# Biodiversity Impact Assessment

# ATHA YZERMYN COAL PROJECT

## BIODIVERSITY BASELINE & IMPACT ASSESSMENT REPORT

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NSS Ref No: 1849,1877 & 1933
Date: August 2013

All pictures taken on site

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**Ref No:** 1649, 1877 & 1933 rev1
**Date:** September 2013

# EXECUTIVE SUMMARY

Natural Scientific Services CC (NSS) was contracted by WSP Environmental (Pty) Ltd (WSP) to perform Biodiversity Scoping, Baseline and Impact Assessments for selected aspects of the proposed ATHA Yzermyn Coal Project (AYCP) near Dirkiesdorp in southern Mpumalanga. This report presents the results of the Biodiversity Phase 2: Baseline Assessment and the Phase 3: Impact Assessment. The Baseline Assessment included desktop and field-based investigation of flora, fauna, aquatic ecology and wetlands for the proposed underground mining area of the AYCP, with emphasis on the proposed surface infrastructure and coal discard areas. Potential impacts of the proposed project, and recommended measures to mitigate these, were rated using WSP's Impact Rating Methodology.

The floral assessment involved desktop and field-based investigation of the structure, dominant species composition and condition of local floral communities including alien and invasive plants. An ordination analysis revealed six main floral communities excluding alien bushcumps and human settlements. The communities ranged in growth form from isolated patches of tall, woody vegetation to expansive open, grassy areas and wet, grassy seeps. NSS detected 32 Conservation Important (CI) plant species on site, and desktop research indicated that several additional CI plant species may occur in the study area. A low diversity of alien invasive flora was recorded, which was concentrated mainly in riverine areas. Within the proposed underground mining and surface infrastructure areas the identified *Leucosidea–Merxmuellera* riverine, *Searsia–Diospyros–Athrixia* kloof, and *Andropogon–Helichrysum-Bulbostylis* seep communities were assigned Very High sensitivity, and *Andropogon–Hyparrhenia* seasonal seeps were assigned a High sensitivity.

The faunal assessment involved desktop- and field-based investigation of mammals, birds, reptiles, frogs and butterflies. Field surveys involved visual observation, grab-sampling, camera- and live-trapping of fauna, as well as mist-netting, harp-trapping and acoustic surveys for bats. Of all potentially occurring species (spp.) in these faunal groups, 104 spp. (53%) of birds, 10 spp. (34%) of frogs, 27 spp. (25%) of mammals, 17 spp. (25%) of reptiles and 23 spp. (15%) of butterflies were detected in the study area. Close to 300 bats (including four CI species) were found roosting inside local abandoned mine adits, which were assigned Very High sensitivity. The two largest of these adits are situated 315-335m outside the proposed surface infrastructure layout, and 180-300m outside the proposed underground mining area. Wetlands and Scarp Forest provided habitat for many observed and potentially occurring CI mammal, bird and frog species, and were assigned Very High sensitivity. Grasslands supported a high diversity of mammals, birds and frogs, and patches of rocky grassland, in particular, supported a high diversity of reptiles.

The aquatic assessment involved high and low flow investigation of water quality, aquatic habitat integrity, macro-invertebrate and fish communities at four perennial sampling sites. For a fifth, non-perennial sampling site, only water quality could be analyzed. Measures of water quality fluctuated slightly with natural seasonal variation in precipitation and flow levels. In general, water quality at the sampled localities was good. Aquatic habitat integrity showed similar (natural) seasonal variation, and ranged from natural to moderately modified. This was because in some places, road crossings, rubbish dumping, alien vegetation, over-grazing and bank erosion impacted water flow and quality. Aquatic macro-invertebrate communities were, therefore, largely natural to seriously modified, and also showed slight seasonal variation in abundance. Three indigenous fish species were caught, and the fish communities were largely natural to moderately modified. Seven additional (including three CI) fish species may occur in the study area. Given the good overall current ecological status of aquatic habitat in the study area, local catchments should be effectively managed to avoid deterioration.

The wetland assessment involved desktop- and field-based delineation of wetlands in the proposed surface infrastructure and coal discard areas, and desktop-delineation of wetlands in the remaining underground mining area. Wetlands were classified and delineated using the methods of Ollis *et al.* (2013) and DWAF (2005), and the Present Ecological State (PES), functionality, importance and sensitivity of wetlands was assessed using the respective methods of Macfarlane *et al.* (2008), Kotze *et al.* (2008) and DWAF (1999). The proposed underground mining, surface infrastructure and discard areas contain extensive wetland systems including rivers, channelled valley bottom wetlands and seeps. Approximately 40% of the underground mining area and 42% of the surface infrastructure area therein, comprises wetland habitat. The wetlands are all natural to largely natural with few modifications and are, therefore, of Very High ecological importance and sensitivity. Findings from the floral, faunal and aquatic assessments confirmed that "maintenance of Biodiversity" is the highest scoring eco-service provided by the wetlands on site.

Separate Sensitivity Maps were compiled for flora, fauna, riverine and wetland habitat, which were combined to create an overall Sensitivity Map for Biodiversity in the study area, where:

- Very High sensitive areas included:
    - The *Leucosidea–Merxmuellera* riverine community.
    - The *Searsia–Diospyros–Athrixia* kloof (and protected outcrops) community.
    - The *Andropogon–Helichrysum-Bulbostylis* seasonal seeps.
    - All wetlands (rivers, channelled valley bottom systems and seeps) and the buffers around these.
    - The two large abandoned adits, and the buffers around these.
- High sensitive areas included:
    - The *Andropogon – Hyparrhenia* temporary seeps.
    - Smaller, abandoned adits and the buffers around these.

The Sensitivity Maps strongly indicated that the AYCP is situated in an extremely sensitive and conservation important area, which corresponds with the MTPA's (2013) Mpumalanga Biodiversity Sector Plan and the DEA *et al's* (2013) Atlas of Sensitive Areas for Mining.
Six major potential impacts of the mining operation on local Biodiversity were identified including:

- Construction of infrastructure and resultant loss of habitat and species.
- Decline in water inputs and resultant deterioration in PES and functionality.
- Decline in water quality and resultant deterioration in PES and functionality.
- Alien species invasion and resultant impacts on Biodiversity.
- Increased erosion and sedimentation and resultant impacts on Biodiversity.
- Sensory disturbance of fauna.

Although the proposed surface infrastructure layout would comprise a small portion (4.6%) of the target mining area, the combined Baseline and Impact Assessments indicate that the AYCP is fatally flawed, and should be NO GO in terms of Biodiversity. This is largely because of the impact of the proposed underground mining on the supply of water to the surface water resources (due to the de-watering activities) and the potential groundwater contamination. These aspects will have a significant impact on aquatic and wetland ecosystem functioning and biodiversity in a far greater area than the underground mining area. This aspect of the mining project, alone, is in strong conflict with international, national and provincial legislation, policies and guidelines. A high number of CI species were detected, and most habitat in the proposed underground mining and surface infrastructure areas was assigned a Very High or High sensitivity. Most potential impacts of the mining operation had a HIGH overall significance rating, even with mitigation. Moreover, the cumulative impacts of numerous mining applications in the study region are of serious concern. Even though NSS recommends that the project is a NO GO from a Biodiversity perspective, mitigation measures have been discussed should the project go ahead.

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# LIST OF ACRONYMS & ABBREVIATIONS

| ACRONYM | DESCRIPTION |
|---|---|
| AD | Adit or shaft from previous mining |
| ADU | Animal Demography Unit – a research unit of the Department of Zoology at the University of Cape Town |
| AGIS | Agricultural Geo-referenced Information System |
| AL | Alien Bushclump |
| AMD | Acid Mine Drainage |
| APPA | Atmospheric Pollution Prevention Act (Act 45 of 1965) |
| ARC | Agricultural Research Council |
| ASPT | Average Score Per Taxon |
| AYCP | ATHA Yzermyn Coal Project |
| BGIS | Biodiversity GIS (website) |
| BH ID | Borehole ID |
| BLSA | BirdLife South Africa |
| BMAP | Biodiversity Management and Action Plan |
| CARA | Conservation of Agricultural Resources Act (Act 43 of 1983) |
| CBA | Critical Biodiversity Area |
| CBD | Convention on Biological Diversity |
| CI | Conservation Important |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CO | Catchment Objectives |
| COD | Chemical Oxygen Demand |
| CoM | Chamber of Mines |
| CoP | Conferences of the Parties |
| CR | Critically Endangered – a classification used for describing species in serious danger of facing extinction |
| CSIR | Council for Scientific and Industrial Research |
| DAFF | Department of Agriculture, Forestry and Fisheries |
| DALA | Department of Agriculture and Land Administration |
| DCA | Detrended Correspondence Analysis |
| DD | Data Deficient – a classification used for describing species for which there is inadequate data available to assess their danger of facing extinction |
| DDT | Data Deficient - Taxonomically Problematic |
| DEA | Department of Environmental Affairs |
| DEAT | Department of Environmental Affairs and Tourism |
| DEC | Delta Environmental Consultants |
| DG | Dry Grassland |
| DMR | Department of Mineral Resources |
| DO | Dissolved Oxygen |
| DWA | Department of Water Affairs (previously known as DWAF) |
| DWAF | Department of Water Affairs and Forestry |

| ACRONYM | DESCRIPTION |
|---|---|
| EC | Ecological Category |
| ECA | Environmental Conservation Act (Act 73 of 1989) |
| ECO | Environmental Control Officer |
| EGBR | Enkangala Grassland Biosphere Reserve |
| EIA | Environmental Impact Assessment |
| EMC | Ecological Management Category |
| EM3 | Echo Meter 3 (bat call detector) |
| EMP | Environmental Management Programme |
| EMPR | Environmental Management Programme Report |
| EN | Endangered – a classification used for describing species in danger of facing extinction |
| End | Endemic |
| EO | Environmental Officer |
| ESA | Ecological Support Area |
| EWT | Endangered Wildlife Trust |
| FEPA | Freshwater Ecosystem Priority Area |
| FAII | Fish Assembly Integrity Index (Kleynhans 1999) |
| FCII | Fish Community Integrity Index (Karr 1981) |
| FRAI | Fish Response Assessment Index (Kleynhans 2008) |
| FROC | Frequency of Occurrence |
| GDARD | Gauteng Department of Agriculture and Rural Development |
| GNorBIG | Gauteng & Northern Regions Bat Interest Group |
| GPS | Global Positioning System |
| GSM | Gravel, Stones, Mud |
| HGM | Hydro-geomorphic |
| IBA | Important Bird Area |
| ICMM | International Council on Mining and Metals |
| IH | Instream Habitat |
| IHAS | Integrated Habitat Assessment System (Kleynhans 1996) |
| IHI | Index of Habitat Integrity |
| IUCN | International Union for Conservation of Nature and Natural Resources, based in Gland, Switzerland |
| IWMI | International Water Management Institute |
| JPoI | Johannesburg Declaration and Plan of Implementation |
| LoO | Likelihood of Occurrence of a species in an area |
| MA | Minerals Act (Act 50 of 1991) |
| MBCP | Mpumalanga Biodiversity Conservation Plan |
| MBSP | Mpumalanga Biodiversity Sector Plan |
| MIRAI | Macro-Invertebrate Response Assessment Index (Thirion 2008) |
| MNCA | Mpumalanga Nature Conservation Act (Act 10 of 1998) |
| MoP | Meeting of the Parties |
| MPAES | Mpumalanga Protected Area Expansion Strategy |
| MPB | Mpumalanga Parks Board |
| MPBA | Mpumalanga Parks Board Act (Act 6 of 1995) |

| ACRONYM | DESCRIPTION |
|---|---|
| MTPA | Mpumalanga Tourism and Parks Agency |
| MTPAA | Mpumalanga Tourism and Parks Agency Act (Act 5 of 2005) |
| MWA | Mines and Work Act Act 27 of 1956) |
| NAEHMP | National Aquatic Ecosystem Health Monitoring Programme |
| NBSAP | National Biodiversity Strategy and Action Plan |
| NEMA | National Environmental Management Act (Act 107 of 1998) |
| NEMAA | National Environmental Management Amendment Act (Act 8 of 2004) |
| NEM:AQA | National Environmental Management: Air Quality Act (Act 39 of 2004) |
| NEM:BA | National Environmental Management: Biodiversity Act (Act 10 of 2004) |
| NEM:PAA | National Environmental Management: Protected Areas Act (Act 57 of 2003) |
| N-End | Near-Endemic |
| NEPAD | New Partnership for Africa's Development |
| NFA | National Forests Act (Act 84 of 1998) |
| NFEPA | National Freshwater Ecosystem Priority Areas project |
| NFFLAA | National Forest and Fire Laws Amendment Act (Act 12 of 2001) |
| NHRA | National Heritage Resources Act (Act 25 of 1999) |
| NMMU | Nelson Mandela Metropolitan University |
| NMPRD | National Mineral and Petroleum Resources Development Act (Act 28 of 2002) |
| NSBA | National Spatial Biodiversity Assessment |
| NSS | Natural Scientific Services CC |
| NT | Near Threatened – a classification used for describing species not yet in danger of facing extinction, but close to such a state |
| NVFFA | National Veld and Forest Fire Act (Act 101 of 1998) |
| NWA | National Water Act (Act 36 of 1998) |
| PCD | Pollution Control Dam |
| PES | Present Ecological State (Kleynhans 1999) |
| POSA | Plants of southern Africa (website) |
| PRECIS | The National Herbarium of Pretoria's Computerized Information System |
| PS | Protected Species |
| PrNatSci | Professional Natural Scientist |
| QDS | Quarter Degree Square – the basic unit used by the Surveyor General for creation of 1:50 000 topographical maps |
| RG | Rocky Grassland |
| RH | Riparian Habitat |
| RHP | River Health Programme |
| SABAAP | South African Bat Assessment Advisory Panel |
| SABAP 1 & 2 | First and second Southern African Bird Atlas Projects, managed by the ADU |
| SABCA | South African Butterfly Conservation Assessment, managed by the ADU |
| SABIF | South African Biodiversity Information Facility |
| SAFAP | South African Frog Atlas Project, managed by the ADU |
| SAIAB | South African Institute of Aquatic Biodiversity |
| SAMBF | South African Mining and Biodiversity Forum |
| SANBI | South African National Biodiversity Institute |

| ACRONYM | DESCRIPTION |
|---|---|
| SANParks | South African National Parks |
| SANS | South African National Standards |
| SARCA | Southern African Reptile Conservation Assessment, managed by the ADU |
| SASS 4 & 5 | Versions 4 and 5 of the South African Scoring System for monitoring aquatic macro-invertebrates (Dickens & Graham 2002) |
| SEF | Strategic Environmental Focus |
| SF | Scarp Forest |
| SIBIS | SANBI's Biodiversity Information System |
| SMP | Strategic Management Plan |
| Spp. | Species |
| SS | Suspended Solids |
| SV | Savanna |
| TDS | Total Dissolved Solids |
| ToR | Terms of Reference |
| TSP | Threatened Species Programme – a programme managed by SANBI to assess the Red Data status of South African plants |
| TWQR | Total Water Quality Range |
| UJ | University of Johannesburg |
| UN | United Nations |
| UNCED | UN Conference on Environment and Development |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNISA | University of South Africa |
| UP | University of Pretoria |
| VU | Vulnerable – a classification used for describing species in danger of facing extinction |
| WGS | World Geodetic System |
| WITS | University of the Witwatersrand |
| WMA | Water Management Area |
| WQ | Water Quality |
| WRC | Water Research Commission |
| WSA | Water Services Act (Act 108 of 1997) |
| WSP | WSP Environment and Energy (Pty) Ltd |
| WSSD | World Summit on Sustainable Development |
| WT | Wetland |
| WWF | World Wildlife Fund |
| YZ1 | Upstream site on the Mawandlane River |
| YZ2 | Downstream site on the Mawandlane River |
| YZ3 | Upstream site on the Mkusaze River |
| YZ4 | Downstream site on a tributary of the Assegaai River |
| YZ5 | Downstream site on the Mawandlane River |

# Section A: Setting the Scene

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# SECTION A: SETTING THE SCENE

## 1. Introduction

South Africa is legally bound to the sustainable use and effective conservation of Biodiversity by various international treaties, our national Constitution (Act 108 of 1996), the National Environmental Management Act (NEMA Act 107 of 1998), the National Environmental Management: Biodiversity Act (NEM:BA Act 10 of 2004), and the National Environmental Management: Protected Areas Act (NEM:PAA Act 57 of 2003), among other things.

