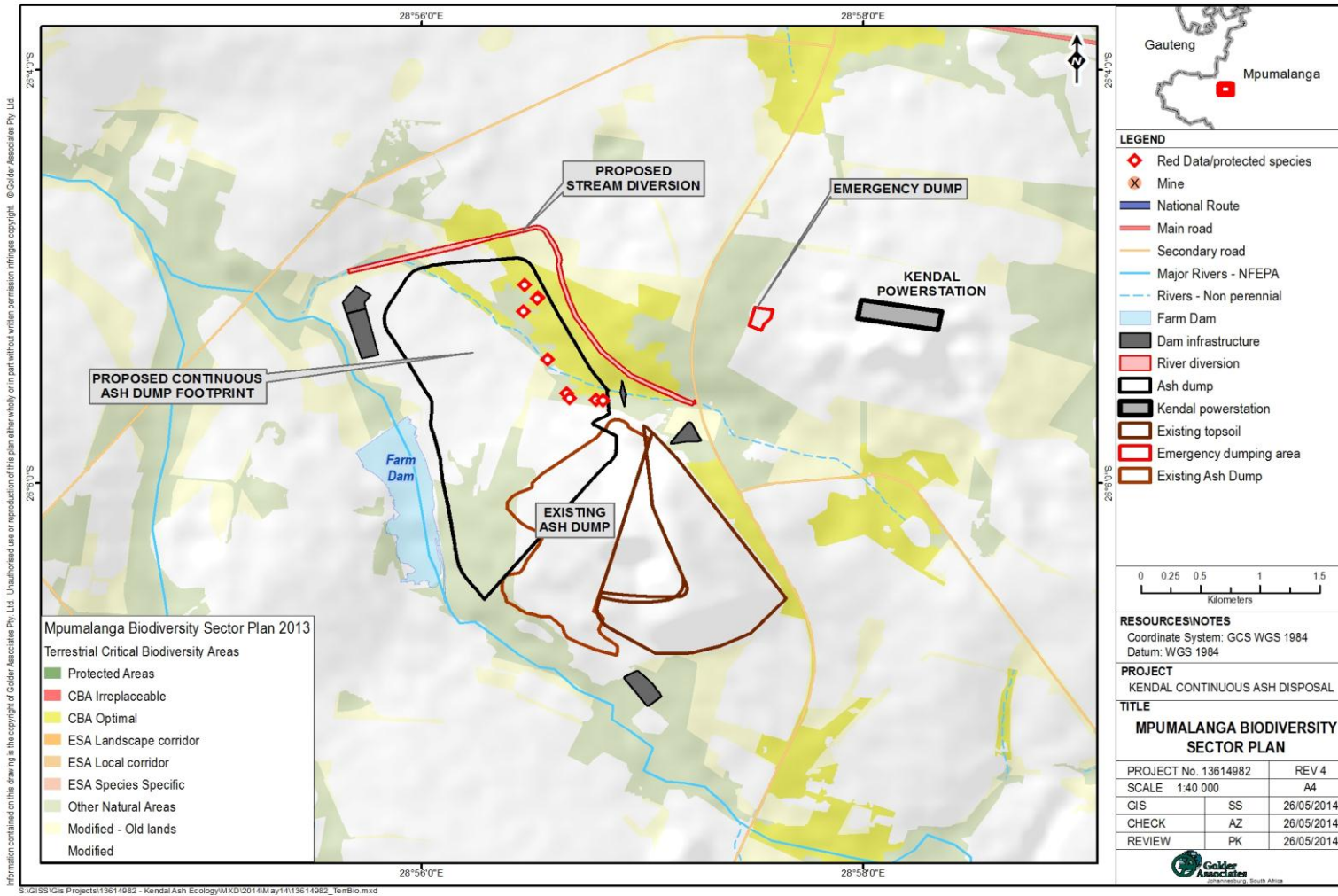


Figure 3: Study area in relation to the Mpumalanga Biodiversity Sector Plan (2013)



4.4 Flora Assessment

4.4.1 Surrounding landscape matrix

The landscape matrix surrounding the study area is highly variable. Dominant land uses include agriculture (mainly in the form of maize production), livestock grazing, mining, and activities related to the Kendal Power Station. Consequently, much of the land surrounding the study area is either completely transformed or highly disturbed. Patches of semi-natural and natural grassland do however occur and are generally associated with wetlands and drainage features.

Emergency dumping site

The emergency dumping site is an existing facility that will be enlarged. It is approximately 2.3 ha in extent and is located, inside the Kendal Power Station, along the western boundary fence. The land to the north, east and west of this site is, therefore, transformed. West of the site, beyond the boundary fences lies an open piece of grassland and a provincial road see Figure 4.

Continuous ash disposal facility and associated sites

The site of the continuous ash dump facility (338.2 ha) is partly contiguous with and extends in a north-westerly direction from the existing ash dump facility. Much of the land to the south of the site is therefore transformed or highly degraded by the existing ash dump facility. The land surrounding the rest of the proposed site comprises cultivated fields, open grasslands, wetlands, a farm dam, and a large area degraded by mining activities – see Figure 4.

4.4.2 Study area characteristics

The site of the continuous ash dump facility comprises four vegetation communities. These were recognised based on physiognomy, moisture regime, slope, species composition and disturbance characteristics. Vegetation communities include:

- Transformed land;
- Cultivated land (current and former);
- *Themeda triandra* mixed grassland;
- *Hyparrhenia hirta* grassland; and
- Moist grass and sedge community.

Transformed land associated with existing ash dumping facility were noted, but were subject to no further investigation. The characteristics of the remaining vegetation communities are detailed below. Refer to Figure 4 for a map of the vegetation types.

Refer to APPENDIX B 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.



TERRESTRIAL ECOSYSTEMS ASSESSMENT

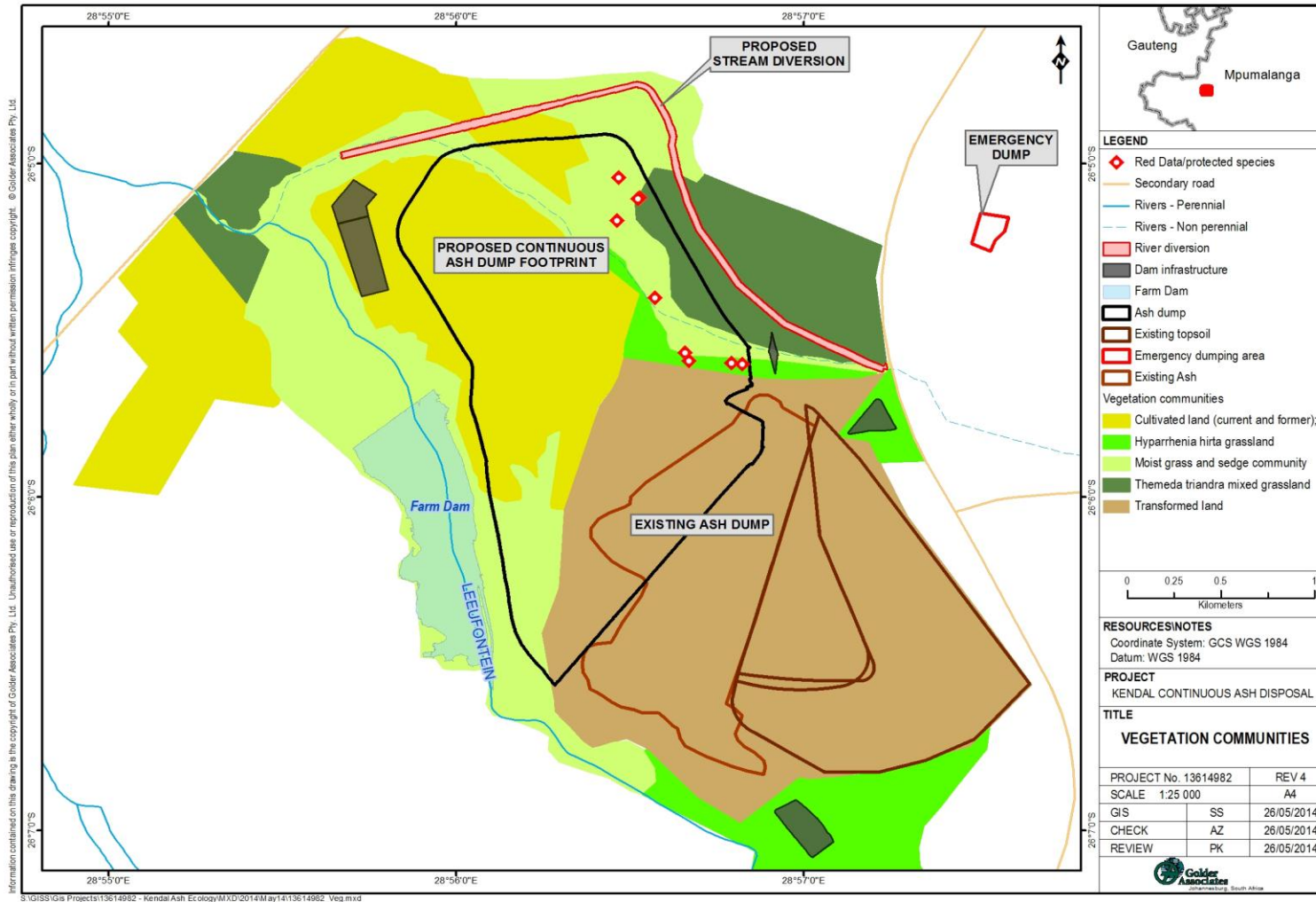


Figure 4: Vegetation communities associated with the study area



Cultivated land (current and former)

Much of the central portion of the continuous ash dump site comprises agricultural fields. Currently cultivated fields are under maize (*Zea mays*) production and have no indigenous vegetation present. Fields that have been left fallow are dominated by ruderal, typically exotic, species such as *Amaranthus viridis*, *Bidens pilosa*, *Chenopodium album*, *Campuloclinium macrocephalum*, *Conyza albida*, *Conyza bonariensis*, *Cosmos bipinnata*, *Datura stramonium*, *Tagetes minuta*, *Verbena bonariensis* and *Verbena brasiliensis*.

Sensitivity Aspects

Cultivated lands are severely degraded and, accordingly, 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 10 and Figure 11).



Figure 5: Cultivated land under maize (*Zea mays*) production

***Themeda triandra* mixed grassland**

This vegetation community is found on the north-east portion of the study area. The area is characteristically rocky, a fact that in all likelihood precluded ploughing and cultivation in the past. Although, cattle have been grazed in the area in the past, evidence suggests that this is not currently taking place. As the name suggests, the grass *Themeda triandra* is very common in this vegetation community (Figure 1). *Themeda triandra* is an important grazing species and where abundant, is indicative of undisturbed, regularly burnt grasslands that are not overgrazed (Van Oudtshoorn 1999). As such, an abundance of this species is indicative of grassland in good condition.

Other recorded grasses include *Aristida congesta* subsp. *congesta*, *Aristida diffusa*, *Aristida* sp., *Bewsia biflora*, *Brachiaria* sp., *Cymbopogon excavatus*, *Digitaria argyrograpta*, *Diheteropogon amplexans*, *Hyparrhenia hirta*, *Eragrostis racemosa*, *Harporchloa falx*, *Hyparrhenia hirta*, *Melinis repens*, *Monocymbium cerasiiforme*, *Panicum natalense*, *Schizachyrium sanguineum*, *Setaria sphacelata*, *Sporobolus africana*, *Tricholaena monachne*, *Trichoneura grandiglumis*, *Tristachya leucothrix* and *Urelytrum agropyroides*.