In cognisance of this, Natural Scientific Services CC (NSS) was contracted by WSP Environmental (Pty) Ltd (WSP) to perform Biodiversity Scoping, Baseline and Impact Assessments for selected aspects of the proposed ATHA Yzermyn Coal Project (AYCP). The AYCP study area is situated within the moist, high-altitude grasslands of south-eastern Mpumalanga Province, South Africa, and includes a mining lease area, a proposed area for underground mining within the lease area, and an area for associated surface infrastructure (including a coal discard area). The lease area includes the Bloemhof-92, Goedgevonden-95, Kromhoek-93, Nauwgevonden-110, Paardekop109 , Uitzicht-108, Van der Waltspoort-81(por-2 &RE), Virginia -91and Yzermyn -96 (por-1) & RE farms (or portions thereof), and Zoetfontein-94, which are situated off the R543 near Dirkiesdorp, Mpumalanga, approximately 58km south-west of Piet Retief and 21km north-east of Wakkerstroom.

Grasslands and wetlands in South Africa provide essential ecosystem services, and support considerable Biodiversity including many Conservation Important (CI) species. Roughly 40%-60% of the Grassland Biome in South Africa has been permanently transformed or severely degraded by cultivation, afforestation, urbanization, mining and erosion (Low & Rebelo 1996; Mucina & Rutherford 2006). Remaining natural grassland is highly fragmented, and in some areas as little as 15% remains. In Mpumalanga, coal-mining has had extensive negative impacts on Biodiversity and remaining grasslands and wetlands are severely threatened by the accelerating demand for low-cost energy from coal (Tweddle *et al*. 2009).

It was within this context that NSS performed the Biodiversity Assessment for the AYCP.

# 2. Terms of Reference

The Terms of Reference (ToR) for the Biodiversity Assessment included a desktop and field-based investigation of flora, fauna, aquatic ecology, and wetlands for the proposed underground mining area of the AYCP (and a wetland assessment in the proposed surface infrastructure area) during three phases:

- Phase 1: Scoping Assessment.
- Phase 2: Baseline Assessment.
- Phase 3: Impact Assessment.

The Scoping Assessment Report was submitted to WSP in May 2012, and was based on desktop research and preliminary findings of field surveys performed during March 2012, for the original (old) underground mining area.

After the boundaries of the AYCP lease, underground mining, and surface infrastructure areas changed, as shown in **Figure 2-1**, the Scoping Assessment Report was revised accordingly and submitted to WSP in February 2013. The ToR were also expanded to include delineation of wetlands in the current (new) surface infrastructure area, and a proposed discard area. The current surface infrastructure area represents a 1km-radius around the proposed Dundas and Alfred declines. The proposed discard area is approximately 400m x 700m, and is situated ~860m north of the proposed declines, outside the current lease area. The 87ha surface infrastructure layout plus the 27ha discard area outside of the current lease boundary, represent 4.6% (114ha) of the 2,500ha 15 year target area. The spatial extent of different components comprising the proposed surface infrastructure layout, as supplied by Mindset Consultants (Pty) Ltd (Mindset), is detailed in **Table 2-1**. The proposed current (0-15 year) and future (>15 year) underground mining areas are shown in **Figure 2-2**. No biodiversity assessment work was performed for the proposed future underground mining area.

**Table 2-1 Spatial extent of the different surface infrastructure components supplied by Mindset**

| COMPONENT | AREA (ha) | AREA ($m^2$) |
|---|---|---|
| Box cut | 2.4507 | 24,507 |
| Workshop and related infrastructure | 2.0047 | 20,047 |
| Bus parking | 0.2652 | 2,652 |
| Office building & car parking | 0.2959 | 2,959 |
| Plant area | 5.7537 | 57,537 |
| Isolated pollution control dam (PCD) | 2.8289 | 28,289 |
| Discard dump within lease area | 22.7625 | 227,625 |
| Discard dump & PCD outside lease area | 12.2901 | 122,901 |
| Road (excluding the municipal road) | 1.0485 | 10,485 |
| **Collective surface infrastructure** | **49.7002** | **497,002** |
| **Total area assigned for surface infrastructure** | **86.5** | **865,000** |


**Figure 2-1 Location and boundaries of the ATHA Yzermyn Coal Project in Mpumalanga**

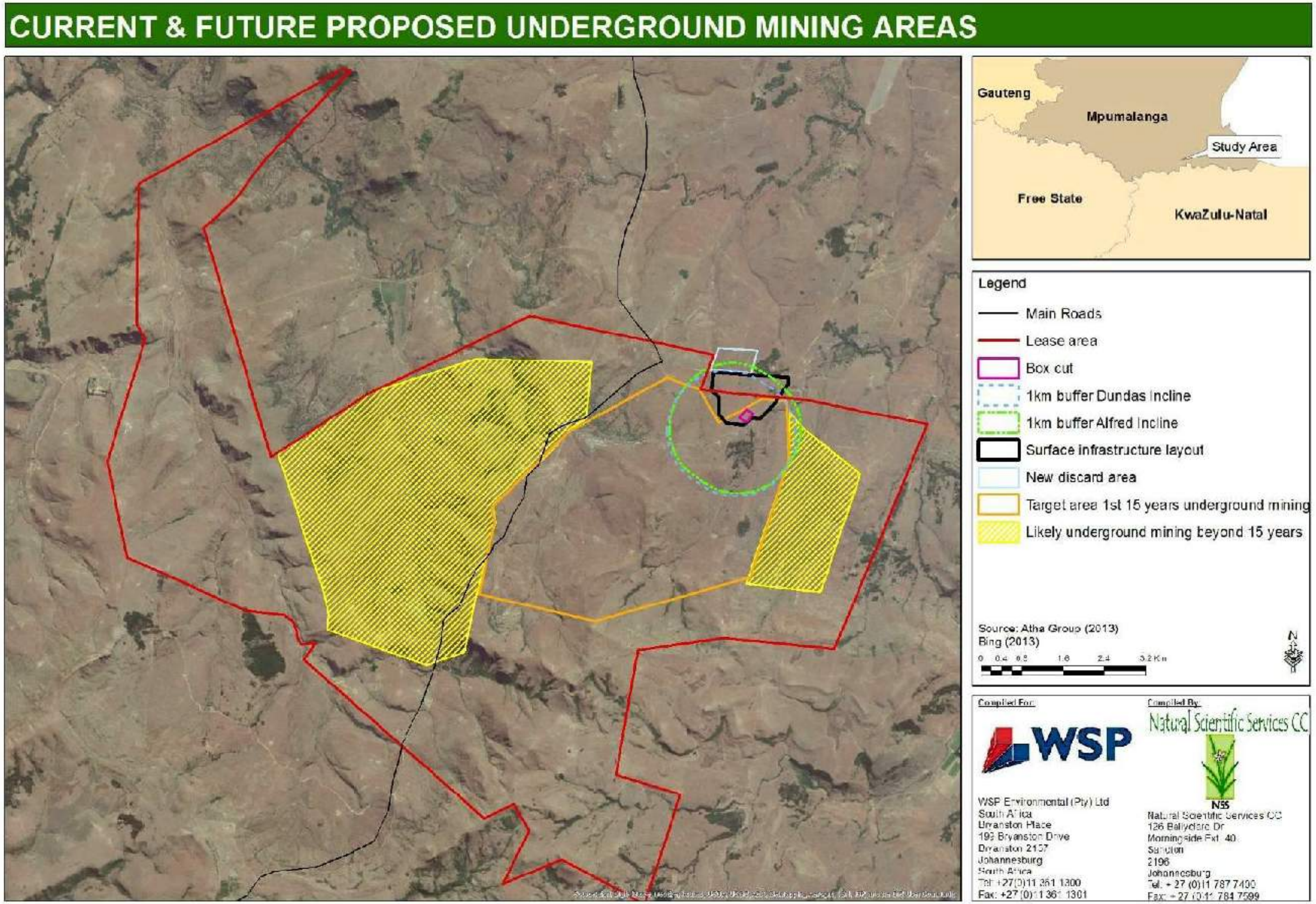


**Figure 2-2 Proposed current (0-15 year) and future (>15 year) underground mining areas for the AYCP**

In this report the floral, faunal, aquatic and wetland baseline studies for Phase 1 and 2 of the Biodiversity Assessment are described, respectively, in **Sections B, C, D** and **E**. Field surveys for flora, fauna and wetlands (excluding delineations) were performed in the original (old) proposed undermining area during 2012 and in the current undermining area during 2013. Wetlands were delineated in the original surface infrastructure area during 2012 and in the current surface infrastructure and discard areas during 2013. The same localities were sampled for the high and low flow aquatic surveys during 2012, which were fortuitously located in close proximity to the 1km radial area around the proposed declines. An overall Biodiversity Sensitivity Assessment including a Sensitivity Map is provided in **Section F**, and the Phase 3 Impact Assessment is described in **Section G**.

WSP also requested a quote for a Biodiversity Management and Action Plan (BMAP) for the AYCP. NSS has, however, indicated from the onset that a BMAP "should be conducted ONLY if the project gets approved by the Competent Authorities."

# 3. Project Team

All components for Phases 1-3 were performed by NSS with specialist avifaunal and bat input received from Delta Environmental Consultants (DEC) and the Gauteng & Northern Regions Bat Interest Group (GNorBIG), respectively (**Table 3-1**).

The NSS team has extensive experience in completing Biodiversity Assessments involving floral, faunal, wetland and aquatic (riverine) work, as well as Environmental Impact Assessments (EIAs), Environmental Management Programme Reports (EMPRs), Strategic Management Plans (SMPs) and Environmental Management Plans (EMPs) for the Conservation, Mining, Waste, Commercial and Industrial sectors. In terms of accreditation and professional registrations the following is applicable to NSS:

- Senior team members are registered Professional Natural Scientists in the ecological, environmental and zoological fields.
- Aquatics team members are accredited with DWA to perform the SASS macro-invertebrate monitoring method in South Africa.
- Wetland team members are accredited through DWA to perform Wetland Delineations.

**Table 3-1 Project team with associated areas of specialisation**

| ASPECT INVESTIGATED | SPECIALIST | QUALIFICATIONS |
|---|---|---|
| Aquatic bio-monitoring | Amanda Austin (NSS) | M.Sc. – Aquatic Health (UJ).<br>DWA accredited to perform the SASS macro-invertebrate monitoring method. |
| Aquatic bio-monitoring | Wynand Malherbe (UJ) | M.Sc. - Aquatic Health (UJ).<br>DWA accredited to perform the SASS macro-invertebrate monitoring method. |
| Aquatic bio-monitoring review | Kerry Brink (Private contract) | Ph.D. Aquatic Health (UJ).<br>DWA accredited to perform the SASS macro-invertebrate monitoring method. |
| Ecology | LD Van Essen (NSS) | Ph.D. Wildlife Management (UP) – in progress. |
| Ecology | Lloyd Mhlongo (NSS) | B.Sc. – Botany (UNISA) - in progress. |
| Fauna & project management | Caroline Lötter (NSS) | Ph.D. – Zoology (UP).<br>Pr.Sci.Nat. Registered – Zoology. |
| Fauna & wetland delineation | Tyron Clark (NSS) | B.Sc. Honours - Zoology (WITS) – in progress. |
| Fauna: birds only | Geoff Lockwood (DEC) | BirdLife South Africa (BLSA) Council member and Vice Chairman for 27 & 5 years.<br>Specialist avifaunal consultant for >40 EIAs. |
| Fauna: bats only | Kate MacEwan (NSS) | M.Sc. – Zoology (WITS) – in progress.<br>Pr.Sci.Nat. Registered – Zoology & Environmental Science.<br>GNorBIG and SABAAP member. |
| Fauna: bats only | Trevor Morgan (NSS) | NSS Bat Specialist.<br>GNorBIG Executive Committee member. |
| Fauna: bats only | Julio Balona (GNorBig) | GNorBIG Executive Committee member. |
| Fauna: mainly reptiles | Bryan Maritz (Private contract) | Ph.D. – Zoology (WITS).<br>Pr.Sci.Nat. Registered – Zoology. |
| Flora & wetland delineation | Susan Abell (NSS) | M.Sc. – Resource Conservation Biology (WITS).<br>Pr.Sci.Nat. Registered – Ecology & Environmental Science. |
| Floral assistant | Crystal Rowe (NSS) | B.Sc. Honours – Botany (NMMU). |
| GIS mapping | Tim Blignaut (NSS) | M.Sc. – Geography (UJ) – in progress. |
| Wetland delineation & project review | Kathy Taggart (NSS) | M.Sc. – Resource Conservation Biology (WITS).<br>Pr.Sci.Nat. Registered – Ecology & Environmental Science.<br>DWA Accredited – Wetland Delineations. |

# 4. Applicable Legislation, Policies & Guidelines

There are several international treaties and considerable national and provincial legislation regarding the sustainable use and conservation of terrestrial and aquatic Biodiversity including species and ecosystems. As coal mining inevitably has major negative impacts on Biodiversity, all the below-mentioned international, regional, national and provincial legislation, policies and guidelines are applicable to the proposed AYCP. While the list below is extensive, additional legislation, policies and guidelines that have not been mentioned may apply.

## 4.1. International Agreements

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES is an international agreement between governments, which aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It was drafted as a result of a resolution adopted in 1963 at a meeting of members of the International Union for Conservation of Nature and Natural Resources (IUCN) in Washington, USA. CITES was opened for signature in 1973 and entered into force during 1975. It accords varying degrees of protection to more than 33,000 species of animals and plants. Since wetlands often form part of special and unique habitats, they are indirectly protected under CITES.

Convention on Wetlands of International Importance, especially as Waterfowl Habitat

This Convention, also called the Ramsar Convention, was developed and adopted by participating nations at a meeting in 1971 hosted by the Iranian Department of Environment in Ramsar, Iran. The Convention deals with the conservation and sustainable use of wetlands. The treaty, which came into force during 1975, aims to stem the increasing transformation and loss of wetlands because of their fundamental ecological, economic, cultural, scientific and recreational value. The Convention works closely with five other organisations including Birdlife International, the IUCN, the International Water Management Institute (IWMI), Wetlands International and the World Wildlife Fund (WWF) International. South Africa is a contracting party to the Convention and has currently got 21 internationally recognized Ramsar sites including Seekoeivlei, which is situated approximately 50km south-west of Yzermyn. Seekoeivlei is drained by the Klip River, which is a tributary of the Vaal River, upon which the highly industrialized and densely populated Gauteng Province depends for its water supply.

Convention Concerning the Protection of World Cultural and Natural Heritage

This Convention, also referred to as the World Heritage or Stockholm Convention, was born during the 1972 United Nations (UN) Conference on Human Environment in Stockholm, Sweden, and aims to preserve the world's superb natural and scenic areas and historic sites for present and future generations of humanity. The most significant feature of the Convention is that it links together the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two. Eight World Heritage Sites are currently recognized in South Africa, including the Ukhahlamba Drakensberg Park, which is situated approximately 235km south-west of the AYCP. The proposed Barberton Mountain Land World Heritage Site is approximately 165km north-east of the AYCP.

Convention on the Conservation of Migratory Species of Wild Animals

This Convention, also known as the Bonn Convention, aims to conserve terrestrial, marine and avian migratory species throughout their range. The treaty was signed in 1979 in Bonn, France, and entered into force in 1983. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme (UNEP), which is concerned with the conservation of wildlife and habitats on a global scale. South Africa is a party to this Convention, which affords protection to all migratory animals in the AYCP area including various bird, bat and butterfly species.

Convention on Biological Diversity (CBD)

This Convention, also referred to as the Biodiversity Convention, was established during the 1992 UN Conference on Environment and Development (UNCED), also known as the 1992 Earth Summit, held in Rio de Janeiro, Brazil. It represented the first global, comprehensive, legally-binding agreement to address all aspects of biological diversity ranging from genetic resources to species and ecosystems. It is regarded as the key document regarding sustainable development. The CBD has three main goals: conservation, and sustainable use of biodiversity, and equitable sharing of benefits arising from genetic resources. South Africa signed this treaty in 1998 showing further commitment to the conservation of biodiversity including biomes (e.g. grassland), ecosystems (e.g. wetlands and rivers), species and sub-specific diversity.

Agenda 21

Agenda 21, an outcome of the 1992 Earth Summit, provides a policy framework and a non-binding, voluntarily implemented action plan for sustainable development at global, national and regional levels. Local Agenda 21 entails the participation and co-operation of local authorities to develop their own Local Agenda 21 plans and strategies according to the region's specific priorities and available resources. The plans need to be submitted to the Department of Environmental Affairs (DEA) and updated every five years. Reporting on the state of the environment is a requirement in terms of the Environmental Conservation Act (ECA; Act 73 of 1989; Section 13(e)) and the National Environmental Management Act (NEMA; Act 107 of 1998).

The water chapter (Chapter 18) of Agenda 21 requires countries 'to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature'. This chapter of the Agenda provides guidance for the protection of water resources, water quality and aquatic ecosystems, and sets targets including:

- Protection and conservation of water resources on a sustainable basis;
- Water pollution prevention and control;
- Establishment of biological, health, physical and chemical quality criteria for all water resources; and
- Adoption of an integrated approach to environmentally sustainable management of water resources, including the protection of aquatic ecosystems and freshwater living resources.

United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC or FCCC, which was also established during the 1992 Earth Summit, is an international agreement to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The treaty itself sets no mandatory limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. It is, therefore, non-binding. However, it does provide for updates called "protocols," which set mandatory emission limits. The principal update is the Kyoto Protocol. The UNFCCC entered into force in 1994 and has approximately 194 parties including South Africa. The parties to the Convention have met annually from 1995 in Conferences of the Parties (CoP) to assess progress in dealing with climate change.

Kyoto Protocol

The Kyoto Protocol is aimed at fighting global warming. It was developed during the 3rd Conference of the Parties (CoP 3) in Kyoto, Japan in 1997, and was entered into force in 2005. Approximately 191 states have signed and ratified the Protocol including South Africa. Under the Protocol, 37 countries ("Annex I countries") committed themselves to reduce their greenhouse gas emissions by 5.2% on average for the period 2008-2012. This reduction was relative to their annual emissions in a base year, generally 1990.

Johannesburg Declaration and Plan of Implementation (JPoI)

The Johannesburg Declaration and JPoI originated from the 2002 UN Conference on Sustainable Development in Johannesburg, which was convened as the World Summit on Sustainable Developement (WSSD), otherwise known as the 2002 Earth Summit. The Declaration builds on earlier declarations made during the UN conferences at Stockholm in

1972 and Rio de Janeiro in 1992. While committing nations to sustainable development there is strong emphasis on factors that pose severe threats to sustainable development such as famine, conflict, corruption, terrorism and disease.

The JPoI acknowledges that biodiversity is critical for the planet, sustainable development, poverty eradication, human well-being and the cultural integrity people. It also recognizes that biodiversity is currently being lost at unprecedented rates due to human activities, and that this trend can only be reversed if local people benefit directly from the conservation and sustainable use of biological diversity in their countries.

Chapter 4 of the JPoI deals with protecting and managing the natural resource base of economic and social development (water, oceans, vulnerability, disaster management, climate change, agriculture, desertification, biodiversity, mountains, tourism, forests, mining). A general target to achieve by 2010 is a significant reduction of the current rate of biodiversity loss at global, regional and national levels, as a contribution to poverty alleviation and to benefit all life on Earth. South Africa uses the National Biodiversity Strategy and Action Plan (NBSAP) as a means to achieve the JPoI biodiversity targets. The NBSAP is discussed under **Section 4.4.**

Copenhagen Accord

The 2009 UNFCCC in Copenhagen, also referred to as the Copenhagen Summit, included the 15th Conference of the Parties (CoP 15) to the UNFCCC and the 5th Meeting of the Parties (MoP 5) to the Kyoto Protocol. A framework for climate change mitigation beyond 2012, the Copenhagen Accord, was drafted during the Summit by the United States, China, India, Brazil and South Africa. It was "taken note of," but not "adopted," in a debate of all the participating countries, and it was not passed unanimously. The Accord recognizes that climate change is one of the greatest challenges of the present day and that actions should be taken to keep any temperature increases to below 2°C. The document is not legally binding and does not contain any legally binding commitments for reducing $CO_2$ emissions. Many countries and non-governmental organisations were opposed to this agreement, but since 2010 > 138 countries have formally signed the agreement. South Africa has agreed to cut emissions by 34% below current expected levels by 2020.

17$^{th}$ Conference of the Parties (CoP 17)

The 2011 UNFCCC in Durban was held to establish a new treaty to limit carbon emissions. This Convention agreed to a legally binding deal comprising all countries, which will be prepared by 2015 and to take effect in 2020. While the president of the conference, Maite Nkoana-Mashabane, declared it a success, scientists and environmental groups warned that the deal was not sufficient to avoid global warming beyond 2°C as more urgent action is needed.

Coal mining releases significant quantities of methane, which is a potent greenhouse gas, and which is released during underground and surface mining, coal transport and processing, and even after mine decommission and abandonment.

## 4.2. Regional Agreements

Action Plan of the Environmental Initiative of NEPAD

This New Partnership for Africa's Development (NEPAD) Action Plan was established during the 2003 African Convention on Conservation of Nature and Natural Resources held in Maputo. As a contracting state, South Africa has undertaken to adopt measures to ensure the conservation, utilization and development of soil, water, flora and faunal resources in accordance with scientific principles and with due regard to the best interests of the people. The Action Plan encourages sustainable development and associated conservation and wise use of biodiversity in Africa. It has been recognised that a healthy and productive environment is a prerequisite for the success of NEPAD, together with the need to systematically address and sustain ecosystems, biodiversity and wildlife. The Action Plan has six main foci:

- Combating land degradation, drought and desertification;
- Conserving Africa's wetlands;
- Preventing and controlling invasive alien species;
- Conservation and sustainable use of coastal and marine resources;
- Combating climate change in Africa; and
- Cross-border conservation and management of natural resources.

## 4.3. National Legislation, Policies & Guidelines

Constitution of the Republic of South Africa (Act 108 of 1996)

According to South Africa's Constitution, South African citizens have the right to have the environment protected for the benefit of present and future generations.

Conservation of Agricultural Resources Act (CARA; Act 43 of 1983)

The CARA includes the use and protection of land, soil, wetlands and vegetation and the control of weeds and invader plants. This is the only legislation that is directly aimed at conservation of wetlands in agriculture. In 1984 regulations were passed under CARA, which declared about 50 plant species as "weeds" or "invader plants." On 30 March 2001 the Minister of Agriculture promulgated an amendment to these regulations, which now contain a comprehensive list of declared weed and invader plant species that are divided into three categories:

- Category 1: Declared weeds that are prohibited on any land or water surface in South Africa. These species must be controlled or eradicated where possible.

- Category 2: Declared invader species that are only allowed in demarcated areas under controlled conditions and prohibited within 30 m of the 1:50 year floodline of any watercourse or wetland.
- Category 3: Declared invader species that may remain, but must be prevented from spreading. No further planting of these species are allowed.

In addition, according to the amendments to the regulations under CARA, landowners are legally responsible for the control of alien species on their properties. Various acts administered by the Department of Environmental Affairs (DEA) and the Department of Water Affairs (DWA), as well as other laws (including local by-laws), detail the fines, terms of imprisonment and other penalties for contravening the law. Although no fines have yet been placed against landowners who do not remove invasive species, authorities may clear their land of invasive alien plants and other alien species entirely at the landowners cost and risk. These regulations are likely to be repealed when the NEM:BA Draft Alien and Invasive Species Regulations (2007) are promulgated.

Environmental Conservation Act (ECA; Act 73 of 1989)

The ECA is mentioned here because it is necessary to ensure that, for the remainder of its phasing out period, it is enforced in terms of the new enforcement provisions in the current National Environmental Management Act (NEMA), which were added to NEMA under the National Environmental Management Amendment Act (NEMAA; Act 8 of 2004). ECA is already partially repealed, and although it is envisaged that ECA will eventually be repealed in its totality, it is still being applied for a number of reasons. For example, regulations are being applied for authorisation of activities in certain coastal areas, which were published in terms of Sections 26 and 28 of the ECA in Government Notice R. 1528 of 27 November 1998. Other remaining provisions of the ECA deal with littering, waste-management and regulations on noise, vibration and shock.

Water Services Act (WSA; Act 108 of 1997)

This Act provides for, among other things, the:

- Setting of national water standards, and of norms and standards for water tariffs.
- Monitoring of water services and intervention by the Minister or by the relevant Province.
- Gathering of information in a national information system and the distribution of that information.
- Promotion of effective water resource management and conservation.

Subject to subsection 3 of the WSA, no person may dispose of industrial effluent in any manner other than that approved by the water services provider nominated by the water services authority having jurisdictionin the area in question. No approval given by a water services authority under this section relieves anyone from complying with any other law relating to the use and conservation of water and water resource, or the disposal of effluent.

National Veld and Forest Fire Act (NVFFA; Act 101 of 1998)

The NVFFA is the principal legislation pertaining to the control of veld fires in South Africa. The purpose of this Act is to prevent and combat veld fires in the country. The Act applies to land owners, lawful occupiers or other persons/organisations in control of land on which a veld, forest or mountain fire can start on the land, burn on the land or spread. Such a person/organization has an obligation to prepare and maintain firebreaks between their land and any adjoining land owned by a Third Party. The NVFFA was amended by the National Forest and Fire Laws Amendment Act (NFFLAA; Act 12 of 2001).

National Water Act (NWA; Act 36 of 1998)

The NWA recognises that water is a scarce and unevenly distributed natural resource that should be equitably utilised in a sustainable manner. The Act ensures that water resources are protected, used, developed, conserved and controlled in ways that take into account a range of needs and obligations, including the need to "Protect aquatic and associated ecosystems and their biological diversity." **The NWA specifies that water use must be authorised**. It indicates the means for authorisation and includes minimum requirements for evaluation and decision-making by relevant authorities. To protect aquatic ecosystems and biodiversity, the NWA has a number of requirements, which are controlled by the DWA, including:

- Section 19(2) which states that: responsible persons of pollution of any water resoures must take all measures to prevent and remedy effects of pollution.
- Section 21 which states that: a license for water use is required if the following activities are expected:
    (a) taking water from a water resource;
    (b) storing water;
    (c) impeding or diverting the flow of water in a watercourse;
    (d) engaging in a stream flow reduction activity contemplated in Section 36;
    (e) engaging in a controlled activity identified as such in Section 37(1) or declared under Section 38(1).
    (f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
    (g) disposing of waste in a manner which may detrimentally impact on a water resource;
    (h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
    (i) altering the bed, banks, course or characteristics of a watercourse;

(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
(k) using water for recreational purposes.

- Section 37(2) states that: the following activities (described in Section 37(1)) require authorization before being undertaken:
  (l) irrigation on any land with waste or water containing waste generated through any industrial activity of by a waterworks;
  (m) intentional recharging of an aquifer with any waste or water containing waste;
  (n) an activity which has been declared by the minister as a "controlled activity."

National Forests Act (NFA; Act 84 of 1998) and Protected Tree Species

An objective of the NFA is to provide special measures for the protection of certain forests and tree species, and to promote the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes. In terms of Section 15(1) of the NFA forest trees or Protected Tree Species may not be cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold – except under license granted by the Department of Agriculture, Forestry and Fisheries (DAFF) or a delegated authority.