Herbs and forbs recorded include *Acalypha villicaulus*, *Alectra sessiliflora*, *Asparagus* sp., *Becium angustifolium*, *Boophone disticha*, *Callilepis leptophylla*, *Crabbea angustifolia*, *Crassula capitella*, *Crinum* sp.,



Cucumis hirsutus, *Cucumis zeyheri*, *Dicoma zeyheri*, *Eucomus autumnalis*, *Gladiolus crassifolius*, *Haplocarpha lyrata*, *Haplocarpha scaposa*, *Helichrysum acutatum*, *Helichrysum aureonitens*, *Helichrysum dasymallum*, *Helichrysum nudifolium*, *Helichrysum oreophilum*, *Hypoxis argentea*, *Hypoxis multiceps*, *Indigofera oxytropis*, *Ipomoea ficifolia*, *Ledebouria ovatifolia*, *Ledebouria revoluta*, *Melolobium wilmsii*, *Pelargonium dolomiticum*, *Pentanisia angustifolia*, *Pollichia campestris*, *Polygala hottentotta*, *Richardia brasiliensis*, *Schkuhria pinnata*, *Senecio coronatus*, *Seriphium plumosum*, *Sphenostylis angustifolia*, *Striga elegans*, *Tephrosia capensis*, *Vernonia natalensis*, *Wahlenbergia caledonica*, *Walafrida densiflora* and *Zornia* sp.

Indigenous woody species such as *Diospyros austro-africana*, *Rhus discolor*, *Rhus pyroides* and *Ziziphus zeyheriana*, as well as exotics such as *Eucalyptus* species were recorded in the *Themeda triandra* vegetation community. These are growing in isolated patches, often on the crests of rocky areas.

Sensitivity Aspects

This vegetation community is typically in good condition and forms important natural grassland habitat. The ecological integrity of this vegetation community is generally high.

Five plant species of conservation importance were recorded in the *Themeda triandra* vegetation community. These are *Boophae disticha*, *Callilepis leptophylla*, *Crinum* sp., *Eucomus autumnalis* and *Gladiolus crassifolius* - refer to Section 4.4.3 for species statuses. 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 10 and Figure 11).



Figure 6: *Themeda triandra* vegetation community

Hyparrhenia hirta grassland

This vegetation community is characterised by a dominance of *Hyparrhenia hirta*. *Hyparrhenia hirta* is a tall, robust grass that when dominant is an indication of grasslands that have been subject to historic and/or current disturbances, most typically overgrazing, frequent fires, cultivation or a combination thereof (Van Oudtshoorn *et al.* 2011). Few other plant species are able to establish amongst the tall, dense *Hyparrhenia* swards and as such these grasslands generally have low flora species richness (Van Oudtshoorn *et al.* 2011) (Figure 1).



Apart from *Hyparrhenia hirta*, other grass species recorded in this community include *Bewisia biflora*, *Cymbopogon excavatus*, *Eragrostis curvula*, *Eragrostis plana*, *Eragrostis racemosa*, *Harpochloa falx*, *Heteropogon contortus*, *Pogonarthria squarrosa*, *Setaria sphacelata*, *Sporobolus africana*, *Themeda triandra* and *Tristachya leucothrix*.

The forb component is characterised by hardy species such as, *inter alia*, *Alectra sessiliflora*, *Cirsium vulgare*, *Conyza alba*, *Eucomis autumnalis*, *Haplocarpha scaposa*, *Helichrysum aureonitens*, *Helichrysum nudifolium*, *Ipomoea ficifolia*, *Monopsis decipiens*, *Portulaca* sp., *Richardia brasiliensis*, *Satyrium hallackii* subsp. *ocellatum*, *Schkuhria pinnata*, *Sebaea grandis*, *Senecio coronatus*, *Seriphium plumosum*, *Striga elegans*, *Tagetes minuta*, *Tephrosia capensis*, *Verbena bonariensis*, *Wahlenbergia caledonica* and *Walafrida densiflora*. Scattered *Acacia mearnsii* trees were also noted in this community.

Sensitivity Aspects

Hyparrhenia hirta grasslands are a secondary vegetation community, originating as a result of past disturbances. Literature suggests that such grasslands are very stable and may remain in a *Hyparrhenia* dominated state for a number of years (Van Oudtshoorn *et al.* 2011). The ecological integrity of this vegetation community is therefore considered moderate.

One plant species of conservation importance, namely *Eucomis autumnalis* was recorded during the 2013 field survey in this vegetation community - refer to Section 4.4.3 for species status. The suitability of *Hyparrhenia hirta* grassland as habitat for other Red Data and/or protected species is considered low. Accordingly, the conservation importance of areas of this vegetation community is medium (refer to Figure 10 and Figure 11).



Figure 7: *Hyparrhenia hirta* grasslands

Moist grass and sedge vegetation community

Areas comprising the moist grass and sedge vegetation community are associated with wetlands, seep zones, artificial dams and stream channels in the study area (see Figure 8).

Where soil moisture is particularly high, this vegetation community is characterised by dense stands of the bulrush *Typha capensis* and other wetland type species such as grasses *Agrostis lachnantha*, *Aristida junciformis*, *Arundinella nepalensis*, *Calamagrostis epigejos* var. *epigejos*, *Cymbopogon plurinodis*, *Cynodon dactylon*, *Imperata cylindrica*, *Eragrostis plana*, *Hemarthria altissima*, *Hyparrhenia hirta*, *Leersia hexandra*,



Paspalum dilatatum, *Paspalum urvillei*, *Phragmites australis*, *Setaria pallid-fusca*, *Setaria sphacelata* and *Themeda triandra*.

Forbs and herbs recorded, in the moist grass and sedge community, include many hydrophilic herb species, as well as common, terrestrial species such as *Berkheya radula*, *Bidens pilosa*, *Campuloclinium macrocephalum*, *Chamaecrista comosa*, *Cirsium vulgare*, *Conyza bonariensis*, *Cosmos bipinnatus*, *Cyperus* sp., *Cyperus marginatus*, *Eleocharis acutangula*, *Epilobium hirsutum*, *Gerbera ambigua*, *Gladiolus crassifolius*, *Gomphocarpus fruticosa*, *Helichrysum aureonitens*, *Helichrysum rugulosum*, *Hypochaeris radicata*, *Hypoxis multiceps*, *Isolepis* sp., *Juncus lomatophyllus*, *Kyllinga erecta*, *Laggera decurrens*, *Mariscus congesta*, *Nesaea sagittifolia*, *Persicaria decipiens*, *Plantago lanceolata*, *Ranunculus meyeri*, *Richardia brasiliensis*, *Rumex* sp., *Schoenoplectus brachyceras*, *Schoenoplectus corymbosus*, *Schoenoplectus muriculatus*, *Senecio coronatus*, *Solanum panduriforme*, *Tagetes minuta*, *Trifolium repens*, *Verbena bonariensis*, *Verbena officinalis*, *Xanthium strumarium* and *Xysmalobium undulatum*.

In terms of woody plants scattered large *Salix babylonica* trees were recorded as well as small *Acacia mearnsii* seedlings and saplings. Both species are exotic problem plants, with the latter being listed under the Conservation of Agricultural Resources Act (No. 43 of 1983) (Refer to Section 4.4.4).



Figure 8: Moist grass and sedge community

A number of artificial dams have been created in this vegetation community in the northern portion of the study area. In one such case, overflow from the dam has caused considerable gully erosion below the dam wall that has led to the formation of a deeply incised channel. The subsequent drying out of the soil on the banks of the channel has facilitated the encroachment of *Hyparrhenia hirta* grasslands into the moist grass and sedge community (Figure 9).



Figure 9: Erosion has formed a deeply incised channel causing degradation of sections of the Moist grass and sedge vegetation community

Sensitivity Aspects

Areas comprising the moist grass and sedge community have been subject to anthropogenic disturbances and accordingly have a moderate ecological integrity (Figure 10). This notwithstanding, they play an important ecological role in the purification and supply of water, and are thus valuable hydrological features. They also form important breeding, feeding and dispersal habitat for a variety of fauna and flora, some of which may be Red Data and/or protected species.

Two threatened plant species were recorded in this vegetation community, namely *Eucomis autumnalis* and *Gladiolus crassifolius*. The suitability of this community as habitat for other Red Data and/or protected species is however considered high. Based on these factors, the conservation importance of these areas is therefore considered high (Figure 11).