Government Notice 835 of 2010 provides the latest List of Protected Tree Species within the borders of South Africa under the NFA. The criteria used to select tree species for inclusion in the protected list were:

- Red List status (rare or threatened species);
- Keystone species value (whether species play a dominant role in an ecosystem's functioning);
- Sustainability of use (whether a species is threatened by heavy use of its products such as timber, bark etc);
- Cultural or spiritual importance (outstanding landscape value or spiritual meaning attached to certain tree species); and
- Other legislation (whether a species is already adequately protected by other legislation).

National Environmental Management Act (NEMA; Act 107 of 1998)

NEMA is an umbrella Act covering broad principles of environmental management. NEMA can be regarded as the most important piece of general environmental legislation covering three main areas namely: Land, planning and development; Natural and cultural resources use and conservation; Pollution control and waste management. According to NEMA sustainable development requires the consideration of all relevant factors including:

- That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- That the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource; and
- That the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised.

According to Section 2(r) in NEMA, sensitive, vulnerable, highly dynamic or stressed ecosystems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Grasslands and wetlands in Mpumalanga are a strong case in point.

National Heritage Resources Act (NHRA; Act 25 of 1999)

According to the NHRA heritage sites, sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, dolomitic land and ridges, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

National Mineral and Petroleum Resources Development Act (NMPRD; Act 28 of 2002)

The NMPRDA is concerned with equitable access to and sustainable development of the nation's mineral and petroleum resources. It replaces the Minerals Act (MA; Act 50 of 1991) except for the definition of "Sunday" in the Mines and Work Act (MWA; Act 27 of 1956).

The new Act specifies, inter alia:

- That every person who has applied for a mining right must conduct an EIA, determine the environmental baseline, and submit an EMP;
- That every holder of a mining reconnaissance permit, prospecting right, mining right, mining permit or retention permit must assess and communicate the impacts of the activity on the environment;
- The need to rehabilitate the environment affected by prospecting or mining operations to its natural or predetermined state;
- That the directors of the mining company are liable for unacceptable impacts on the environment.

National Environmental Management: Protected Areas Act (NEM:PAA; Act 57 of 2003)

The NEM:PAA is focussed on the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes, and addresses, inter alia:

- The protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes;
- The establishment of a national register of all national, provincial and local protected areas;
- The management of those areas in accordance with national standards;
- Inter-governmental co-operation and public consultation in matters concerning protected areas.

National Environmental Management: Biodiversity Act (NEM:BA; Act 10 of 2004)

A main objective of NEM:BA is to provide for the management and conservation of South Africa's biodiversity within the framework of NEMA and to ensure the sustainable use of indigenous biological resources. In addition to regulations on Threatened, Protected, Alien and Invasive Species in South Africa, the NBSAP was formulated where under the NSBA was used to identify Terrestrial and Aquatic Priority Areas and Threatened Ecosystems for biodiversity conservation.

Threatened, Protected, Alien and Invasive Species Regulations

Chapter 4, Part 2 of NEM:BA provides for listing of species that are threatened or in need of protection to ensure their survival in the wild while regulating the activities, including trade, which may involve such listed threatened or protected species and activities which may have a potential impact on their long-term survival. According to Section 56(1) of NEM:BA, in February 2007 the Minister of Environmental Affairs and Tourism published a list of Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Protected Species (PS).

The Draft Alien and Invasive Species Regulations (2007) under Section 70 of NEM:BA list all declared weeds and invasive plant species in South Africa. These include 47 invasive plant species in addition to those listed in CARA. The Regulations have not yet been promulgated but are already widely used. Their purpose is to:

- Prevent the unauthorized introduction and spread of alien species to ecosystems and habitats where they do not naturally occur;
- Manage and control invasive species to prevent or minimize harm to the environment and to biological diversity in particular;
- Where possible and appropriate, eradicate invasive species that may cause such harm.

National Biodiversity Strategy and Action Plan (NBSAP)

The development of the NBSAP is part of South Africa's obligations as a signatory to the CBD, and was compiled by the Department of Environmental Affairs and Tourism (DEAT 2005). The NBSAP is based on the recognition that South Africa is extremely rich in terms of biodiversity, but is also a developing country where the majority of the population resides in poverty. It provides an overarching framework for the conservation and sustainable use of South Africa's biodiversity, and equitable sharing of benefits from use of genetic resources. As far we know South Africa is the first country to include a comprehensive spatial assessment of biodiversity (the NSBA) as part of its NBSAP.

Through the NBSAP it is recognized that biodiversity cannot be conserved through protected area networks only. All stakeholders, from private landowners and communities to business and industry must get involved in biodiversity management. NBSAP identified mining as one of the activities that causes significant habitat transformation and degradation, and seriously threatens aquatic and terrestrial biodiversity. The strategy therefore promotes the inclusion of biodiversity considerations in mining regulations, guidelines and best practice codes to mitigate negative impacts and encourage sustainable mining practices through partnerships.

The NBSAP highlights, in particular, that South Africa's rivers are poorly protected and that the present status of many of these freshwater ecosystems is disturbing. To ensure further protection and sustainability of South Africa's wetlands, the Department of Water Affairs and Forestry (DWAF) initiated the National Aquatic Ecosystem Health Monitoring Program (NAEHMP) and River Health Program (RHP).

National Spatial Biodiversity Assessment (NSBA)

The NSBA, which is part of the NBSAP, was led by the SANBI (Driver *et al.* 2004). Its main focus was on mainstreaming biodiversity priorities and making links between biodiversity and socio–economic development in South Africa. The NSBA represents South Africa's first national assessment of spatial priorities for conservation action, integrating terrestrial, river, estuarine and marine ecosystems, using available spatial data, biodiversity planning software and a series of expert and stakeholder workshops.

The NSBA involved systematic biodiversity planning based on three principles:

- The need to conserve a representative sample of biodiversity pattern, such as species and habitats (the principle of representation).
- The need to conserve the ecological and evolutionary processes that allow biodiversity to persist over time (the principle of persistence).

- The need to set quantitative biodiversity targets that tell us how much of each biodiversity feature should be conserved in order to maintain functioning landscapes and seascapes.

National Aquatic Ecosystem Health Monitoring Program (NAEHMP) & River Health Program (RHP)

The NAEHMP is a national programme managed by DWA's Resource Quality Services with support from the Water Research Commission (WRC), the Council for Scientific and Industrial Research (CSIR) and various regional and provincial authorities. The overall purpose of the NAEHMP is to provide ecological information for South African rivers and the broader aquatic ecosystems required to support the rational management of these systems. The best-known component of the NAEHMP is the RHP.

The RHP was initiated in 1994 by the DWAF. It provides information on the overall ecological status of river ecosystems in South Africa, and primarily makes use of in-stream and riparian biological communities (e.g. fish, invertebrates, vegetation) to characterize the response of the aquatic environment to multiple disturbances. The rationale is that the integrity or health of the biota inhabiting the river ecosystems provides a direct and integrated measure of the health of the river as a whole. To date, the implementation of the RHP has been largely voluntary and, therefore, the DWAF initiated the "National Coverage Phase" to establish the RHP as a national programme that is aligned with the requirements of the NWA.

National Environmental Management: Air Quality Act (NEM:AQA; Act 39 of 2004)

The Atmospheric Pollution Prevention Act (APPA; Act 45 of 1965), which largely governed point-source emission control and therefore did not take into consideration the cumulative impacts of air pollution, has been repealed by the NEM:AQA. Amongst other objectives, this Act provides for the "prevention of air pollution and ecological degradation."

Mining & Biodiversity Guideline

The mining industry plays a vital role in South Africa's growth and development. But if mining is not strategically planned and carefully implemented, it has significant negative impacts on Biodiversity and ecosystems, in particular, catchments, rivers and wetlands that support water-related services. The Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector (DEA *et al*. 2013), interprets the best available Biodiversity knowledge and science in terms of the implications and risks for mining in a practical and user-friendly guideline for integrating relevant biodiversity information into decision making. The development of this guideline was initiated by the Chamber of Mines and the South African Mining and Biodiversity Forum (SAMBF), in partnership with the DEA, the Department of Mineral Resources (DMR), and with technical input and co-ordination by the SANBI Grasslands Programme.

## 4.4. Mpumalanga Legislation, Policies & Guidelines

Mpumalanga Parks Board Act (MPBA; Act 6 of 1995)

The MPBA provides for the:

- Establishment of the Mpumalanga Parks Board (MPB);
- Effective conservation management of natural resources;
- Creation of economic and employment opportunities in pursuit of nature conservation and biodiversity;
- Maintenance of natural systems, biodiversity and ecological functions and processes;
- Determination and enforcement of limits to sustainable utilization of natural resources;
- Advancement of scientific knowledge and technology transfer in respect of conservation; and
- Information and extension services to the public on conservation management, problem species, legal aspects of conservation and other conservation matters.

Mpumalanga Nature Conservation Act (MNCA; Act 10 of 1998)

This Act makes provision with respect to nature conservation in Mpumalanga Province. It provides for, among other things, protection of wildlife, hunting, fisheries, protection of endangered fauna and flora as listed in the CITES, the control of harmful animals, freshwater pollution and enforcement.

Mpumalanga Tourism and Parks Agency Act (MTPAA; Act 5 of 2005)

The MTPAA provides for the:

- Establishment of the Mpumalanga Tourism and Parks Agency (MTPA)
- Confer of powers and functions upon the Agency;
- Sustainable development and improvement of the tourism industry;
- Conservation management of natural resources.

MTPA Guidelines for Biodiversity Assessments

The MTPA is responsible for biodiversity conservation in Mpumalanga, and aims to provide an integrated tourism and bio-diversity conservation management system to stimulate sustainable economic growth for the Province. To promote national uniform standards in EMPs, the MTPA has set minimum standards that need to be conformed to in terms of biodiversity assessments for development applications. These guidelines cover flora, fauna, wetland and aquatic systems.

Mpumalanga Biodiversity Sector Plan (MBSP)

The biodiversity of Mpumalanga has been recorded and catalogued by the Province's conservation biologists for >21 years. This data were analysed to produce a spatial plan for biodiversity conservation called the Mpumlanga Biodiversity Conservation Plan (MBCP), which was jointly developed by the MTPA and the Department of Agriculture and Land Administration (DALA) to guide conservation and land-use decisions in support of sustainable development in the province (Ferrar & Lötter 2007). The MBCP has recently been updated and replaced with the Mpumalanga Biodiversity Sector Plan (MBSP; MTPA 2013), which recognizes Ecological Support Areas (ESAs), and Critical Biodiversity Areas (CBAs) containing Irreplaceable, Optimal and Protected Areas for Biodiversity.

# 5. Study Area Description

## 5.1. Climate

The vegetation types in the AYCP study area are characterized by mean annual precipitation (MAP) ranging between 800mm and 1,250mm (Mucina & Rutherford 2006). Overall MAP is approximately 900mm, with peak rainfall during mid-summer (i.e. December and January). This higher precipitation relative to adjacent areas is due to the effect of the local, mountainous topography on rainfall.

**Figure 5-1** shows total monthly rainfall between January 2012 and August 2013 for Ermelo and Vryheid, which are situated ca. 75km north-west and south-east of the AYCP site, respectively. Asterisks indicate when field surveys for the AYCP Biodiversity Assessment were performed. This approximate weather data suggest that field surveys were performed during months when the AYCP study area had received low to intermediate levels of rainfall (~0-100mm/month).

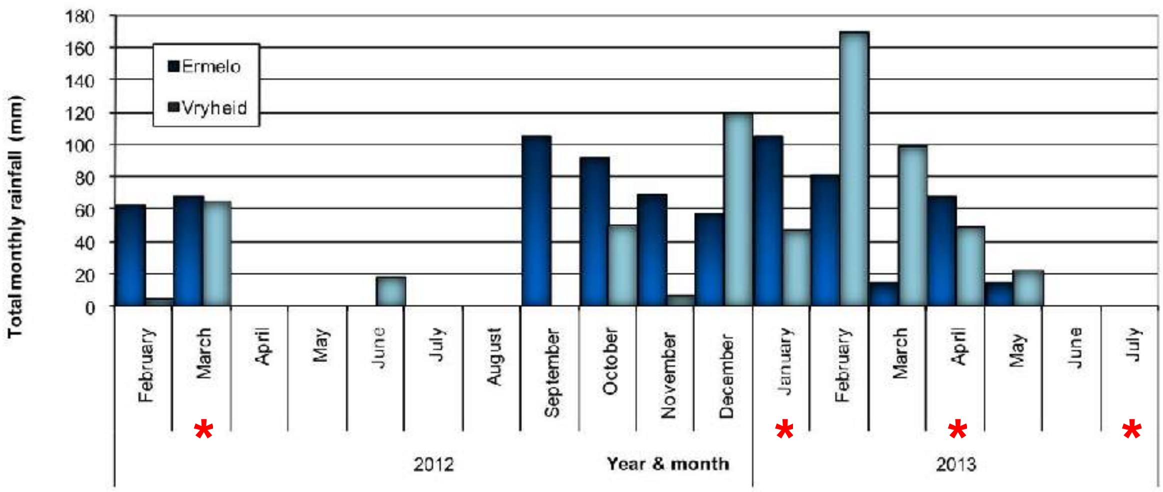


**Figure 5-1 Total monthly rainfall for Ermelo and Vryheid (SAWS 2012 & 2013). Asterisks indicate when field surveys for the AYCP Biodiversity Assessment were performed**

Mean daily maximum and minimum temperatures in the study area for January and July, are approximately 25°C and 2°C, respectively. Overall mean annual temperature is approximately 15°C. Incidence of frost is relatively high, but ranging widely from 11 days (at lower altitudes) to 31 days (at higher altitudes) per annum. Presented in **Figure 5-2** are mean monthly values of rainfall and temperature for Wakkerstroom, which is situated ca. 11km south-west of the AYCP site.