TERRESTRIAL ECOSYSTEMS ASSESSMENT

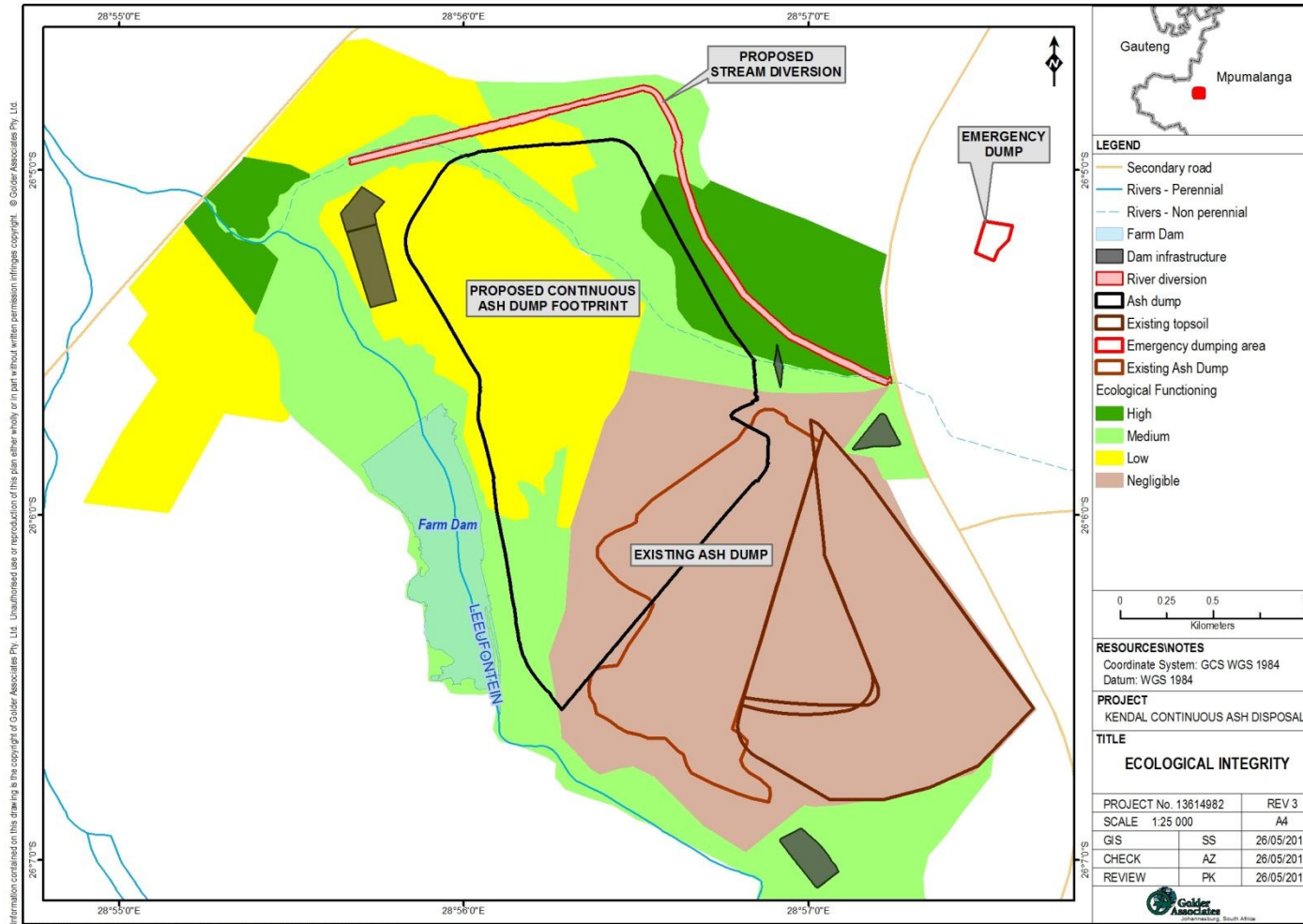


Figure 10: Ecological integrity of the study area



TERRESTRIAL ECOSYSTEMS ASSESSMENT

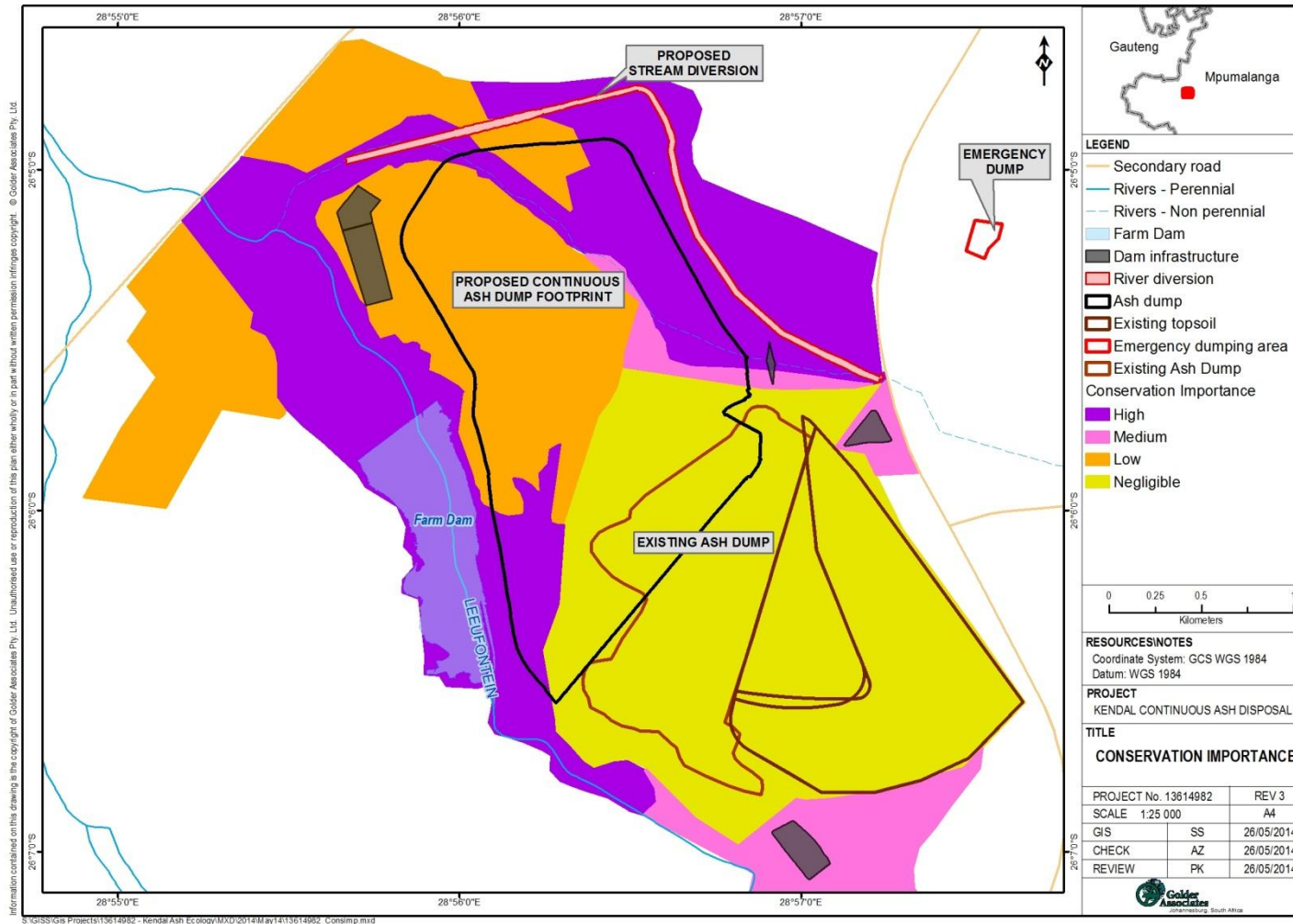


Figure 11: Conservation importance of the study area



4.4.3 Flora species of conservation importance

Five Red Data/protected plant species were recorded in the study area. These are *Gladiolus crassifolius*, *Callilepis leptophylla*, *Eucomis autumnalis* (see Figure 12), *Crinum* sp. and *Boophone disticha*.

An additional 26 plant species have previously been recorded in the quarter degree square (2628BB) in which the study area is located. These species are primarily from the families IRIDACEAE (6 species), AMARYLLIDACEAE (5 species) and MESEMBRYANTHEMACEAE (5 species). All have a high probability of occurring in the study area. Refer to Table 2 for a list of Red Data and/or protected plant species.



Figure 12: *Eucomis autumnalis* recorded in the study area



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Table 2: 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	<i>Boophone disticha</i>	Declining	-	Protected
AMARYLLIDACEAE	<i>Crinum bulbispermum</i>	Declining	-	Protected
AMARYLLIDACEAE	<i>Crinum graminicola</i>	-	-	Protected
AMARYLLIDACEAE	<i>Cyrtanthus breviflorus</i>	-	-	Protected
AMARYLLIDACEAE	<i>Nerine gracilis</i>	Near Threatened	-	
AQUIFOLIACEAE	<i>Ilex mitis</i>	Declining	-	-
ASPHODELACEAE	<i>Aloe ecklonis</i>			Protected
ASTERACEAE	<i>Callilepis leptophylla</i>	Declining		
EUPHORBIACEAE	<i>Euphorbia clavarioides</i>	-	-	-
FABACEAE	<i>Melolobium subspicatum</i>	Vulnerable	-	-
HYACINTHACEAE	<i>Eucomis autumnalis</i>	Declining	-	Protected
HYPOXIDACEAE	<i>Hypoxis hemerocallidea</i>	Declining	-	Protected
IRIDACEAE	<i>Gladiolus crassifolius</i>	-	-	Protected
IRIDACEAE	<i>Gladiolus elliotii</i>	-	-	Protected
IRIDACEAE	<i>Gladiolus permeabilis</i>	-	-	Protected
IRIDACEAE	<i>Gladiolus vinosomaculatus</i>	-	-	Protected
IRIDACEAE	<i>Gladiolus papilio</i>	-	-	Protected
IRIDACEAE	<i>Watsonia bella</i>	-	-	Protected
ISOETACEAE	<i>Isoetes transvaalensis</i>	Near Threatened	-	-
LILIACEAE	<i>Kniphofia ensifolia</i>	Endangered	-	-
MESEMBRYANTHEMACEAE	<i>Delosperma gautengense</i>	Vulnerable	-	-
MESEMBRYANTHEMACEAE	<i>Delosperma macellum</i>	Endangered	-	-
MESEMBRYANTHEMACEAE	<i>Frithia humilis</i>	Vulnerable	-	Protected



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Scientific name	Status		
		IUCN (2011)	NEMBA TOPS List (2007)	Mpumalanga Protected Species (1998)
MESEMBRYANTHEMACEAE	<i>Frithia pulchra</i>	Rare	-	-
MESEMBRYANTHEMACEAE	<i>Khadia beswickii</i>	Vulnerable	-	-
ORCHIDACEAE	<i>Eulophia coddii</i>	Vulnerable	-	Protected
ORCHIDACEAE	<i>Habenaria clavata</i>	-	-	Protected
ORCHIDACEAE	<i>Habenaria mossii</i>	Endangered	-	Protected
PROTEACEAE	<i>Protea welwitschii</i>	-	-	Protected
ZAMIACEAE	<i>Encephalartos lanatus</i>	Vulnerable	Protected	Protected
ZAMIACEAE	<i>Encephalartos middelburgensis</i>	Critically Endangered	Critically Endangered	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 3 were recorded in the study area during the 2013 field survey and are declared weeds or invasive plants according to the CARA.

Table 3: CARA listed exotic species recorded in the study area

Scientific name	Common name	CARA Category	NEMBA Category (Proposed)	Community where recorded
<i>Acacia mearnsii</i>	Wattle	2	2	<i>Hyparrhenia hirta</i> grassland Moist grass and sedge community
<i>Campuloclinium macrocephalum</i>	Pompom weed	1	1b	Moist grass and sedge community <i>Hyparrhenia hirta</i> grassland Cultivated land (current and former)
<i>Cirsium vulgare</i>	Scottish thistle	1	1b	Moist grass and sedge community. <i>Hyparrhenia hirta</i> grassland Cultivated land (current and former)
<i>Datura stramonium</i>	Large thorn apple	1	1b	Cultivated land (current and former)
<i>Eucalyptus</i> species	Blue gum	2	1b	Moist grass and sedge community.
<i>Xanthium strumarium</i>	Large cocklebur	1	1b	Cultivated land (current and former)
<i>Salix babylonica</i>	Weeping willow	2	-	Moist grass and sedge community

4.5 Fauna Assessment

4.5.1 Mammals

Five mammal species were recorded in the study area during the 2013 field study. These are the Reddish-grey musk shrew (*Crocidura cyanea*), Multimammate mouse (*Mastomys* sp.), Serval (*Leptailurus serval*), Black-backed jackal (*Canis mesomelas*), Cape clawless otter (*Aonyx capensis*), Water mongoose (*Atilax paludonosus*), Steenbok (*Raphicerus campestris*) and Warthog (*Phacochoerus africanus*).

Previous studies conducted in areas surrounding Kendal Power Station and the nearby Kusile Power Station have recorded an additional 10 mammal species - Table 4 (refer to Golder 2007 Report no. 10613-5792-1, Golder 2013 Report 13614949-11847-1 & Du Preez 2006). These range from small rodents to medium-sized ungulates, the majority of which are fairly-common, to common with widespread distributions. Based on historic distributions, a further 47 species are known to occur in the region in which the study area is located (refer to APPENDIX C for a list of all species).

¹ CARA is in the process of being revised.



Table 4: Additional mammals previously recorded in the Kendal / Kusile Power Station areas

Scientific name	Common name
<i>Crocidura hirta</i>	Lesser red musk shrew
<i>Cynictis penicillata</i>	Yellow mongoose
<i>Damaliscus dorcas phillipsi</i>	Blesbok
<i>Dendromys mystacalis</i>	Chestnut climbing mouse
<i>Hystrix africaeaustralis</i>	Porcupine
<i>Lepus saxatilis</i>	Scrub hare
<i>Orycteropus afer</i>	Aardvark
<i>Otomys angoniensis</i>	Angoni vlei rat
<i>Rhodomys pumilio</i>	Striped mouse
<i>Sylvicarpa grimmia</i>	Common duiker

Red Data and protected mammals

Steenbok (*Raphicerus campestris*) were observed in the study area, and evidence of Cape clawless otter (*Aonyx capensis*) and Serval (*Leptailurus serval*) was also recorded - See Figure 13 and Figure 14.

The **Steenbok (*Raphicerus campestris*)** is a relatively common, widespread small antelope (IUCN 2013.3) and is accordingly not considered threatened or rare. Be that as it may, it is listed as protected according to the Mpumalanga Nature Conservation Act (No 10 of 1998) and for this reason has been include in this section.

The **Cape clawless otter (*Aonyx capensis*)** is protected in terms of Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1998) and the NEMBA TOPS list (2013). Cape clawless otters (*Aonyx capensis*) are found near permanent water where they feed on a mixture of fish, amphibians and crustaceans (Estes, 1991). Threats to otters include habitat loss, and habitat degradation mainly in the form of pollution, increased siltation and agricultural run-off. Additionally, otters are hunted for their pelt and for medicinal purposes (IUCN Otter Specialist Group, 2012, internet). Otters are likely to frequent the stream channels and artificial dams in the study area and environs.

Serval (*Leptailurus serval*) are listed as protected on the NEMBA TOPS list (2013) and Near threatened according to the IUCN (2013.1). They are solitary and mainly nocturnal, preferring grassland and wetland habitats where they prey upon small mammals, birds, reptile and insects (Stuart & Stuart 2007). Like many threatened fauna, habitat loss and persecution are the main threats to this species.



Figure 13: Fresh Cape clawless otter (*Aonyx capensis*) droppings recorded in the study area

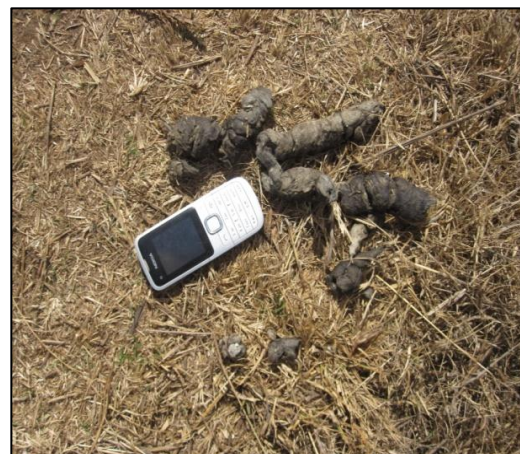


Figure 14: Serval (*Leptailurus serval*) scat recorded in the study area



An additional eighteen Red Data and/or protected mammal species potentially occur in the study area. These, along with a probability of occurrence, are listed in Table 5.

Table 5: Red Data and protected mammals potentially occurring in the study area

Scientific name	Common name	Status			Probability of occurrence
		IUCN (2013.1)	NEMBA TOPS List (2013)	Mpumalanga Protected Species (1998)	
<i>Chrysofalax villosus</i>	Rough-haired golden mole	Critically Endangered	-	-	Moderate
<i>Amblysomus robustus</i>	Robust golden mole	Vulnerable	Endangered	-	Moderate
<i>Amblysomus septentrionalis</i>	Highveld golden mole	Near Threatened	-	-	High
<i>Miniopterus schreibersii</i>	Schreibers' long-fingered bat	Near Threatened	-	-	Low
<i>Dasymys incomtus</i>	Water rat	Near Threatened	-	-	High
<i>Vulpes chama</i>	Cape fox	-	Protected	-	Low
<i>Aonyx capensis</i>	Cape-clawless otter	-	Protected	Protected	Recorded
<i>Leptailurus serval</i>	Serval	Near Threatened	Protected	-	Recorded
<i>Proteles cristatus</i>	Aardwolf	-	-	Protected	High
<i>Panthera pardus</i>	Leopard	Near Threatened	Protected	Protected	High
<i>Hyaena burnea</i>	Brown hyaena	Near Threatened	Protected	-	Low
<i>Mellivora capensis</i>	Honey badger	Near Threatened	-	Protected	Moderate
<i>Ourebia ourebi</i>	Oribi	-	Endangered	Protected	High
<i>Raphicerus campestris</i>	Steenbok	-	-	Protected	Recorded
<i>Pelea capreolus</i>	Grey rhebok	-	-	Protected	High
<i>Lutra maculicollis</i>	Spotted-necked otter	Near Threatened	-	Protected	High
<i>Felis nigripes</i>	Black-footed cat	-	Protected	Protected	High
<i>Atelerix frontalis</i>	South African hedgehog	Near Threatened	-	Protected	High
<i>Orycteropus afer</i>	Aardvark	-	Protected	Protected	High
<i>Redunca fulvorufula</i>	Mountain reedbuck	-	-	Protected	High

4.5.2 Birds

Forty one bird species were recorded in the study area during the 2013 field survey (Table 6). Most of these are common and widespread species typical of grassland and wetland habitats in Mpumalanga. Refer to APPENDIX D for a list of birds species potentially occurring in the study area.

Table 6: Birds recorded in the study area

Scientific name	Common Name
<i>Alcedo cristata</i>	Malachite kingfisher
<i>Alopochen aegyptiacus</i>	Egyptian goose
<i>Anas undulata</i>	Yellow-billed duck
<i>Anhinga rufa</i>	Darter
<i>Ardea melanocephala</i>	Black-headed heron
<i>Asio capensis</i>	Marsh owl
<i>Bostrychia hagedash</i>	Hadedda ibis
<i>Bradypterus baboecala</i>	African sedge warbler
<i>Bubulcus ibis</i>	Cattle egret
<i>Burhinus capensis</i>	Spotted thick knee
<i>Calandrella cinerea</i>	Red-capped lark
<i>Centropus burchellii</i>	Burchell's coucal



Scientific name	Common Name
<i>Chlidonias hybridus</i>	Whiskered tern
<i>Chrysococcyx caprius</i>	Diederik's cuckoo
<i>Columba guinea</i>	Rock pigeon
<i>Corvus albus</i>	Pied crow
<i>Euplectes afer</i>	Golden bishop
<i>Euplectes orix</i>	Red bishop
<i>Euplectes progne</i>	Long-tailed widow
<i>Francolinus swainsonii</i>	Swainson's francolin
<i>Fulica cristata</i>	Red-knobbed coot
<i>Haliaeetus vocifer</i>	African fish-eagle
<i>Hirundo albigularis</i>	White throated swallow
<i>Hirundo cucullata</i>	Greater striped swallow
<i>Hirundo rustica</i>	European swallow
<i>Larus cirrocephalus</i>	Grey-headed gull
<i>Mirafra sabota</i>	Sabota lark
<i>Myrmecocich formicivora</i>	Anteating chat
<i>Numida meleagris</i>	Helmeted guineafowl
<i>Passer melanurus</i>	Cape sparrow
<i>Phalacrocorax capensis</i>	Reed comorant
<i>Phoenicopterus sp.</i>	Flamingo sp.
<i>Ploceus velatus</i>	Masked weaver
<i>Quelea quelea</i>	Red-billed quelea
<i>Sagittarius serpentarius</i>	Secretary bird
<i>Spreo bicolor</i>	African pied starling
<i>Streptopelia capicola</i>	Cape turtle dove
<i>Streptopelia senegalensis</i>	Laughing dove
<i>Vanellus armatus</i>	Blacksmith plover
<i>Vidua macroura</i>	Pin-tailed whydah

Red Data and protected birds

A solitary Secretary bird (*Sagittarius serpentarius*) was observed hunting in the study area, and anecdotal evidence from a local farmer suggests that Flamingo (*Phoenicopterus* sp.) frequently use a pan located approximately one kilometre north of the study area (Co-ordinates: 26° 4.412 S, 28° 56.876 E).

Two species of flamingo occur in southern Africa, namely the **Greater flamingo (*Phoenicopterus ruber*)** and the **Lesser flamingo (*Phoenicopterus minor*)**. Both species are listed as Near Threatened by the IUCN and are protected according to the NEMBA TOPS list (2013) and Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1998). Flamingos inhabit shallow water bodies such as pans and lakes where they feed on *inter alia*, small fish, aquatic insects and crustaceans.

Secretarybirds (*Sagittarius serpentarius*) inhabit open grassland to lightly wooded savanna and are even found in agricultural areas. They are large raptors that prey on a variety of small mammals and reptiles. They are listed as Vulnerable by the IUCN (2013.1) and protected according to Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1998).

According to Emery, Lotter and Williamson (2002) many of Mpumalanga's most threatened bird species are dependent on wetlands and the short, dense grasslands, as well as tall grasslands in the province – habitats



found to some measure in the study area. An additional 14 Red Data/protected species may occur in the study area. These, along with a probability of occurrence, are listed in Table 7.

Table 7: Red Data and protected bird species potentially occurring in the study area

Scientific name	Common name	Status			Probability of occurrence
		IUCN (2013.1)	NEMBA TOPS List (2013)	Mpumalanga Protected Species (1998)	
<i>Anthropoides paradiseus</i>	Blue crane	Vulnerable	Vulnerable	Protected	Moderate
<i>Sagittarius serpentarius</i>	Secretary bird	Vulnerable	-	Protected	Recorded
<i>Falco peregrinus</i>	Peregrine falcon	Near threatened	-	Protected	Moderate
<i>Eupodotis caerulescens</i>	Blue korhaan	Near threatened	-	Protected	Moderate
<i>Eupodotis senegalensis</i>	White-bellied korhaan	Vulnerable	-	Protected	Low
<i>Charadrius pallidus</i>	Chestnut-banded plover	Near threatened	-	Protected	Moderate
<i>Glareola nordmanni</i>	Black-winged pratincole	Near threatened	-	Protected	Moderate
<i>Alcedo semitorquata</i>	Half-collared kingfisher	Near threatened	-	Protected	Moderate
<i>Mirafra cheniana</i>	Melodious lark	Near threatened	-	Protected	Moderate
<i>Falco naumanni</i>	Lesser Kestrel	Vulnerable	-	Protected	High
<i>Falco biarmicus</i>	Lanner falcon	Near threatened	-	Protected	High
<i>Circus ranivorus</i>	African marsh harrier	Vulnerable	-	Protected	High
<i>Tyto capensis</i>	African grass owl	Vulnerable	-	Protected	High
<i>Geronticus calvus</i>	Southern bald ibis	Vulnerable	Vulnerable	Protected	High

4.5.3 Herpetofauna

Three amphibians were recorded in the study area - Common river frog (*Afrana angolensis*), Striped stream frog (*Strongylopus fasciatus*) and Red toad (*Schismaderma carens*). These are all common species with widespread distributions. In terms of reptiles only the Striped skink (*Mabuya striata punctatissima*) was observed in the study area during the 2013 field survey.

Seventeen other species of herpetofauna as listed in Table 8 have been recorded in the general area in which the study area is located (refer to 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.

Table 8: Herpetofauna recorded in and adjacent to the study area

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



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

Red Data and protected herpetofauna

According to Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1998), 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 that 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 (2012) 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 1998) this species is protected. Giant bullfrog (*Pyxicephalus adspersus*) used to be listed as Near Threatened by the NEMBA TOPS List (2007) and IUCN (2012) however they have since been downgraded by both. The probability of Giant bullfrog (*Pyxicephalus adspersus*) occurring in the Moist grass and sedge vegetation community in the study area is considered medium.

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 arthropoda 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. Be that as it may, the on-site habitat is suitable 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 *Opisththalmus glabrifrons*. Although these were not recorded in the study area, the probability that they are present is also considered high.



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:

- Magnitude;
- 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 summary of each of the qualitative descriptors along with the equivalent quantitative rating scale for each of the aforementioned criteria is given in Table 9.

Table 9: Quantitative rating and equivalent descriptors for the impact assessment criteria

Rating	Magnitude	Extent Scale	Temporal Scale
1	VERY LOW	<i>Isolated sites / proposed route</i>	<u>Incidental</u>
2	LOW	<i>Study area</i>	<u>Short-term</u>
3	MODERATE	<i>Local</i>	<u>Medium-term</u>
4	HIGH	<i>Regional / Provincial</i>	<u>Long-term</u>
5	VERY HIGH	<i>Global / National</i>	<u>Permanent</u>

A more detailed description of each of the assessment criteria is given in the following sections.

5.1.1 Magnitude Assessment

Magnitude rating (importance) of the associated impacts embraces the notion of extent and significance, but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of area affected by atmospheric pollution may be extremely large (1 000 km²) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common. A more detailed description of the impact significance rating scale is given in Table 10.



Table 10: Description of the magnitude rating scale

Rating		Description
10	Very high	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
8	High	Impact is of substantial order within the bounds of impacts, which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
6	Moderate	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
4	Low	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
2	Minor	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity are needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
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 the local, regional, or global scale. The spatial assessment scale is described in more detail in Table 11.

Table 11: Description of the spatial scale

Rating		Description
5	International	The maximum extent of any impact will be at an international scale.
4	National	The maximum extent of any impact will be at a national scale.
3	Regional/Provincial	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a regional scale (District Municipality to Provincial Level).
2	Local	The impact will affect an area up to 10 km from the proposed activity.
1	Study Area	The impact will affect an area not exceeding the development footprint.
0	None	-



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	Immediate	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 5-15 years
4	Long term	The environmental impact identified will cease with 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 will be described as shown in Table 13.