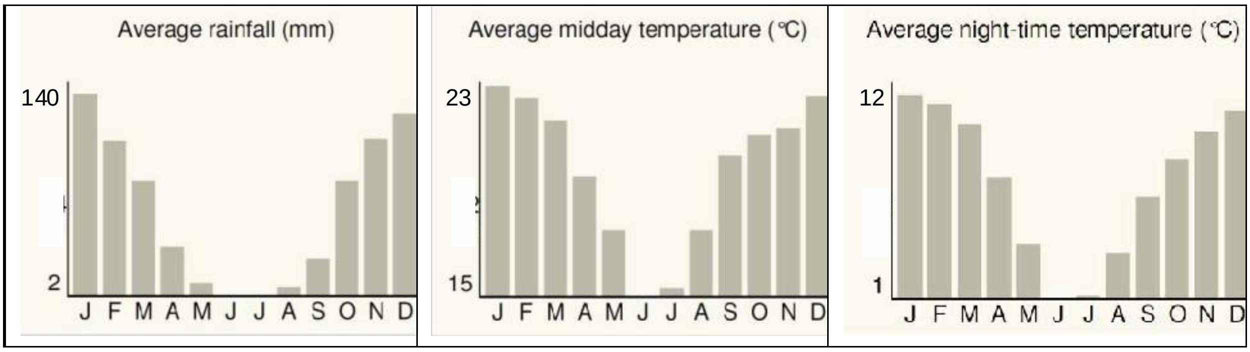


**Figure 5-2 Historical climate data for Wakkerstroom (SA Explorer, 2013).**

## 5.2. Geology, Soils & Land Types

The greater AYCP study area comprises low mountains and undulating plains that link the southern and northern Drakensberg escarpments. The geology of the landscape features mainly mudstones, sandstones and shale of the Madzaringwe and Volkrust Formations (Karoo Supergroup), which were intruded by voluminous Jurassic/Karoo dolerite dykes and sills (Mucina & Rutherford, 2006).

Land types represent areas that are uniform with respect to climate, terrain form, and geology and soil. The Agricultural Geo-referenced Information System (AGIS 2010) indicates that seven different land types occur within the boundaries of the AYCP lease area, namely Ab64, Ac39, Ac101, Ba45, Ea25, Fa362 and Fa362 (**Figure 5-3**). Fa362 represents the dominant land type in the proposed undermining area. The proposed surface infrastructure area comprises both the Fa362 and Ba45 land types.

Any one land type may be commonly associated with a number of vegetation types and any one vegetation type may be associated with a number of land types or soils. Specific floral and faunal taxa may, however, be restricted to specific soil or land types.

## 5.3. Hydrology

The AYCP is situated within the W51A quaternary catchment of the Assegaai River (DWA 2009), which flows through the far north-western corner of the lease/prospecting area (**Figure 5-4**), and which is considered to have a very high ecological sensitivity based on the local diversity of habitats and species. Although, there will be no underground mining directly under this north-western corner of the area at any time during the life of Mine, the cone of depression will extend to within close proximity of the Assegaai River. Such quaternary catchments and rivers are generally highly sensitive to flow modifications and have no or limited capacity for commercial use. Numerous small headwater and mountain streams, and associated channelled valley bottom wetlands, flow from the study area into small rivers that drain into the Assegaai River. There is also a very high density of seep wetlands in the study area, which are discussed in detail under **Section D**.

### 5.4. Biome, Eco-region & Vegetation

The AYCP is situated in Rutherford & Westfall's (1994) Grassland Biome and the Olson *et al*. (2001) Highveld Grassland Terrestrial Eco-region. The Grassland Biome has extremely high Biodiversity, second only to the Fynbos Biome. At a 1km$^2$ scale, the average species richness of the Grassland Biome is even higher than that of most Fynbos communities, being surpassed only by Renosterveld (Cowling *et al*., 1997; van Wyk, 2002). As the majority of rare and threatened plant species in the summer rainfall region of South Africa are restricted to high-rainfall grassland, this vegetation is in urgent need of protection.

The majority of plant species within grasslands are non-grassy herbs (forbs), most of which are perennial plants with large underground storage structures. Tree species are limited due to frost, fire and grazing, which maintains the herbaceous grass and forb layer and ultimately prevents the establishment of tall woody plants (Tainton, 1999).

According to Mucina & Rutherford (2006) there are three main vegetation types within the boundaries of the AYCP lease area, which include Gm 14 Wakkerstroom Montane Grassland, GM 15 Paulpietersburg Moist Grassland and Foz 2 Northern Afro-temperate Forest (**Figure 5-5**). The most abundant and prominent plant species in these vegetation types are listed in **Table 5-1.**

Wakkerstroom Montane Grassland is the most widespread vegetation type within the AYCP lease and undermining areas. It occurs on flat to undulating terrein where predominant short, montane grassland is interspersed by short forest and *Leucosidea* thickets on steep, mainly east-facing slopes and drainage areas. Wakkerstroom Montane Grassland is classified as Least Threatened by Mucina & Rutherford (2006), although only 1% of this vegetation type is statutorily protected and invasion by Black Wattle (*Acacia mearnsii*) is problematic in riverine areas.

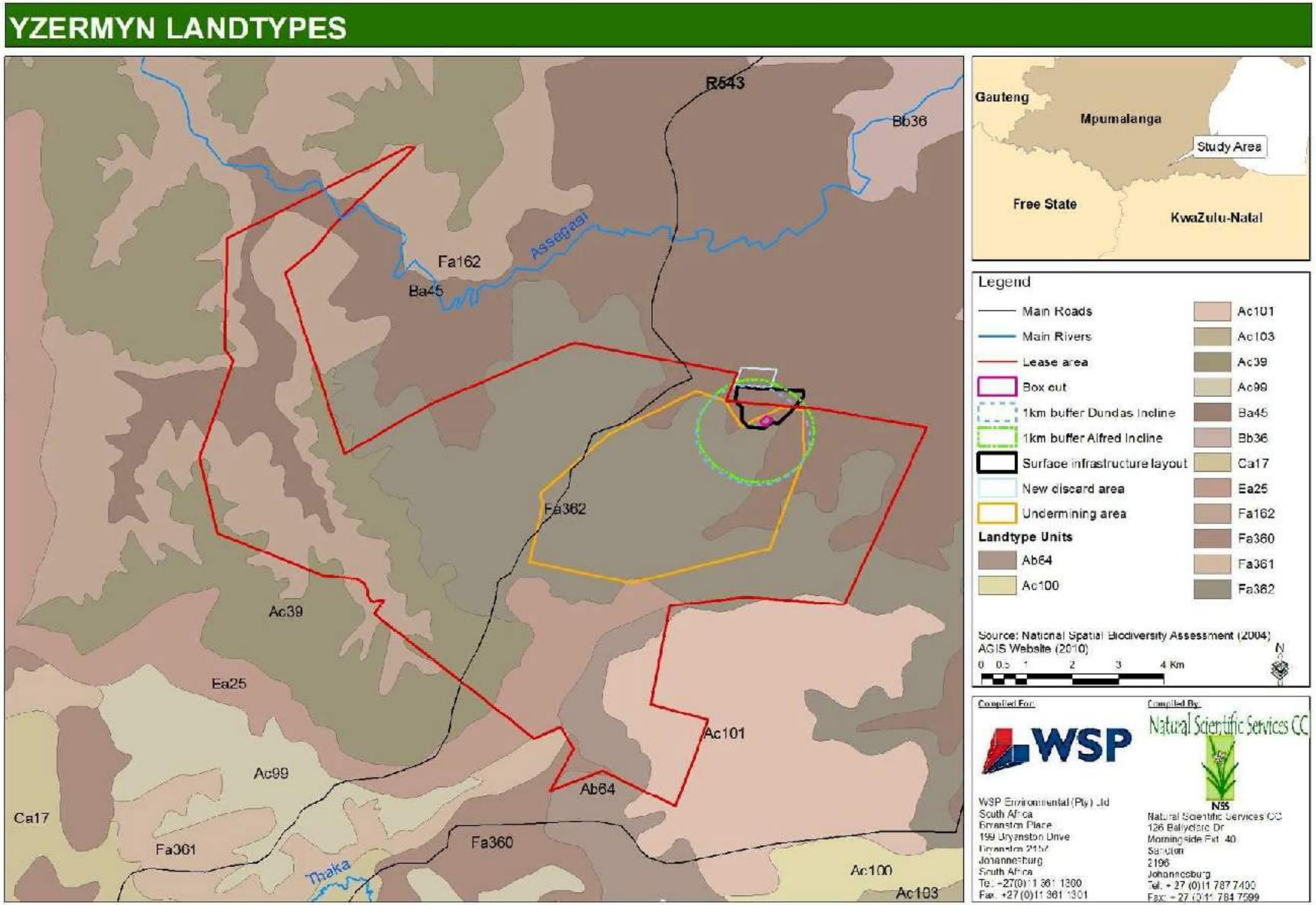


**Figure 5-3** **Land Types in the study area**

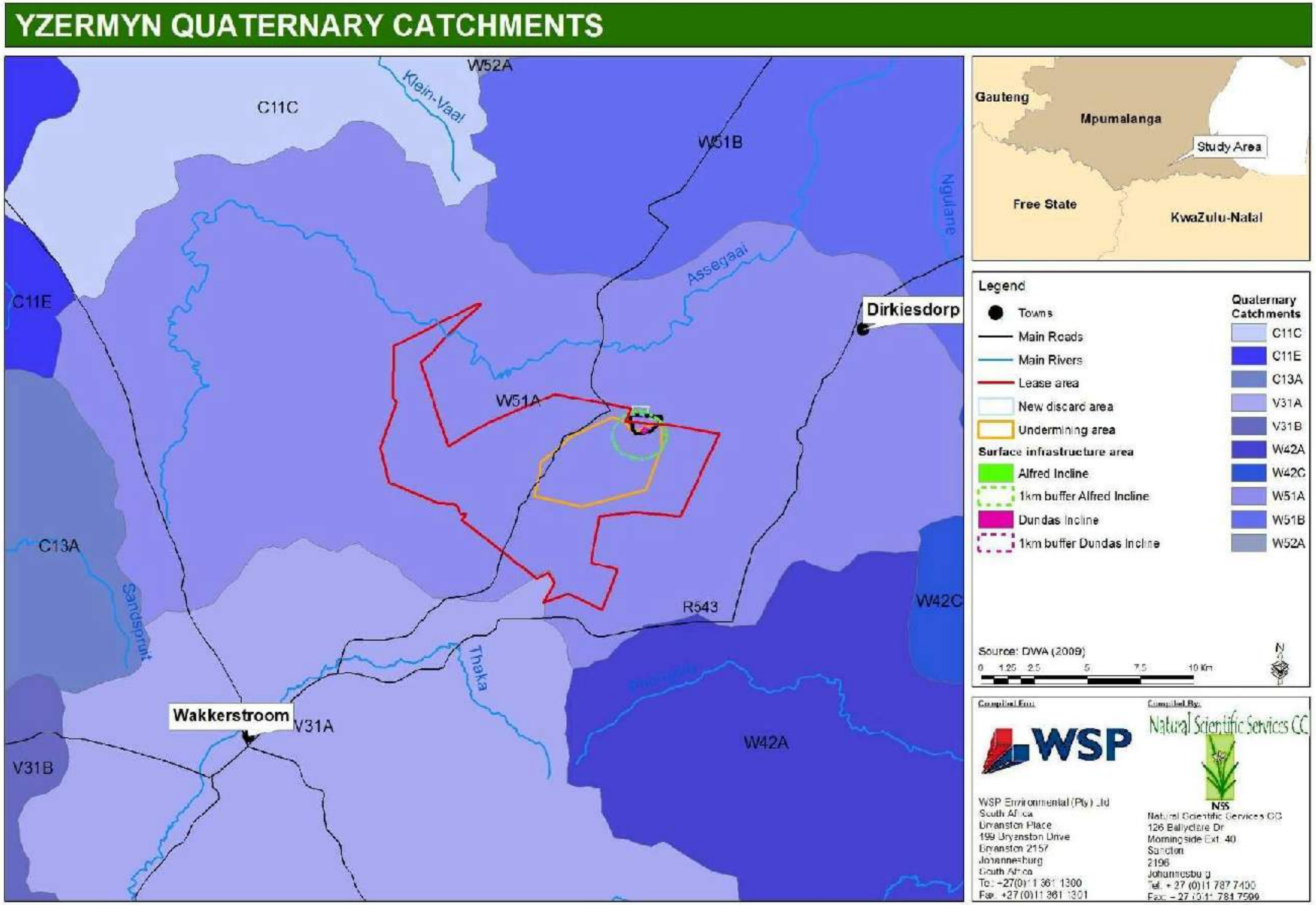


**Figure 5-4** **Quaternary catchments and major drainage lines in the study area**

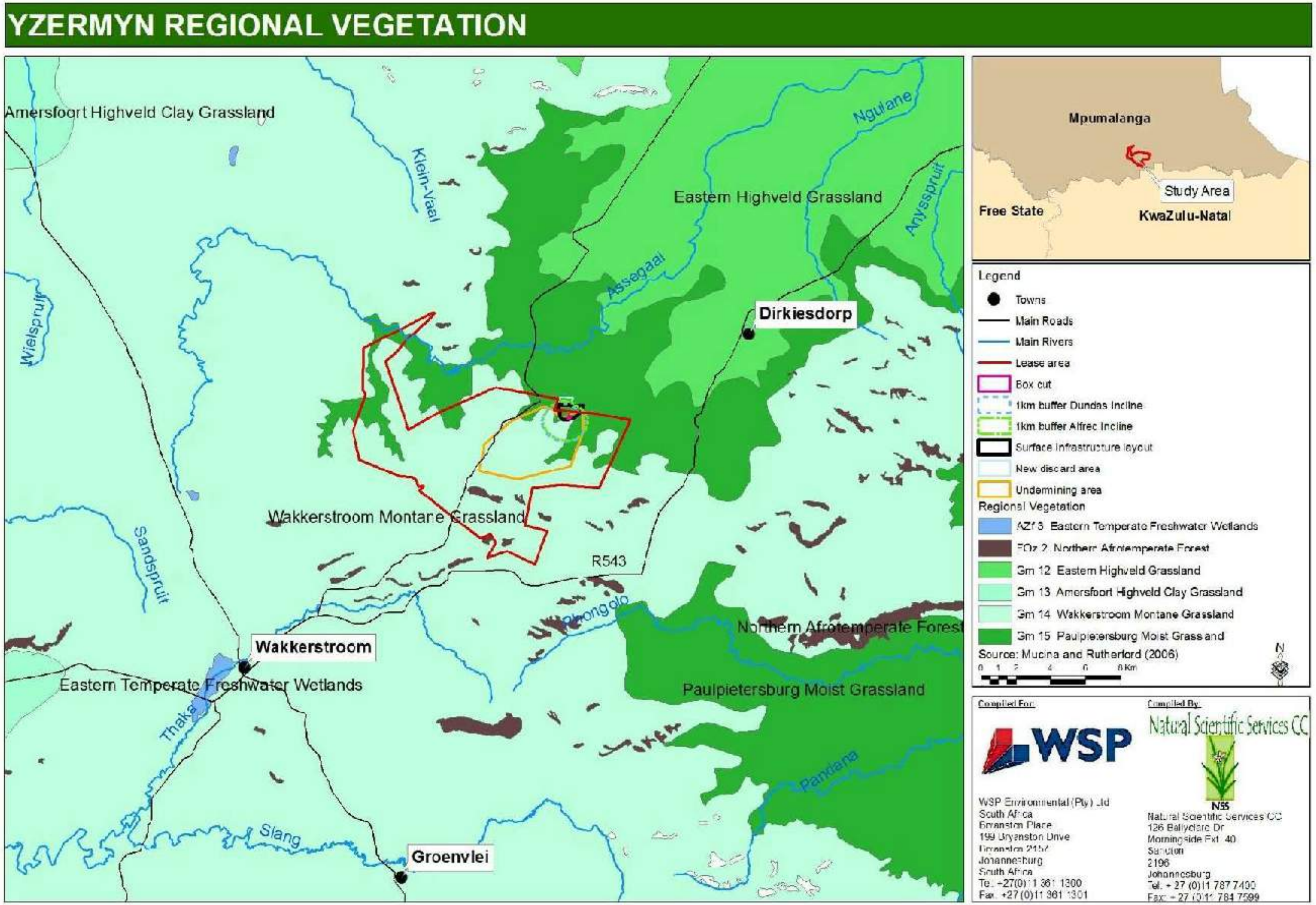


**Figure 5-5** **Vegetation types in the study area**

Paulpietersburg Moist Grassland is found in the eastern regions of the surface infra-structure and undermining areas, and also in the north-western region of the AYCP lease area. This vegetation occurs on slightly steeper mountain slopes and valleys, and features taller, closed grassland rich in forbs and dominated by *Tristachya leucothrix*, *Themeda triandra*, and *Hyparrhenia hirta*. Evergreen woody vegetation is characteristic on rocky outcrops. Paulpietersburg Moist Grassland is listed as **Vulnerable** by Mucina & Rutherford (2006) because one third of this vegetation type has been transformed by cultivation and afforestation, and remaining areas are highly threatened by livestock over-grazing, alien plant invasion and altered fire regimes.