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

Rating	Description
0	None
1	Improbable
2	Low probability
3	Medium probability
4	Highly probable
5	Definite / don't know

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.
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.
Don't know	The consultant cannot, or is unwilling, to make an assessment given available information.



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 = (Magnitude + Spatial + Temporal) X Probability

5.2 Direct Impacts

The principle project related concern is the loss and disturbances of natural habitat leading to a reduction in ecological functioning and biodiversity in the study area. Specific issues relating to this primary concern are listed in Table 15 and characterised in Section 5.3.

Table 15: Potential ecological impacts resulting from the proposed project

Table with 2 columns: Impact and Phase. Rows include: Habitat loss and degradation through vegetation clearing; Increase in erosion and possible sedimentation of drainage features; Increased dust generation; Increased exotic and/or declared Category 1, 2 & 3 invader species; Killing or injuring of fauna in the study area; Loss of species of conservation importance.

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 also 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.

Impact in relation to proposed project

Vegetation clearing will occur across the entire ash dump footprint, at proposed pollution and clean water dams, and along the proposed route of the stream diversion. In areas of cultivated land, this will not cause significant negative impacts as these areas are already highly degraded. However, vegetation clearing in natural/semi-natural areas comprising Themeda triandra grassland, the Moist grass and sedge vegetation community and Hyparrhenia hirta grasslands, will result in the loss and degradation of important natural



habitat – some of which is designated as CBA – Optimal by the MBCP (2013). Vegetation clearing will commence during the construction phase and will continue as the ash dump expands.

5.3.2 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.

Impact in relation to proposed project

It is likely that the additional vegetation clearing and earth works associated with various aspects of the proposed project may lead to an increase in erosion, particularly during the wet season. This may result in increased sedimentation of downstream rivers and dams. Specific components of the project that warrant concern regarding this include:

- Stream diversion - this is located in an area with a steep gradient and the potential for erosion and downstream sedimentation is high;
- Construction of the additional pollution and clean water dams; and
- Lowering of farm dam wall - earth works associated with removing and existing dam wall and constructing the new, lower wall may cause erosion. Moreover, increased water volumes and water velocity entering the downstream wetland may cause erosion and subsequent stream-channelling both during and after dam wall reconstruction.

Erosion impacts are likely to arise during the construction phase, but will persist throughout the life of the project unless correctly management.

5.3.3 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).

Impact in relation to proposed project

Vegetation clearing and earth works associated with all project infrastructure and activities, as well as the subsequent deposition of ash at the ADF, will increase the potential for dust entrainment in and around the study area. Dust therefore has the potential to be a major negative impact during all phases of the project.

5.3.4 Increased exotic and/or declared Category 1, 2 & 3 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 construction. However, if not controlled, the scale and magnitude of infestation will rapidly increase and may persist for the entire lifecycle of the project.

Impact in relation to proposed project

Exotic invasive species were noted throughout much of the project area. Of particular concern is the presence of the CARA Category 1 species *Acacia mearnsii*, *Campuloclinium macrocephalum*, *Xanthium strumarium* and *Cirsium vulgare*. These species are highly invasive and will spread rapidly in response to disturbances of natural vegetation. The establishment and spread of exotic invasive plants is a potential impact throughout the life of the project.

5.3.5 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 activities 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.

Impact in relation to proposed project

A number of fauna species were recorded in the Kendal area during the 2013 survey and previous surveys. It is highly probable that many species will be disturbed during the construction phase, and to a lesser extent the operational phases. Particularly activities of concern include vegetation clearing and earth works. This impact will be particularly acute in the Moist grass and sedge vegetation community, where various birds nest and where aquatic species, such as amphibians reside.

5.3.6 Loss of species of conservation importance

Nature of impact

During initial vegetation clearing and earth works, flora and fauna of conservation importance such as Red Data and protected species may be killed, injured or damaged. Moreover, habitat loss and degradation may result in sensitive species being disturbed.

Impact in relation to proposed project

A number of species of conservation importance occur, or potentially occur in the study area. Construction phase activities are most likely to affect these species. Elements of concern viz. the proposed project are:

- Evidence of Cape clawless otter (*Aonyx capensis*) and Serval (*Leptailurus serval*) was observed in the study area. Alterations to water bodies and wetland-type habitat in the study area may have a particularly negative impact on the prey base and habitat suitability of these species;
- Protected plants such as *Boophane disticha*, *Crinum* sp., *Gladiolus crassifolius*, *Callilepis leptophylla* and *Eucomis autumnalis* were recorded in the study area. These may be destroyed during vegetation clearing in the following communities:
 - *Themeda triandra* mixed grassland;
 - *Hyparrhenia hirta* grassland;
 - Moist grass and sedge community.



- A Secretary bird (*Sagittarius serpentarius*) was observed hunting in the study area, and anecdotal evidence suggests that flamingo (*Phoenicopterus* sp.) utilise a natural pan situated approximately 1 km north of the study area (Co-ordinates: 26° 4.412 S, 28° 56.876 E). Construction activities in the area may disturb the flamingos and other bird species of conservation importance.

Without correct management the environmental significance of this impact is regarded as high. However, if the mitigation measures outlined in Table 16 are implemented, the significance can be decreased to a moderate rating.

5.4 Summary of mitigation and monitoring measures

Based on the study areas ecological characteristics and the nature of potential impacts, the environmental significance of each impact were assessed and thereafter suitable mitigation and monitoring measures identified and described. These along with the impact assessment scores are detailed in Table 16.



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Table 16: Impact significance and recommended mitigation measures – CONSTRUCTION PHASE

Impact	Impact rating before mitigation	Impact rating after mitigation	Proposed mitigation measure
Habitat loss and degradation through vegetation clearing.	High	High	<ul style="list-style-type: none"> ■ As feasible, vegetation clearing should be conducted in a phased approach in line with the continuation of the ash dump. ■ Vegetation clearing should be restricted to the proposed development footprints only, with no unnecessary clearing permitted outside of these sites. ■ Sites to be cleared should be marked/taped-off to prevent unnecessary clearing outside of these demarcated sites (see below for recommendations <i>viz.</i> plant species of conservation importance). ■ Existing drainage features that fall within the development footprint should be re-routed and designed with the aim of recreating wetland habitats. ■ 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.
Increase in erosion and possible sedimentation of drainage features.	Moderate	Low	<ul style="list-style-type: none"> ■ Construct berms and sediment traps in construction areas where surface water run-off and erosion is likely. These areas include <i>inter alia</i>: <ul style="list-style-type: none"> ▪ site of proposed stream diversion; ▪ below the farm dam wall; and ▪ sites of the proposed new pollution and clean water control dams. ■ Regularly inspect existing erosion sites or those potentially susceptible to erosion. ■ Eroded sites must be actively stabilised and re-vegetated (see rehabilitation recommendations in Table 17).
Increased dust generation.	Moderate-High	Moderate-Low	<ul style="list-style-type: none"> ■ Areas should be cleared of vegetation only immediately prior to construction. ■ All topsoil stockpiles and cleared areas should be re-vegetated, covered or kept moist to prevent dust generation (see rehabilitation recommendations in Table 17). ■ Dust suppression through the use of water bowsers should be implemented on all exposed areas



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Impact	Impact rating before mitigation	Impact rating after mitigation	Proposed mitigation measure
			including roads, parking zones and lay down areas. Water spraying on high use roads should be prioritised.
Killing or injuring of fauna in the study area.	Moderate	Low	<ul style="list-style-type: none"> An ECO should be on-site during vegetation clearing to monitoring for, and manage any wildlife-human interactions. 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.	Moderate - High	Low	<ul style="list-style-type: none"> 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. In the event that Red Data/protected flora are identified within the construction footprint 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.

Table 17: Impact significance and recommended mitigation measures – OPERATIONAL PHASE

Impact	Impact rating before mitigation	Impact rating after mitigation	Proposed mitigation measure
Increase in erosion and possible sedimentation of drainage features.	Moderate	Low	<ul style="list-style-type: none"> Permanent berms and sediment traps should be constructed around project infrastructure where surface water run-off and erosion is likely. Regularly monitor existing erosion sites, sites of potential to erosion, as well as storm water infrastructure (e.g. sediment traps) to ensure continued operational efficiency. All exposed sites or sites displaying incidence of erosion must be actively stabilised and re-vegetated, see below.



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Impact	Impact rating before mitigation	Impact rating after mitigation	Proposed mitigation measure
			<p>Rehabilitation recommendations</p> <ul style="list-style-type: none"> ■ A suitable rehabilitation programme should be developed and implemented at all disturbed areas. ■ It is recommended that only indigenous grasses be used for habitation. Suggested species include: <i>Cynodon dactylon</i>, <i>Digitaria eriantha</i>, <i>Eragrostis curvula</i>, <i>Eragrostis plana</i>, <i>Eragrostis racemosa</i>, <i>Heteropogon contortus</i>, <i>Hyparrhenia hirta</i>, <i>Sporobolus africana</i> and <i>Themeda triandra</i>. ■ It is recommended that regular monitoring of rehabilitated areas, by a qualified ECO, be undertaken to ensure successful stabilisation and revegetation of disturbed areas.
Increased dust generation.	Moderate-High	Moderate-Low	<ul style="list-style-type: none"> ■ All temporary/permanent stockpiles and cleared areas should be re-vegetated (see above rehabilitation recommendation), covered or kept moist to prevent dust generation. ■ Dust suppression through the use of water bowsers should be implemented on all exposed areas including the ADF, access 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 grass species – see above rehabilitation recommendations
Increased exotic and/or declared Category 1, 2 & 3 invader species.	Moderate	Moderate	<ul style="list-style-type: none"> ■ 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.	Low	Low	<ul style="list-style-type: none"> ■ Employees and contractors should be made aware of the presence of, and rules regarding fauna through suitable induction training and on-site signage.



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Table 18: Impact significance and recommended mitigation measures – CLOSURE & POST-CLOSURE PHASE

Impact	Impact rating before mitigation	Impact rating after mitigation	Proposed mitigation measure
Increase in erosion and possible sedimentation of drainage features.	Moderate	Low	<ul style="list-style-type: none">Continue to conduct regular monitoring of erosion sites and sites of potential erosion for a two year period following closure
Increased dust generation.	Moderate-Low	Low	<ul style="list-style-type: none">All exposed areas should be stabilised and re-vegetated (see above rehabilitation recommendation).Dust suppression through the use of water bowsers and sprayers should continue on all exposed surfaces until vegetation covering is sufficient to reduce dust entrainment.
Increased exotic and/or declared Category 1, 2 & 3 invader species.	Moderate	Moderate	<ul style="list-style-type: none">Continue to conduct exotic invasive species control, including monitoring, for a two year period following closure.



6.0 CONCLUSION AND RECOMMENDATIONS

The study area is located in a landscape dominated by agriculture, mining and activities associated with power generation. The site of the existing emergency dumping area is situated within the Kendal Power Station complex and is already mostly transformed. Enlargement of this facility is therefore not a major concern *viz.* terrestrial ecology.

The site of the proposed continuous ash dump is located to the west of the power station, where it extends in a north-west direction, off the existing ash dump and across a small stream. The central portion of the proposed continuous ash dump site is already degraded, primarily through maize cultivation and the spread of exotic, invasive plant species. Semi-natural and natural habitat patches were noted and are typically associated with areas where cultivation is precluded, such as wetland zones and rocky slopes.

The ecological integrity of natural habitat patches ranges from medium (*Hyparrhenia hirta* grasslands & Moist grass and sedge community) to high (*Themeda triandra* grasslands), based on existing disturbance characteristics. This notwithstanding, they do provide important habitat for flora and fauna and some are designated as CBA – Optimal by the MBSP (2013).