Northern Afro-temperate Forest is found in small patches in kloofs, and on sub-ridge scarps in the south-eastern region of the AYCP study area. As its name implies, this forest type is of afro-montane origin. The forest canopy is low (up to 20m) and species richness is relatively poor. Approximately a third of Northern Afro-temperate Forest is statutorily protected and, therefore, this vegetation type is considered Least Threatened by Mucina & Rutherford (2006). Harvesting of certain plant species, and hot fires in surrounding vegetation, are problematic in some areas.

**Table 5-1 Vegetation types and their diagnostic plant species in the AYCP lease area**

| **VEGETATION TYPE** | |
|---|---|
| **PLANT GROWTH FORM** | **SPECIES** |
| **Wakkerstroom Montane Grassland (Least Threatened)** | |
| Small Trees: | *Canthium ciliatum; Protea subvestita* |
| Shrubs: | *Asparagus devenishii (d); Buddleja salviifolia (d); Buddleja auriculata; Cliffortia linearifolia (d); Helichrysum melanacme (d), Helichrysum splendidium (d); Leucosidea sericea (d); Anthospermum rigidum subsp. pumilum; Clutia natalensis; Diospyros lycioides subsp. guerkei; Erica oatesii; Euclea crispa subsp. crispa; Felicia filifolia subsp. filifolia; Gymnosporia heterophylla; Helichrysum hypoleucum; Hermannia geniculata; Inulanthera dregeana; Metalasia densa; Printzia pyrifolia; Searsia discolor; Searsia montana; S. rehmanniana; S. transvaalensis; Rubus ludwigii subsp. ludwigii.* |
| Herbs: | *Berkheya onopordifolia var. glabra (d); Cephalaria natalensis (d); Pelargonium luridum (d); Acalypha depressinerva; A. peduncularis; A. wilmsii; Aster bakerianus; Berkheya setifera; Euryops transvaalensis subsp. setilobus; Galium thunbergianum var. thunbergianum; Geranium ornithopodiodes; Helichrysum cephaloideum; H. cooperi; H. monticola; H. nudifolium var. nudifolium; H. oreophillum; H simillimum; Pentanisia prunelloides subsp. latifolia ; Plectranthus laxiflorus; Sebaea leistyla; S. sedoides var. sedoides; Selago densiflora; Striga bilabiata subsp. bilabiata; Vernonia hirsuta; V. natalensis; Wahlenbergia cuspidata.* |
| Geophytic Herbs: | *Hypoxis costata (d); Agapanthus inarpertus subsp. intermedius; Asclepias aurea; Cheilanthes hirta; Corycium dracomontanum; C. nigrescens; Cyrtanthus tuckii var.* |

| VEGETATION TYPE<br>PLANT GROWTH FORM | SPECIES |
|---|---|
| | *transvaalensis; Disa versicolor; Eriospermum cooperi var. cooperi; Eucomis bicolor; Geum capense; Gladiolus ecklonii; G. Sericeo villosus subsp. villosus; Hesperantha coccinea; Hypoxis rigidula var. pilosissima; Moraea brevistyla; Rhodohypoxis baurii var. confecta.* |
| Grasses: | *Andropogon schirensis (d); Ctenium concinnum (d); Cymbopogon caesius (d); Digitaria tricholaenoides (d); Diheteropogon amplectens (d); Eragrostis chloromelas (d); E. plana (d); E. racemosa (d); Harpochloa falx (d); Heteropogon contortus (d); Hyparrhenia hirta (d); Microchloa caffra (d); Themeda triandra; Trachypogon spicatus (d); Tristachya leucothrix (d); Alloteropsis semialata subsp. eckloniana; Aristida junciformis subsp galpinii; Brachiaria serrata; Diheteropogon filifolius; Elionurus muticus; Eragrostis capensis; Eulalis villosa; Festuca scabra; . Loudetia simplex; Rendlia altera; Setaria nigrirostris.* |
| **Paulpietersburg Moist Grassland (Vulnerable)** | |
| Small Trees: | *Canthium ciliatum* (d); *Aloe marlothii* subsp. *marlothii; Dombeya rotundifolia; Vangueria infausta.* |
| Shrubs: | *Anthospermum rigidum* subsp*. rigidum* (d); *Calpurnia sericea* (d); *Diospyros lycioides* subsp*. guerkei; Searsia discolor* (d); *S. rehmanniana* (d): *Anthospermum rigidum* subsp. *pumilum; Clutia monticola; Diospyros galpinii; Erica oatesii; E. woodii; Hermannia geniculata; Euclea crispa* subsp. *crispa.; Euphorbia pulvinata; Indigofera arrecta; Otholobium wilmsii; Polygala uncinata; Pseudarthria hookeri; Rubus rigidus.* |
| Herbs: | *Argyrolobium speciosum* (d); *Cissus diversilobata* (d); *Dicoma seyheri* (d); *Eriosema kraussianum* (d); *Geranium wakkerstroomianum* (d); *Helichrysum nudifolium* var. *nudifolium* (d); *Ipomoea oblongata* (d); *Pelargonium luridum* (d); *Acalypha glandulifolia; A. peduncularis;* ***Acanthospermum australe****; Aster bakerianus; Becium filamentosum; Berkheya setifera; Dicoma anomala; Euryops laxus; E. transvaalensis; Helichrysum rugulosum; H. simillimum; Indigofera hilaris* var. *hilaris; I. velutina; Kohautia amatymbica; Pearsonia grandifolia; Pentanisia prunelloides* subsp. *latifolia; Rhynchosia totta; Senecio bupleuroides; S. coronatus; S. inornatus; S. isatideus; S. latifolius; Sonchus nanus; Thunbergia atriplicifoli; Vernonia capensis; V. natalensis; Xerophyta retinervis.* |
| Geophytic Herbs: | *Chlorophytum haygarthii* (d); *Gladiolus aurantiacus* (d); *Agapanthus inapertus* subsp. *intermedius*; *Aloe ecklonis; A. maculata; Asclepias aurea*; *Cheilanthus hirta*; *Cyrtanthus tuckii* var. *transvaalensis*; *Hypoxis colchifolia*; *H. costata*; *H. rigidula* var. *pilosissima; Lopholaena segmentata; Moraea brevistyla*; *Pteridium aquilinum*; *Watsonia latifolia*; *Zantedeschia; rehmannii.* |
| Grasses: | *Alloteropsis semialata* subsp. *eckloniana (d); Andropogon schirensis (d); Brachiaria serrata (d) Ctenium concinnum (d); Cymbopogon caesius (d); Digitaria trichloronoides (d); Eragrostis racemosa d); Harpochloa falx (d); Heteropogon contortus (d); Hyparrhenia hirta (d); Loudetia simplex (d); Microchloa caffra (d); Monocymbium cereciiforme (d); Rendia altera (d); Setaria nigririgrostis (d); Themeda triandra (d);* |

| VEGETATION TYPE PLANT GROWTH FORM | SPECIES |
|---|---|
| | *Tristachya leucothrix (d); Andropogon appendiculatus; Cynodon hirsutus; Diheteropogon amplectens; D. filifolius; Festuca scabra; Melinis nerviglumis; Panicum ecklonii; P. natalense; Trachypogon spicatus; Uryletrum agropyroides.* |
| **Northern Afro-temperate Forest (Least Threatened)** | |
| Tall trees: | *Celtis africana* (d); *Halleria lucida* (d) *Olinia emarginata* (d); *Pittosporum viridiflorum* (d); *Podocarpus latifolius* (d); *Rothmannia capensis* (d); *Scolopia mundii* (d); *Afrocarpus falcatus*; *Buddleja saligna*; *Dais cotonifolia*; *Ilex mitis*. |
| Small Trees: | *Acalypha glabrata* (d); *Buddleja salvifolia* (d); *Calpurnia aurea* (d); *Combretum erythrophyllum* (d); *Diospyros lycioides* subsp. *guerkei*; *D. whyteana* (d); *Euclea crispa* subsp. *crispa* (d); *Widdringtonia nodiflora* (d); *Bowkeria verticillata*; *Canthium ciliatum*; *Leucosidea sericea*; *Scolopia flanaganii*. |
| Shrubs: | *Isoglossa grantii* (d); *Myrsine africana* (d); *Cliffortia nitidula*. *Hypoestes aristata*; *Plectranthus fruticosus*. |
| Woody climber: | *Cassinopsis ilicifolia* (d). |
| Herbs: | *Plectranthus grallatus* (d); *P. hereroensis* (d); *Peperomia retusa*; *Streptocarpus haygarthii*; *S. pusillus.* |
| Sedges: | *Cyperus albostriatus*; *Schoenoxiphium lehmannii*; *Thamnocalamus tessellates*. |

Key: (d) = dominant species; alien species in **bold**.

Source: Mucina & Rutherford (2006).

## 5.5. Land-use

Within and around the AYCP lease area the main form of land-use includes livestock (mainly cattle) grazing. Isolated areas show evidence of past or current crop (mainly maize) cultivation.

# Section B: Floral Assessment

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# SECTION B: FLORAL ASSESSMENT

## 1. Introduction

As the main component to a Biodiversity Baseline Assessment, the terrestrial fauna and floral hold the basis for the understanding system functioning within the study area. It is important to note that vegetation is a major component when studying ecosystems. The composition, diversity, and structure of vegetation are important factors for assessing biological diversity. Vegetation is the source of primary production, plays a direct role in water and nutrient cycling, and interacts strongly with other biotic components being a determinant habitat for many species.

Within the study region, as indicated in **Section A,** the vegetation is representative of the Grassland Biome. Grasslands provide essential ecosystem services, which include:

- water production,
- wetland functioning and flood attenuation,
- good quality soil and forage for livestock;
- cultural and heritage value; and
- the support for livelihoods (i.e. the use of medicinal plants).

It is well documented that grasslands contain a high diversity of both plants and animals and in South Africa Grasslands are second only to the Cape Floristic Region.

Natural Scientific Services CC (NSS) was contracted by WSP Environment and Energy (Pty) Ltd (WSP) to perform Biodiversity Scoping, Baseline and Impact Assessments for selected aspects of the proposed ATHA Yzermyn Coal Project (AYCP). This report **Section B** details the baseline floral component, which involved desktop and field-based investigations of the structure, dominant species composition and condition of local floral communities including alien and invasive plants.

According to the South African National Biodiversity Institute (SANBI), the AYCP falls within the NPAs South Eastern Escarpment as well as the proposed Enkangala / Grassland Biosphere Reserve (see insert). The NPA assessment was based on integrating data on species, habitats and ecological processes to identify areas of greatest biodiversity significance. This resulted in the identification of nine spatial priority areas for terrestrial biodiversity. These priority areas represent areas with high concentrations of biodiversity features and/or areas where there are

***Enkangala Grasslands Project – WWF-SA***
The main objective of the Enkangala Trust is to promote the concept of biosphere reserves and the establishment and maintenance of a biosphere reserve for the high altitude moist grasslands of the Mpumalanga, KwaZulu Natal and Free State Provinces of South Africa. This is in order to ensure the continued functioning of natural systems and associated biodiversity of this threatened biome, taking into account the existing industry and land use, in such a way that it provides for sustained tangible benefits to the affected communities at local, regional and national levels.

few options for meeting biodiversity targets. Further discussions on the national and provincial priority areas will be discussed in **Section F**. Potential impacts on flora of the AYCP and recommended measures to mitigate these impacts are discussed in **Section G**.

# 2. Methodology

## 2.1. Desktop Research

A desktop-based investigation of vegetation including Conservation Important (CI) floral species in the greater AYCP area, was performed by consulting the following information sources:

- Google Earth (2011) and Bing satellite imagery.
- Mucina & Rutherford's (2006) vegetation map of southern Africa.
- SANBI's online PRECIS (PREtoria Computerised Information System), which provides taxonomic information for plant species occurring in southern Africa (in the format of Germishuizen & Meyer, 2003).
- SANBI's online Threatened Species Programme (TSP).
- CI plant species records in the greater study area, supplied by the Mpumalanga Tourism and Parks Agency (MTPA, *pers. comm.*).
- The Mpumalanga Biodiversity Sector Plan (MBSP, 2013).

## 2.2. Fieldwork

As outlined in **Section A**, no detailed information on the AYCP was available until recently, and the boundaries of the lease, underground mining and surface infrastructure areas changed during the course of this Assessment. Consequently, field surveys for flora were performed in the original (old) proposed undermining area and more specifically in the area in which the surface infrastructure was to be placed during 2012 (March 2012). Once the updated surface infrastructural areas were supplied (**Section A: Figure 2-1**), NSS performed additional surveys on the following dates:

- 14-18 January 2013,
- 4-8 April 2013, and
- 15-17 July 2013.