A number of species of conservation importance were recorded in the study area, including the Cape clawless otter (*Aonyx capensis*) and several plant species. These warrant careful management and accordingly the conservation importance of the vegetation communities in which they occur are rated medium (*Hyparrhenia hirta* grasslands) and high (Moist grass and sedge community & *Themeda triandra* grasslands).

The principle project related impact concerning terrestrial ecosystems in the study area, is the loss of important natural habitat through the clearing of natural vegetation and earth works. Habitat loss and degradation will occur at most proposed infrastructure sites. Although these impacts are largely inevitable, it is important that measures be implemented for mitigation. Principle mitigation measures include:

- Clearing only the minimum area required for construction purposes;
- Conduct search and rescue operations for plant species of conservation importance;
- Actively rehabilitate disturbed areas, and continue to monitor rehabilitation efforts.

A number of other secondary impact, such as dust entrainment, erosions and exotic species encroachment, have also been identified and will also warrant careful management and mitigation.



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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



Literature Review Component

Vegetation

Flora species lists for the 2628BB 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 relevant to the region in which the study area is located. These include Du Preez (2006) and Golder Report No. 10613-5792-1 (2007). Information relating to specific areas and species of concern for the study area and its surrounds was obtained from the SANBI SIBIS database and data received from the Mpumalanga Tourism and Parks Agency.

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 from the 18-20th of February 2013. Relevé data was collected in the



field by means of point transects for species occurring in the herbaceous layer. Owing to the patchiness of woody species, the presence of woody species was noted.

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 18-20th of February 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. Branch (1994) was used to identify observed reptile species, while Carruthers (2001) was used to identify any amphibians found in the study area.

Anthropoda

Active searching 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

Table with 3 columns: Rating, Ecological integrity, and Conservation importance. Rows include High and Moderate categories with detailed descriptions of ecosystem characteristics.



	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

Flora species recorded in study area and in the QDS 2628BB



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Species name	Recorded
ACANTHACEAE	<i>Crabbea angustifolia</i>	X
AMARYLLIDACEAE	<i>Boophone disticha</i>	X
AMARYLLIDACEAE	<i>Crinum graminicola</i>	
AMARYLLIDACEAE	<i>Crinum sp.</i>	X
AMARYLLIDACEAE	<i>Nerine gracilis</i>	
ANACARDIACEAE	<i>Rhus discolor</i>	X
ANACARDIACEAE	<i>Rhus pyroides</i>	X
APIACEAE	<i>Alepidea peduncularis</i>	
APIACEAE	<i>Ammi majus var. glaucifolium</i>	
APOCYNACEAE	<i>Asclepias adscendens</i>	
APOCYNACEAE	<i>Aspidoglossum interruptum</i>	
ASCLEPIADACEAE	<i>Gomphocarpus fruticosa</i>	X
ASCLEPIADACEAE	<i>Xysmalobium undulatum</i>	X
ASPHODELACEAE	<i>Aloe ecklonis</i>	
ASPHODELACEAE	<i>Trachyandra saltii var. saltii</i>	
ASTERACEAE	<i>Schkuhria pinnata</i>	X
ASTERACEAE	<i>Berkheya radula</i>	X
ASTERACEAE	<i>Berkheya setifera</i>	
ASTERACEAE	<i>Bidens pilosa</i>	X
ASTERACEAE	<i>Callilepis leptophylla</i>	X
ASTERACEAE	<i>Campuloclinium macrocephalum</i>	X
ASTERACEAE	<i>Cirsium vulgare</i>	X
ASTERACEAE	<i>Conyza alba</i>	X
ASTERACEAE	<i>Conyza bonariensis</i>	X
ASTERACEAE	<i>Conyza podocephalum</i>	X
ASTERACEAE	<i>Cosmos bipinnatus</i>	X
ASTERACEAE	<i>Dicoma zeyheri</i>	X
ASTERACEAE	<i>Gerbera ambigua</i>	X
ASTERACEAE	<i>Haplocarpha lyrata</i>	X
ASTERACEAE	<i>Haplocarpha scaposa</i>	X
ASTERACEAE	<i>Helichrysum acutatum</i>	X
ASTERACEAE	<i>Helichrysum aureonitens</i>	X
ASTERACEAE	<i>Helichrysum caespitium</i>	
ASTERACEAE	<i>Helichrysum dasymallum</i>	X
ASTERACEAE	<i>Helichrysum nudifolium</i>	X
ASTERACEAE	<i>Helichrysum oreophilum</i>	X
ASTERACEAE	<i>Helichrysum rugulosum</i>	X
ASTERACEAE	<i>Hypochoeris radicata</i>	X
ASTERACEAE	<i>Senecio coronatus</i>	X
ASTERACEAE	<i>Senecio inornatus</i>	X
ASTERACEAE	<i>Seriphium plumosa</i>	X



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Species name	Recorded
ASTERACEAE	<i>Tagetes minuta</i>	X
ASTERACEAE	<i>Vernonia natalensis</i>	X
ASTERACEAE	<i>Xanthium strumarium</i>	X
BORAGINACEAE	<i>Trichodesma physaloides</i>	
CAESALPINIACEAE	<i>Chamaecrista comosa</i>	X
CAMPANULACEAE	<i>Wahlenbergia caledonica</i>	X
CHENOPODIUM	<i>Chenopodium album</i>	
CHRYSOBALANACEAE	<i>Parinari capensis subsp. capensis</i>	
CONVOLVULACEAE	<i>Ipomoea ficifolia</i>	X
CONVOLVULACEAE	<i>Ipomoea oblongata</i>	
CRASSULACEAE	<i>Crassula capitella</i>	X
CRASSULACEAE	<i>Crassula natans var. natans</i>	
CUCURBITACEAE	<i>Cucumis hirsutus</i>	X
CUCURBITACEAE	<i>Cucumis zeyheri</i>	X
CYPERACEAE	<i>Cyperus marginatus</i>	
CYPERACEAE	<i>Cyperus sp.</i>	X
CYPERACEAE	<i>Cyperus usitatus</i>	
CYPERACEAE	<i>Eleocharis acutangula</i>	X
CYPERACEAE	<i>Eleocharis limosa</i>	
CYPERACEAE	<i>Kyllinga erecta</i>	X
CYPERACEAE	<i>Mariscus congestus</i>	X
CYPERACEAE	<i>Schoenoplectus brachyceras</i>	X
CYPERACEAE	<i>Schoenoplectus corymbosus</i>	X
CYPERACEAE	<i>Schoenoplectus muriculatus</i>	X
CYPERACEAE	<i>Schoenoplectus pulchellus</i>	
EBENACEAE	<i>Diospyros austro-africana</i>	X
EUPHORBIACEAE	<i>Acalypha villicaulus</i>	X
EUPHORBIACEAE	<i>Euphorbia sp.</i>	
EXORMOTHECACEAE	<i>Exormotheca holstii</i>	
FABACEAE	<i>Indigastrum burkeanum</i>	
FABACEAE	<i>Indigofera oxytropis</i>	X
FABACEAE	<i>Indigofera setiflora</i>	
FABACEAE	<i>Lotononis arida</i>	
FABACEAE	<i>Melolobium wilmsii</i>	X
FABACEAE	<i>Pearsonia cajanifolia subsp. cajanifolia</i>	
FABACEAE	<i>Sphenostylis angustifolia</i>	X
FABACEAE	<i>Tephrosia capensis</i>	X
FABACEAE	<i>Trifolium africanum var. africanum</i>	
FABACEAE	<i>Zornia sp.</i>	X
GENTIANACEAE	<i>Sebaea grandis</i>	X
GERANIACEAE	<i>Pelargonium dolomiticum</i>	X



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Species name	Recorded
HIPPOCRATEACEAE	<i>Eucomus autumnalis</i>	X
HYACINTHACEAE	<i>Drimia intricata</i>	
HYDROCHARITACEAE	<i>Lagarosiphon major</i>	
HYPOXIDACEAE	<i>Hypoxis argentea</i>	X
HYPOXIDACEAE	<i>Hypoxis multiceps</i>	X
ILLECEBRACEAE	<i>Pollichia campestris</i>	X
IRIDACEAE	<i>Gladiolus crassifolius</i>	X
IRIDACEAE	<i>Gladiolus papilio</i>	
IRIDACEAE	<i>Gladiolus permeabilis subsp. edulis</i>	
IRIDACEAE	<i>Gladiolus vinosomaculatus</i>	
JUNCACEAE	<i>Juncus lomatoophyllus</i>	X
JUNCACEAE	<i>Juncus oxycarpus</i>	
LAMIACEAE	<i>Becium angustifolium</i>	X
LILIACEAE	<i>Ledebouria ovatifolia</i>	X
LILIACEAE	<i>Ledebouria revoluta</i>	X
LILIACEAE	<i>Monopsis decipiens</i>	X
MALVACEAE	<i>Nesaea sagittifolia</i>	X
MESEMBRYANTHEMACEAE	<i>Mossia intervallis</i>	
OCHNACEAE	<i>Epilobium hirsutum</i>	X
ORCHIDACEAE	<i>Satyrium hallackii</i>	X
POACEAE	<i>Agrostis lachnantha</i>	X
POACEAE	<i>Andropogon schirensis</i>	
POACEAE	<i>Aristida aequiglumis</i>	
POACEAE	<i>Aristida congesta subsp. barbicollis</i>	
POACEAE	<i>Aristida congesta var. congesta</i>	X
POACEAE	<i>Aristida diffusa</i>	X
POACEAE	<i>Aristida junciformis</i>	X
POACEAE	<i>Aristida sp.</i>	X
POACEAE	<i>Arundinella nepalensis</i>	X
POACEAE	<i>Bewsia biflora</i>	X
POACEAE	<i>Brachiaria serrata</i>	
POACEAE	<i>Brachiaria sp.</i>	X
POACEAE	<i>Calamagrostis epigejos var. capensis</i>	X
POACEAE	<i>Cymbopogon excavatus</i>	X
POACEAE	<i>Cymbopogon plurinodis</i>	X
POACEAE	<i>Cynodon dactylon</i>	X
POACEAE	<i>Digitaria argyrograpta</i>	X
POACEAE	<i>Digitaria monodactyla</i>	
POACEAE	<i>Digitaria tricholaenoides</i>	
POACEAE	<i>Diheteropogon amplexans</i>	X
POACEAE	<i>Elionurus muticus</i>	



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Species name	Recorded
POACEAE	<i>Eragrostis capensis</i>	
POACEAE	<i>Eragrostis chloromelas</i>	
POACEAE	<i>Eragrostis curvula</i>	X
POACEAE	<i>Eragrostis plana</i>	X
POACEAE	<i>Eragrostis racemosa</i>	X
POACEAE	<i>Harpochloa falx</i>	X
POACEAE	<i>Hemarthria altissima</i>	X
POACEAE	<i>Heteropogon contortus</i>	X
POACEAE	<i>Hyparrhenia hirta</i>	X
POACEAE	<i>Imperata cylindrica</i>	X
POACEAE	<i>Leersia hexandra</i>	X
POACEAE	<i>Melinis nerviglumis</i>	
POACEAE	<i>Microchloa caffra</i>	
POACEAE	<i>Monocymbium ceresiiforme</i>	X
POACEAE	<i>Oropetium capense</i>	
POACEAE	<i>Panicum natalense</i>	X
POACEAE	<i>Panicum natalense</i>	
POACEAE	<i>Paspalum dilatatum</i>	X
POACEAE	<i>Paspalum urvillei</i>	X
POACEAE	<i>Phragmites australis</i>	X
POACEAE	<i>Pogonarthria squarrosa</i>	X
POACEAE	<i>Schizachyrium sanguineum</i>	X
POACEAE	<i>Setaria pallid-fusca</i>	X
POACEAE	<i>Setaria sphacelata</i>	X
POACEAE	<i>Sporobolus africana</i>	X
POACEAE	<i>Sporobolus pectinatus</i>	
POACEAE	<i>Themeda triandra</i>	X
POACEAE	<i>Tricholaena monachne</i>	X
POACEAE	<i>Trichoneura grandiglumis</i>	X
POACEAE	<i>Tristachya leucothrix</i>	X
POACEAE	<i>Typha capensis</i>	X
POACEAE	<i>Urelytrum agropyroides</i>	X
POLYGALACEAE	<i>Polygala hottentotta</i>	X
POLYGONACEAE	<i>Persicaria decipiens</i>	X
POLYGONACEAE	<i>Persicaria limbata</i>	
POLYGONACEAE	<i>Rumex sp.</i>	X
PORTULACACEAE	<i>Portulaca sp.</i>	X
POTAMOGETONACEAE	<i>Potamogeton pectinatus</i>	
POTTIACEAE	<i>Trichostomum brachydontium</i>	
RANUNCULACEAE	<i>Ranunculus meyeri</i>	X
RHAMNACEAE	<i>Ziziphus zeyheriana</i>	X