The floral surveys involved:

- Sampling vegetation plots to determine the spatial extent and structure of different floral communities (**Figure 2-1**) specifically in a 1km radius of the surface infrastructure area. Sampling plot size was standardised at 100m$^2$. Whilst a plot was sampled, a list of plant taxa was compiled and each taxon was assigned a cover-abundance estimate using the Braun-Blanquet approach (Mueller-Dombois & Ellenberg, 1974). The cover-abundance categories that were used for this purpose are listed in **Table 2-1**.

- Walking random transects to detect localised and conservation important plant species (i.e. Red Data, endemic, protected and medicinal species).
- Describing vegetation communities/habitats within each sampling plot (including the structure, dominant plant composition and condition of the vegetation).
- Recording alien and invasive plant species and bushclumps.

## 2.3. Data Analysis

The analysis of floral data involved:

- The Juice (version 7.0.41) software program for management, analysis and classification of ecological data was used to conduct a TWINSPAN analysis and DCA ordination (Tichy & Holt, 2006). The R-program was included as an add-on programme to Juice to conduct the DCA ordination.
- A TWINSPAN analysis (Hill, 1979) of the Braun-Blanquet data, which represented the cover-abundance of species in each sample plot, was used to classify vegetation assemblages. TWINSPAN is used to investigate associations between samples with the purpose of objectively distinguishing groups or assemblages. Samples that cluster together are believed to have similar compositions. The data were left untransformed to allow for only common or dominant species to participate in the analysis.
- An Ordination using a Detrended Correspondence Analysis (DCA) of the same Braun Blanquet data was used to determine the proximity of relationships between sample entities, and confirm the vegetation assemblages (plant communities) identified in the TWINSPAN analysis.

**Table 2-1 Braun-Blanquet cover classes (Mueller-Dombois & Ellenberg, 1974)**

| Class | Range of cover (%) | Mean |
|---|---|---|
| 5 | 75-100 | 87.5 |
| 4 | 50-75 | 62.5 |
| 3 | 25-50 | 37.5 |
| 2 | 5-25 | 15.0 |
| 1 | 1-5 | 2.5 |
| + | <1 | 0.1 |
| r | <<1 | 0.01 |

## 2.4. Study Limitations

- Survey work was limited to the current proposed underground mining area, and was not performed in remaining parts of the AYCP lease area.
- NSS was not commissioned to perform surveys for roads, pipelines, power lines, and conveyer systems or any other infrastructure or listed activity (e.g. water extraction) beyond the boundaries of the current proposed underground mining area.
- No detailed information on the AYCP was available until recently, and the boundaries of the lease, underground mining and surface infrastructure areas changed during the course of this Assessment. Consequently, field surveys for flora were performed in the

original (old) proposed undermining area during 2012 and in the current undermining area during 2013.

- Floral survey work was intended for when the study area received significant rain in early summer (i.e. November 2012). Due to delayed finalization of the current surface infrastructure layout and other administrative issues, the survey commenced in January 2013 (mid-summer).
- Some species, which are small, rare or otherwise difficult to detect may not have been detected even though they were potentially present on site.
- Sampling Method
    - As an alternative to other vegetation cover methods (such as the Domin method), the Braun-Blanquet cover-abundance scale was used to analyze vegetation. It is reported that the Braun-Blanquet method requires only one third to one fifth the field time required to other similar methods (Wikum & Shanholtzer, 1978). Furthermore, cover-abundance ratings are better suited than density values to elucidate graphically species-environment relationships. For extensive surveys this method provides sufficiently accurate baseline data to allow environmental impact assessment as required by regulatory agencies. However, there are a couple of problems that have been detected with such sampling methods (Hurford & Schneider, 2007). These are as follows:
        - It can be seen as subjective and dependent upon the experience and knowledge of the vegetation type by the surveyor. The cover estimate may vary from observer to observer.
        - There also may be a problem when the cover estimate is very close to two different classes (on the border so to speak) and then it is for the observer to decide which class it should be allocated to. In Hurford & Schneider's (2007) experience, in marginal situations, where the cover of a species is close to a boundary between two classes, the chance of two observers allocating the species to the same cover class is no better than 50:50. However, when comparing to other sampling methods such as Domin, Braun-Blanquet scale is better adapted for monitoring (less cover classes and fewer boundaries).

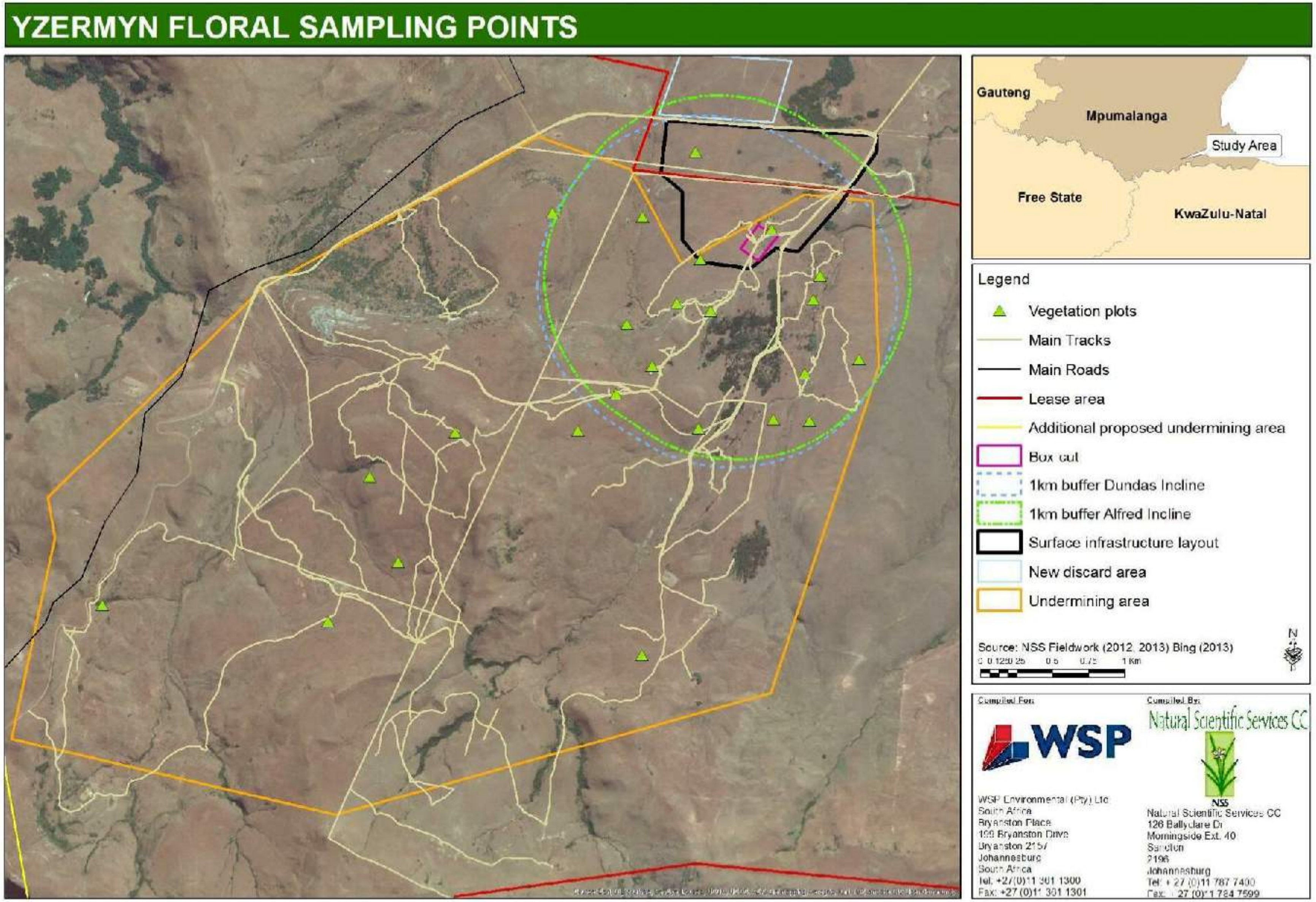


**Figure 2-1 Main extracted sampling plots areas**

# 3. Results

SANBI frequently collect/collate floral data within Southern Africa and update their PRECIS database system (National Herbarium Pretoria (PRE) Computerised Information System) and is captured according to QDG squares. For this study, data was extracted from the QDG square 2730AA to AD. From the PRECIS data supplied by SANBI, 1300 plant species of 154 families were recorded (accessed: August 2013). The dominant families were ASTERACEAE; POACEAE and CYPERACEAE (**Table 3-1**), with the herbs representing 33.5%, graminoids representing 9% and geophytic species representing 17.8% of the total species listed for the area.

**Table 3-1 Top Ten Dominant Families and Most Dominant Growth Forms obtained from the POSA website for the QDS 2730AA to AD**

| IMPORTANT FAMILIES | No. OF SPP | GROWTH FORMS | % TOTAL SPP |
|---|---|---|---|
| ASTERACEAE | 176 | Herbs/forb species | 33.56 |
| POACEAE | 116 | Geophytes | 17.8 |
| CYPERACEAE | 62 | Graminoids | 9.09 |
| FABACEAE | 60 | Dwarf shrubs | 7.6 |
| ORCHIDACEAE | 56 | Shrubs | 5.09 |
| APOCYNACEAE | 48 | Cyperoid species | 4.87 |
| IRIDACEAE | 46 | Shrub to small trees | 4.4 |
| RUBIACEAE | 34 | Succulents | 3.76 |
| HYACINTHACEAE | 34 | Climbers (geophytic, herbs, shrubs) | 3.45 |

The study area is located within the Mesic Highveld Grassland Bioregion which predominates throughout the higher rainfall, eastern regions of the Highveld and forms a part of the Grassland Biome (Mucina & Rutherford, 2006). Hence the make-up of the different families and growth forms mentioned above (**Table 3-1**). The proposed lease and undermining area span three regional vegetation types within this biome (Section A). These vegetation types are the (i) Paulpietersburg Moist Grassland, (ii) Wakkerstroom Montane Grassland and (iii) Northern Afrotemperate Forest (Mucina & Rutherford, 2006). These vegetation types, like many other units within the Grassland Biome, are highly diverse and under threat through anthropogenic influences. The greater study area (*excluding* the 1km-wide sampling area around the proposed declines) contains the following defined broader habitats (shown in **Figure 3-1** and mapped in **Figure 3-5**):

- Forested Areas;
  - Montane Riverine Forest (3.69ha)
  - Hillslope Forests (13.69ha)
- Exposed Rocky Outcrops and associated grasslands (44.28ha);
- Savanna type *Acacia* – *Ziziphus* (49.65ha) and *Acacia* – *Eucomis* (4.56ha) Slope Communities;

- Rocky slope grasslands (482.62ha) and associated hydromorphic seep zones (5.69ha);
- Valley bottom hydromorphic grassland (203.91ha) and riparian communities (18.53ha); and
- *Hyparrhenia - Eragrostis* Pioneer Grasslands (377.84ha).

In addition, transformed areas include:

- Alien invasive bush clumps (7.33ha);
- Small scale crop farming (12.28ha);
- Dwellings and cattle camps (2.77ha);
- Gravel road networks; and
- Old mining adit areas.

These areas were refined into six vegetation communities within the 1km sampling area for the surface infrastructure (refer to **Table 3-2**).

*Valley bottom hydromorphic grassland*



*Riverine Community*

*Exposed Rock and Slope Grasslands*

*Alien Invasive bushclumps*

**Figure 3-1 Photographic representation of the different broad communities found within the study area**

## 3.1. Vegetation Communities

For the detailed sampling area (1km radius of the shaft complex), numerous sample points were investigated in various natural and semi natural habitats of the study area, with a refined 24 being analysed using TWINSPAN. Results of an ordination analysis of the phytosociological data are presented in **Figure 3-2** and **Figure 3-3**. 6 main groups of plant communities emerge from the ordination. The TWINSPAN table (**Appendix 1**) identifies the plant communities in **Table 3-2** and **Figure 3-4**. A clear gradient of growth form is evident from this ordination with **Unit A** and **B** containing a more wooded component, **Units C-F** within the open grasslands and seepage zones.

**Table 3-2 Vegetation Communities**

| UNIT | HABITAT & VEGETATION COMMUNITIES | HECTARES |
|---|---|---|
| | **Wooded / Open Thicket Areas** | |
| A | *Leucosidea* – *Merxmuellera* Riverine Community | 30.72 |
| B | *Searsia* – *Diospyros* – *Athrixia* Protected Outcrops & Kloof Community | 3.33 |
| | **Upper Slope / Plateau Grasslands** | |
| C | *Hyparrhenia* – *Microchloa* – *Helichrysum* Plateau | 18.87 |
| D | *Hyparrhenia* – *Cymbopogon* – *Monocymbium* Slope Community | 192.65 |
| | **Hydromorphic Grasslands** | |
| E | *Andropogon* – *Hyparrhenia* temporary seeps | 99.87 |
| F | *Andropogon* – *Helichrysum- Bulbostylis* seasonal seeps | 36.37 |
| | **Transformed** | |
| | Settlement Areas & Alien Bushclumps | 32.7 |

A preliminary description and photographic evidence for each main unit is given in the Tables below (**Table 3-3** to **Table 3-8**).