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Species name	Recorded
RICCIACEAE	<i>Riccia atropurpurea</i>	
RICCIACEAE	<i>Riccia cupulifera</i>	
RICCIACEAE	<i>Riccia nigrella</i>	
RICCIACEAE	<i>Riccia okahandjana</i>	
RICCIACEAE	<i>Riccia rosea</i>	
RICCIACEAE	<i>Riccia volkii</i>	
RUBIACEAE	<i>Oldenlandia herbacea</i> var. <i>herbacea</i>	
RUBIACEAE	<i>Pentanisia angustifolia</i>	X
RUBIACEAE	<i>Richardia brasiliensis</i>	X
SALICACEAE	<i>Salix babylonica</i>	X
SCROPHULARIACEAE	<i>Alectra sessiliflora</i>	X
SCROPHULARIACEAE	<i>Mimulus gracilis</i>	
SCROPHULARIACEAE	<i>Selago densiflora</i>	
SCROPHULARIACEAE	<i>Striga bilabiata</i>	X
SCROPHULARIACEAE	<i>Striga elegans</i>	X
SELAGINACEAE	<i>Walafrida densiflora</i>	X
SELAGINELLACEAE	<i>Selaginella dregei</i>	
SOLANACEAE	<i>Solanum panduriforme</i>	X
VERBENACEAE	<i>Verbena bonariensis</i>	X
VERBENACEAE	<i>Verbena officinalis</i>	X
XYRIDACEAE	<i>Xyris capensis</i>	

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



TERRESTRIAL ECOSYSTEMS ASSESSMENT

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



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
<i>Orycteropus afer</i>	Aardvark
<i>Otomys angoniensis</i>	Angoni vlei rat
<i>Otomys irroratus</i>	Vlei rat
<i>Ourebia ourebi</i>	Oribi
<i>Pelea capreolus</i>	Grey rhebok
<i>Poecilogale albinucha</i>	African striped weasel
<i>Potamochoerus procus</i>	Bush pig
<i>Procavia capensis</i>	Rock hyrax
<i>Proteles cristatus</i>	Aardwolf
<i>Raphicerus campestris</i>	Steenbok
<i>Redunca fulvorufula</i>	Mountain reedbuck
<i>Rhabdomys pumilio</i>	Striped mouse
<i>Rhinolophus clivosus</i>	Geoffroy's horseshoe bat
<i>Steatomys pratensis</i>	Fat mouse
<i>Suncus varilla</i>	Lesser dwarf shrew
<i>Suricata suricatta</i>	Suricate
<i>Sylvicapra grimmia</i>	Common duiker
<i>Tadarida aegyptiaca</i>	Egyptian free-tailed bat
<i>Tatera brantsii</i>	Highveld gerbil
<i>Thryonomys swinderianus</i>	Greater cane rat
<i>Vulpes chama</i>	Cape fox

Source: Stuart & Stuart (1997)



APPENDIX D

Birds potentially occurring in the study area



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
<i>Acridotheres tristis</i>	Indian myna
<i>Acrocephalus baeticatus</i>	African marsh wabler
<i>Acrocephalus gracilirostris</i>	Cape reed warbler
<i>Acrocephalus schoenobaenus</i>	European sedge wabler
<i>Actitis hypoleucos</i>	Common sandpiper
<i>Alopochen aegyptiaca</i>	Egyptian goose
<i>Amadina erythrocephala</i>	Redheaded finch
<i>Amandava subflava</i>	Orange breasted waxbill
<i>Amaurornis flavirostris</i>	Black crane
<i>Anas erythrorhyncha</i>	Red-billed teal
<i>Anas hottentota</i>	Hottentot teal
<i>Anas smithii</i>	Cape shoveller
<i>Anas sparsa</i>	African black duck
<i>Anas undulata</i>	Yellow-billed duck
<i>Anhinga rufa</i>	Darter
<i>Anomalospiza imberbis</i>	Cuckoofinch
<i>Anthropoides paradiseus</i>	Blue crane
<i>Anthus cinnamomeus</i>	Grassveld pipit
<i>Anthus leucophrys</i>	Plain backed pipit
<i>Anthus similis</i>	Long billed pipit
<i>Apus affinis</i>	Little swift
<i>Apus caffer</i>	White rumped swift
<i>Ardea cinerea</i>	Grey heron
<i>Ardea goliath</i>	Goliath heron
<i>Ardea melanocephala</i>	Blackheaded heron
<i>Ardea purpurea</i>	Purple heron
<i>Ardeola ralloides</i>	Squacco heron
<i>Asio capensis</i>	Marsh owl
<i>Bostrychia hagedash</i>	Hadedda ibis
<i>Bradypterus baboecala</i>	African sedge warbler
<i>Bubo africanus</i>	Spotted eagle owl
<i>Bubulcus ibis</i>	Cattle egret
<i>Burhinus capensis</i>	Spotted thick-knee
<i>Buteo rufofuscus</i>	Jackal Buzzard
<i>Buteo vulpinus</i>	Steppe buzzard
<i>Calandrella cinerea</i>	Red capped lark
<i>Calendulauda sabota</i>	Sabota lark
<i>Calidris ferruginea</i>	Curlew sandpiper



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
<i>Calidris minuta</i>	Little stint
<i>Centropus burchelli</i>	Burchell's coucal
<i>Ceryle rudis</i>	Pied kingfisher
<i>Chalcomitra amethystina</i>	Black sunbird
<i>Charadrius hiaticula</i>	Ringed lapwing
<i>Charadrius pecuarius</i>	Kittlitz's lapwing
<i>Charadrius tricollaris</i>	Three-banded lapwing
<i>Chersomanes albofasciata</i>	Spike heeled lark
<i>Chlidonias hybrida</i>	Whiskered tern
<i>Chlidonias leucopterus</i>	White winged tern
<i>Chrysococcyx caprius</i>	Diederik's cuckoo
<i>Ciconia abdimii</i>	Adbims' stork
<i>Ciconia ciconia</i>	White stork
<i>Circus ranivorus</i>	African marsh harrier
<i>Cisticola aridulus</i>	Desert cisticola
<i>Cisticola ayresii</i>	Ayre's cisticola
<i>Cisticola fulvicapilla</i>	Neddicky
<i>Cisticola juncidis</i>	Fantailed cisticola
<i>Cisticola textrix</i>	Cloud cisticola
<i>Cisticola tinniens</i>	Levaillant's cisticola
<i>Colius striatus</i>	Speckled mousebird
<i>Columba guinea</i>	Rock pigeon
<i>Columba livia</i>	Feral pigeon
<i>Corvus albus</i>	Pied crow
<i>Corvus capensis</i>	Black crow
<i>Cossypha caffra</i>	Cape robin
<i>Coturnix coturnix</i>	Common quail
<i>Creatophora cinerea</i>	Wattled starling
<i>Crithagra atrogularis</i>	Black-throated canary
<i>Crithagra gularis</i>	African cuckoo
<i>Crithagra mozambicus</i>	Yellow-fronted canary
<i>Cuculus solitarius</i>	Red-chested cuckoo
<i>Cypsiurus parvus</i>	Palm swift
<i>Delichon urbicum</i>	House martin
<i>Dendrocygna bicolor</i>	Fulvous duck
<i>Dendrocygna viduata</i>	White-faced duck
<i>Dicrurus adsimilis</i>	Fork tailed drongo
<i>Egretta alba</i>	Great white egret



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
<i>Egretta ardesiaca</i>	Black egret
<i>Egretta garzetta</i>	Little egret
<i>Egretta intermedia</i>	Yellowbilled egret
<i>Elanus caeruleus</i>	Blackshouldered kite
<i>Emberiza tahapisi</i>	Rock bunting
<i>Eremopterix leucotis</i>	Chestnut-backed sparrow-lark
<i>Estrilda astrild</i>	Common waxbill
<i>Euplectes afer</i>	Golden bishop
<i>Euplectes albonotatus</i>	White winged widow
<i>Euplectes ardens</i>	Red-collared widow
<i>Euplectes axillaris</i>	Red-shouldered widow
<i>Euplectes capensis</i>	Yellow-rumped widow
<i>Euplectes orix</i>	Red bishop
<i>Euplectes progne</i>	Longtailed widow
<i>Eupodotis afra</i>	Southern black korhaan
<i>Eupodotis caerulescens</i>	Blue korhaan
<i>Eupodotis senegalensis</i>	White-bellied korhaan
<i>Falco amurensis</i>	Eastern red-footed kestrel
<i>Falco naumanni</i>	Lesser kestrel
<i>Falco rupicolis</i>	Rock kestrel
<i>Falco rupicoloides</i>	Greater kestrel
<i>Fulica cristata</i>	Red-knobbed coot
<i>Gallinago nigripennis</i>	Ethiopian snipe
<i>Gallinula chloropus</i>	Common moorhen
<i>Haliaeetus vocifer</i>	African fish eagle
<i>Himantopus himantopus</i>	Black winged stilt
<i>Hirundo albigularis</i>	White throated swallow
<i>Hirundo cucullata</i>	Greater striped swallow
<i>Hirundo fuligula</i>	Rock Martin
<i>Hirundo rustica</i>	Eurasian Swallow
<i>Hirundo semirufa</i>	Red-breasted Swallow
<i>Hirundo spilodera</i>	South African Cliff Swallow
<i>Hirundo spilodera</i>	South African cliff swallow
<i>Lamprotornis nitens</i>	Glossy Starling
<i>Lanius collaris</i>	Fiscal shrike
<i>Lanius collurio</i>	Red-backed shrike
<i>Larus cirrocephalus</i>	Greyheaded gull
<i>Lybius torquatus</i>	Black collared barbet



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
<i>Macronyx capensis</i>	Orange throated longclaw
<i>Megaceryle maximus</i>	Giant kingfisher
<i>Mirafra africana</i>	Rufousnaped lark
<i>Mirafra apiata</i>	Cape clapper lark
<i>Motacilla capensis</i>	Cape wagtail
<i>Muscicapa striata</i>	Spotted flycatcher
<i>Mycteria ibis</i>	Yellow billed stork
<i>Myrmecocichla formicivora</i>	Ant-eating chat
<i>Netta erythrophthalma</i>	Southern pochard
<i>Numida meleagris</i>	Helmeted guineafowl
<i>Nycticorax nycticorax</i>	Black-crowned night heron
<i>Oena capensis</i>	Namaqua dove
<i>Oenanthe monticola</i>	Mountain chat
<i>Oenanthe pileata</i>	Capped wheatear
<i>Onychognathus morio</i>	Red-winged starling
<i>Oriolus larvatus</i>	Blackheaded oriole
<i>Ortygospiza atricollis</i>	Quail finch
<i>Oxyura maccoa</i>	Maccoa duck
<i>Passer diffusus</i>	Southern greyheaded sparrow
<i>Passer domesticus</i>	House sparrow
<i>Passer melanurus</i>	Cape sparrow
<i>Peliperdix coqui</i>	Coqui francolin
<i>Petronia supercilialis</i>	Yellow-throated sparrow
<i>Phalacrocorax africanus</i>	Reed cormorant
<i>Phalacrocorax lucidus</i>	White-breasted cormorant
<i>Phoenicopterus minor</i>	Lesser flamingo
<i>Phoenicopterus ruber</i>	Greater flamingo
<i>Phoeniculus purpureus</i>	Red-billed woodhoopoe
<i>Phylloscopus trochilus</i>	Willow warbler
<i>Platalea alba</i>	African spoonbill
<i>Plectropterus gambensis</i>	Spurwinged goose
<i>Plegadis falcinellus</i>	Glossy ibis
<i>Plocepasser mahali</i>	White-browed sparrowweaver
<i>Ploceus capensis</i>	Cape weaver
<i>Ploceus velatus</i>	Masked weaver
<i>Ploceus xanthops</i>	Golden weaver
<i>Podica senegalensis</i>	African finfoot
<i>Podiceps cristatus</i>	Great crested grebe



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
<i>Porphyrio madagascariensis</i>	Purple gallinule
<i>Prinia flavicans</i>	Black-chested prinia
<i>Prinia subflava</i>	Tawny-flanked prinia
<i>Pternistis swainsonii</i>	Swainson's francolin
<i>Pycnonotus tricolor</i>	Blackeyed bulbul
<i>Quelea quelea</i>	Redbilled quelea
<i>Rallus caerulescens</i>	African rail
<i>Recurvirostra avosetta</i>	Pied avocet
<i>Rhinopomastus cyanomelas</i>	Greater scimitarbill
<i>Riparia cincta</i>	Banded martin
<i>Riparia paludicola</i>	Brown-throated martin
<i>Riparia riparia</i>	Sand martin
<i>Sagittarius serpentarius</i>	Secretarybird
<i>Sarkidiornis melanotos</i>	Knobilled duck
<i>Sarothrura rufa</i>	Red chested flufftail
<i>Saxicola torquatus</i>	Stonechat
<i>Scopus umbretta</i>	Hamerkop
<i>Serinus canicollis</i>	Cape canary
<i>Sigelus silens</i>	Fiscal flycatcher
<i>Sphenoeacus afer</i>	Grassbird
<i>Spizocorys conirostris</i>	Pink-billed lark
<i>Spreo bicolor</i>	Pied starling
<i>Streptopelia capicola</i>	Cape turtle dove
<i>Streptopelia semitorquata</i>	Red-eyed dove
<i>Streptopelia senegalensis</i>	Laughing dove
<i>Struthio camelus</i>	Ostrich
<i>Sylvia borin</i>	Garden warbler
<i>Sylvietta rufescens</i>	Long-billed crombec
<i>Tachybaptus ruficollis</i>	Dabchick
<i>Tadorna cana</i>	South African shelduck
<i>Telophorus zeylonus</i>	Bokmakierie
<i>Terpsiphone viridis</i>	Paradise flycatcher
<i>Thalassornis leuconotus</i>	White-backed duck
<i>Threskiornis aethiopicus</i>	Sacred ibis
<i>Trachyphonus vaillantii</i>	Crested barbet
<i>Tricholaema leucomelas</i>	Pied barbet
<i>Tringa glareola</i>	Woods
<i>Tringa nebularia</i>	Greenshank



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
<i>Tringa stagnatilis</i>	Marsh sandpiper
<i>Turdoides jardineii</i>	Arrow-marked babbler
<i>Turdus libonyanus</i>	Kurrichane thrush
<i>Turdus olivaceus</i>	Olive thrush
<i>Turnix sylvaticus</i>	Kurrichane buttonquail
<i>Turtur chalcospilos</i>	Green-spotted wood dove
<i>Tyto alba</i>	Barn owl
<i>Upupa africana</i>	African hoopoe
<i>Urocolius indicus</i>	Red-faced mousebird
<i>Vanellus armatus</i>	Blacksmith lapwing
<i>Vanellus coronatus</i>	Crowned lapwing
<i>Vanellus senegallus</i>	Wattled lapwing
<i>Vidua macroura</i>	Pintailed whydah
<i>Zosterops pallidus</i>	Cape white-eye

Source: PRECIS Database - SIBIS South African Biodiversity Facility (Internet, Accessed: January 2013)



APPENDIX E

Herpetofauna potentially occurring in the study area



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Scientific name	Common name
Reptiles	
<i>Agama aculeata</i>	Ground agama
<i>Aparallactus capensis</i>	Cape centipede eater
<i>Bitis arietans</i>	Puff adder
<i>Causus rhombeatus</i>	Rhombic night adder
<i>Chamaesaura aenea</i>	Transvaal grass lizard
<i>Ichnotropis squamulosa</i>	Common rough-scaled Lizard
<i>Nucras taeniolata</i>	Ornate sandveld Lizard
<i>Cordylus vittifer</i>	Transvaal girdled Lizard
<i>Crotaphopeltis hotamboeia</i>	Red-lipped snake
<i>Dasyplectis scabra</i>	Rhombic egg eater
<i>Duberria lutrix</i>	Common slug eater
<i>Elapsoidea sundevallii</i>	Sundevall's garter snake
<i>Gerrhosaurus flavigularis</i>	Yellow-throated plated lizard
<i>Hemachatus heamachatus</i>	Rinkhals
<i>Homoroselaps dorsalis</i>	Striped harlequin snake
<i>Homoroselaps lacteus</i>	Spotted harlequin snake
<i>Lamprophis aurora</i>	Aurora house snake
<i>Lamprophis fuliginosus</i>	Brown house snake
<i>Leptotyphlops conjunctus</i>	Cape thread snake
<i>Leptotyphlops distanti</i>	Distant's thread snake
<i>Leptotyphlops scutifrons</i>	Peter's thread snake
<i>Lycodonomorphus rufulus</i>	Common brown water snake
<i>Lycophidion capense</i>	Cape wolf snake
<i>Naja haje</i>	Egyptian cobra
<i>Naja mossambica</i>	Mozambique spitting cobra
<i>Philothamnus hoplogaster</i>	Green water snake
<i>Philothamnus natalensis</i>	Natal green snake
<i>Psammophis crucifer</i>	Montane grass snake
<i>Psammophylax rhombeatus</i>	Rhombic skaapstekker
<i>Panaspis wahlbergii</i>	Wahlberg's snake-eyed skink
<i>Pseudaspis cana</i>	Mole snake
<i>Tetradactylus breyeri</i>	Breyer's long-tailed Seps
<i>Typhlops bibronii</i>	Bibron's blind snake
<i>Typhlops lalandei</i>	Delalandes blind snake
<i>Varanus exanthematicus</i>	Rock monitor
<i>Varanus niloticus</i>	Water monitor
<i>Kinixys belliana</i>	Bell's hinged tortoise
<i>Typhlops schlegelii</i>	Schlegel's blind snake
<i>Leptotyphlops nigricans</i>	Black thread snake
<i>Psammophylax tritaeniatus</i>	Striped skaapstekker
<i>Atractaspis bibronii</i>	Southern burrowing asp



Scientific name	Common name
<i>Philothamnus semivariegatus</i>	Spotted bush snake
<i>Pedioplanis lineoocellata</i>	Spotted sand snake
<i>Mabuya capensis</i>	Cape skink
<i>Mabuya striata</i>	Striped skink
<i>Mabuya varia</i>	Variable skink
<i>Acontias gracilicauda</i>	Thin-tailed legless skink
<i>Pachydactylus capensis</i>	Cape thick-toed gecko
<i>Pelomedusa subrufa</i>	Marsh terrapin
<i>Chamaeleo dilepis</i>	Flap-neck chameleon

Amphibians

<i>Bufo gutturalis</i>	Guttural toad
<i>Bufo garmani</i>	Eastern olive toad
<i>Bufo rangeri</i>	Raucous toad
<i>Schismaderma carens</i>	Red toad
<i>Kassina senegalensis</i>	Bubbling kassina
<i>Semnodactylus wealii</i>	Rattling frog
<i>Breviceps adspersus</i>	Bushveld rain frog
<i>Breviceps mossambicus</i>	Mozambique rain frog
<i>Xenopus laevis</i>	Common platanna
<i>Cacosternum boettgeri</i>	Common caco
<i>Phrynobatrachus natalensis</i>	Snoring puddle frog
<i>Afrana angolensis</i>	Common river frog
<i>Afrana fuscigula</i>	Cape river frog
<i>Ptychadena porosissima</i>	Striped grass frog
<i>Pyxicephalus adspersus</i>	Giant bullfrog
<i>Strongylopus fasciatus</i>	Striped stream frog
<i>Strongylopus grayii</i>	Clicking stream frog
<i>Tomopterna cryptotis</i>	Tremelo sand frog
<i>Tomopterna natalensis</i>	Natal sand frog

Sources: Branch (1994) & Carruthers (2001)



APPENDIX F

Arthropoda recorded in the study area and surrounding land



TERRESTRIAL ECOSYSTEMS ASSESSMENT

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



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Genus
Reduviidae	<i>Etrichodia crux</i>
	<i>Glymmatophora</i>
	<i>Lopodytes grassator</i>
Plataspidae	<i>Solenostethium lilligerum</i>
Alydidae	<i>Mirperus faculus</i>
Pentatomidae	<i>Nezara viridula</i>
Scarabidae	<i>Gymnopleurus humanus</i>
	<i>Anachalcos convexus</i>
	<i>Copris mesacanthus</i>
Cerambycidae	<i>Prosopocera lactator</i>
	<i>Macrotoma palmata</i>
	<i>Acanthophorus confinis</i>
Carabidae	<i>Passalidius fortipes</i>
	<i>Acanthoscelis ruficornis</i>
	<i>Anthia maxillosa</i>
Meliridae	<i>Melyris sp.</i>
Tenebrionidae	<i>Psammodes striatus</i>
	<i>Stenocara dentata</i>
	<i>Dichtha incantatoris</i>
Meloidae	<i>Actenoidia curtula</i>
Curculionidae	<i>Prionorhinus canus</i>
	<i>Brachycerus ornatus</i>
Myrmeleontidae	<i>Centroclisi sp.</i>
	<i>Cymothales sp.</i>
	<i>Hagenomyia tristis</i>
Tabanidae	<i>Philoliche rostrata</i>
Culicidae	<i>Aedes sp.</i>
	<i>Culex sp.</i>
Bombyliidae	<i>Exoprosopa sp.</i>
Calliphoridae	<i>Chrysomya chloropyga</i>
Saturniidae	<i>Bunaea alcinoe</i>
Pieridae	<i>Eurema brigitta</i>
Nymphalidae	<i>Hamanumida daedalus</i>
	<i>Precis hierta</i>
	<i>Precis oenone</i>
	<i>Junonia cebrene</i>
	<i>Junonia orithya madagascariensis</i>
Lycaenidae	<i>Species 1</i>
	<i>Danaus chrysippus</i>
Vespididae	<i>Ropalidia sp.</i>
	<i>Belonogaster dubia</i>
Apidae	<i>Apis mellifera</i>



TERRESTRIAL ECOSYSTEMS ASSESSMENT

Family	Genus
Formicidae	<i>Solenopsis sp.</i>
	<i>Anoplolepis custodiens</i>
	<i>Messor sp.</i>
	<i>Camponotus sp.</i>
Buthidae	<i>Uroplectes olivaceus</i>
	<i>Uroplectes formosus</i>
	<i>Parabuthus ganulatus</i>
Arachnidae	<i>Species 1</i>
Araneidae	<i>Argiope australis</i>
	<i>Gasteracanthus sanguinolenta</i>
	<i>Isoxya sp.</i>

Source: Golder (2007) Report no. 10613-5792-1 and 2013 field survey of continuous ash dump site



APPENDIX G

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