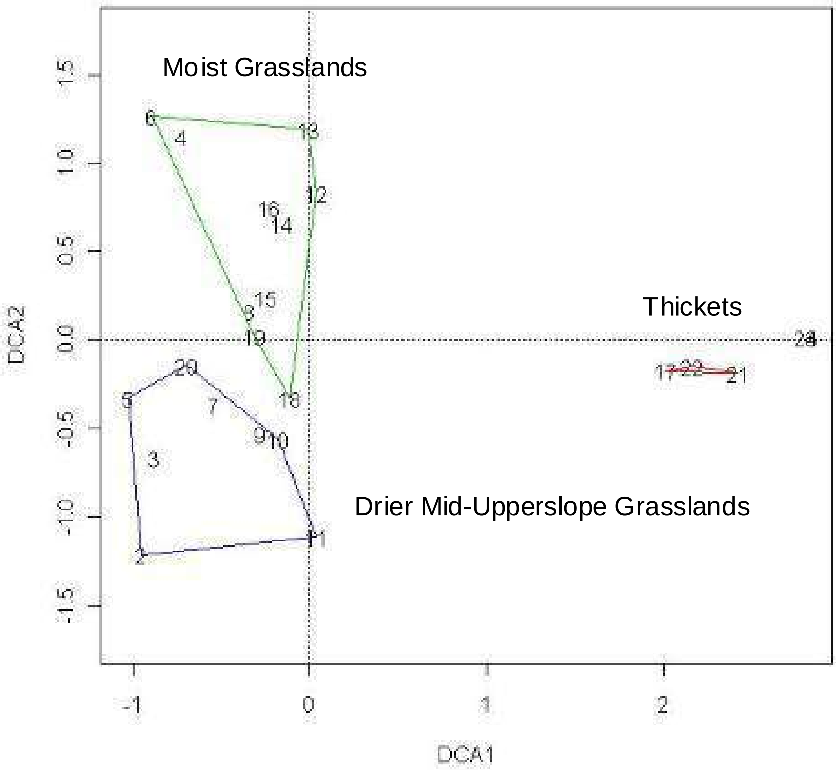


**Figure 3-2 DCA ordination of phytosociological data from 24 sampling plots showing a distinct growth form separation for the 4 broader units**

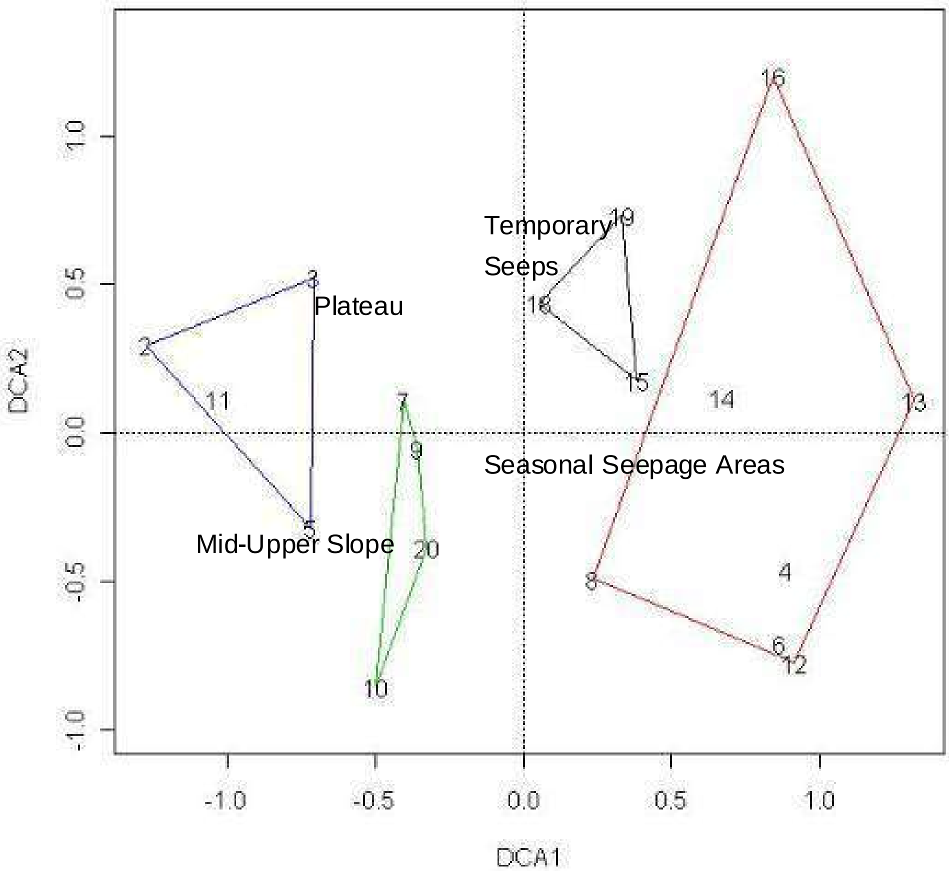


**Figure 3-3 DCA ordination of phytosociological data showing a distinct moisture gradient for the grassland units**

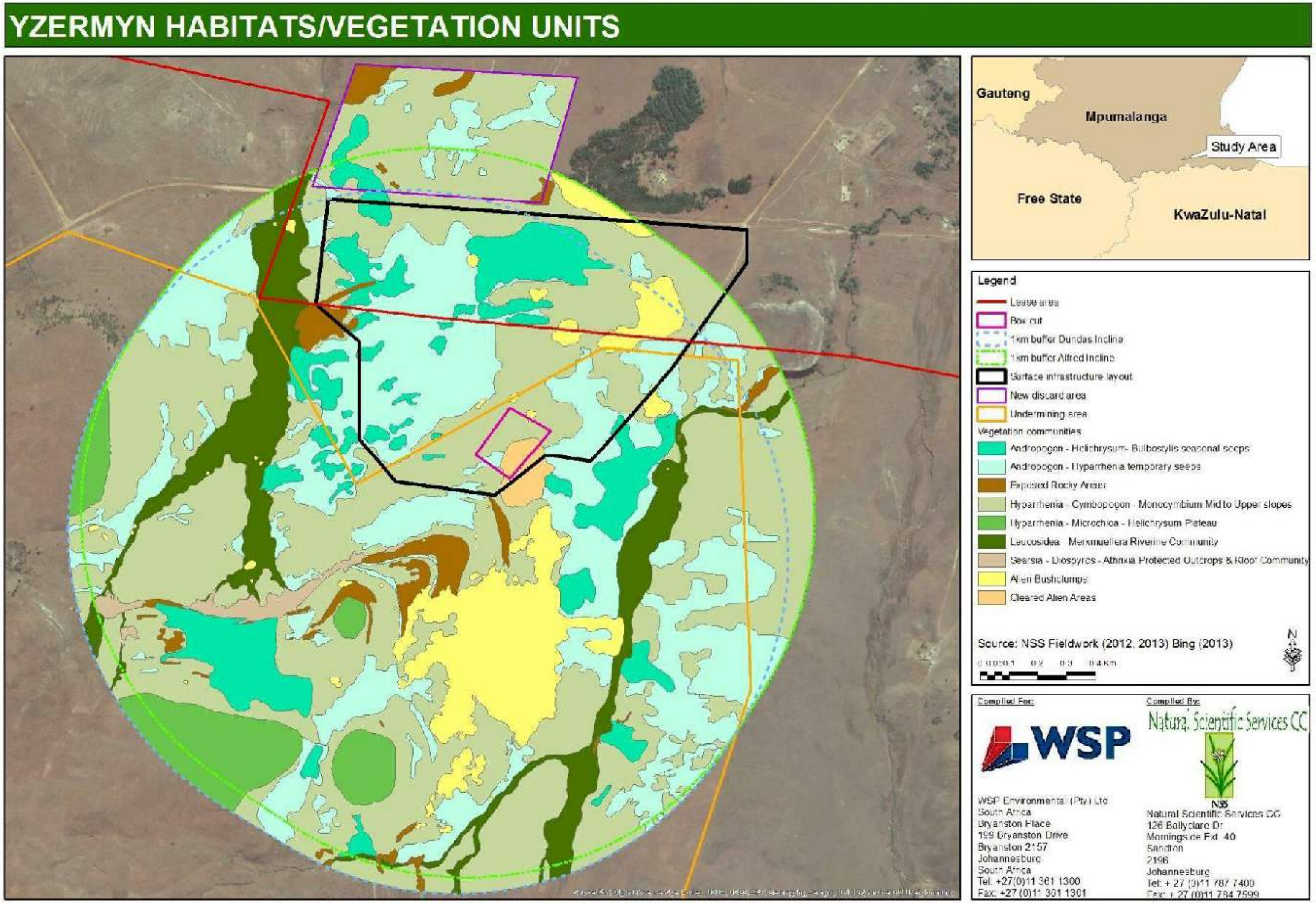


**Figure 3-4** **Vegetation Units within the 1km buffer of the immediate study area**

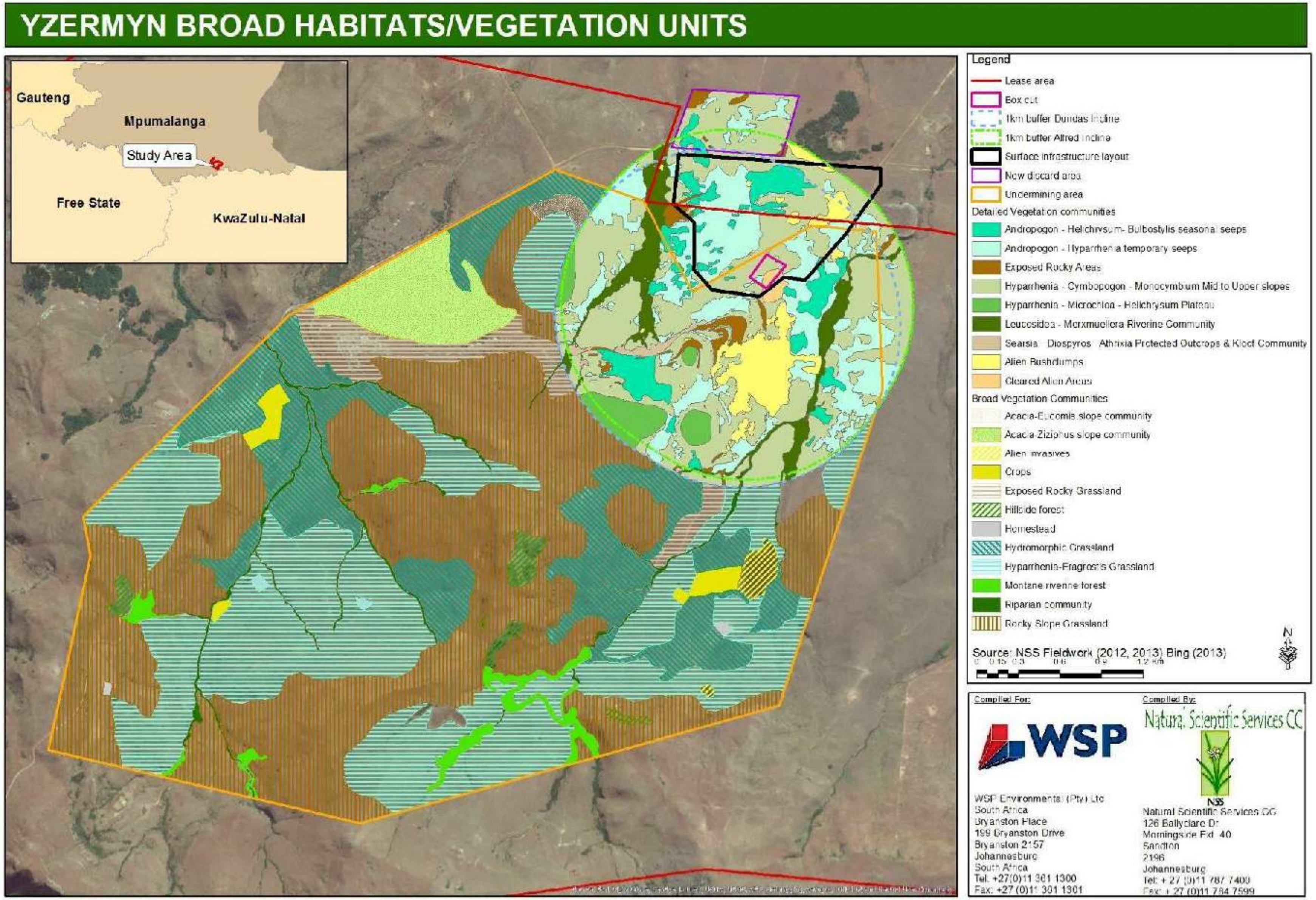


**Figure 3-5 Broader Vegetation Units within the underground mining area**

**Table 3-3 Unit A *Leucosidea – Merxmuellera* Riverine Community**

| ***Leucosidea – Merxmuellera Riverine Community*** | | | |
|---|---|---|---|
| **Photographic representation** |  |  | |
| **National Zones:** | Wakkerstroom Montane Grassland; Paulpietersburg Moist Grassland; South Eastern Escarpment Priority Areas; Proposed Mabola Protected Environment; Wakkerstroom/Luneburg Threatened Ecosystems; MTPA CBA Irreplaceable & Optimal Areas | | |
| **Estimated Woody Height:** | Approximately 3-4m | **Estimated ground cover:** | Approximately 85-90% Good cover on edges of streams in most sampling spots |
| **Condition:** | Evidence of erosion on the banks of the watercourses from cattle grazing, drinking and crossing points. Alien infestations included wooded clumps along the systems which consisted of species such as *Acacia mearnsii**[2], *Acacia melanoxylon**[1b] *Populus x canescens**[2] and *Salix babylonica**. Herbaceous species along the banks included: *Solanum incanum; Datura stramonium**[1b]*; Physalis viscosa** and *Verbena bonariensis** | | |
| **Notes:** | Woody component scattered and in patches along the river systems. Some areas, however, contain exposed flat rock and limited woody or shrub species. | | |
| **CI Species:** | - *Hesperantha coccinea* (P)<br>- *Gunnera perpensa* (Dec) | - *Kniphofia spp*<br>- *Eulophia streptopetala* (P)<br>- *Zantedeschia aethiopica* (P) | |
| **CI Faunal Species:** | - *Serval (Leptailurus serval)* – NT | | |
| **Common species:** | - *Aponogeton junceus*<br>- *Asplenium spp.*<br>- *Berula erecta*<br>- *Buddleja salviifolia*<br>- *Cliffortia linearifolia*<br>- *Cynoglossum lanceolatum*<br>- *Cyperus congestus*<br>- *Cyperus digitatus*<br>- *Drosera natalensis*<br>- *Falkia repens*<br>- *Heteromorpha arborescens*<br>- *Hyparrhenia filipendula*<br>- *Hyparrhenia tamba*<br>- *Juncus oxycarpus*<br>- *Leersia hexandra* | - *Leucosidea sericea*<br>- *Melianthus villosus*<br>- *Merxmuellera disticha*<br>- *Miscanthus junceus*<br>- *Nidorella anomala*<br>- *Paspalum dilatatum*<br>- *Paspalum urvillei*<br>- *Pelargonium spp.*<br>- *Persicaria serrulata*<br>- *Phragmites australis*<br>- *Schoenoplectus corymbosus*<br>- *Searsia dentata*<br>- *Senecio glaberrimus*<br>- *Sida dregei*<br>- *Sporobolus africana* | |

| *Leucosidea – Merxmuellera Riverine Community* | | |
|---|---|---|
| **Species Examples:** |  |  |
| | *Cynoglossum lanceolatum* | *Hesperantha coccinea (P)* |
| **Current Conservation Status** | | **Very High** |

* Alien Species; *[1] Category 1 Alien Invasive; *[2] Category 2; Dec: Declining TSP; P: Protected – MTPA; NT: Near Threatened

**Table 3-4 Unit B *Searsia – Diospyros – Athrixia* Protected Outcrops & Kloof Community**

| *Searsia – Diospyros – Athrixia Protected Outcrops & Kloof Community* | | | |
|---|---|---|---|
| **Photographic representation** |  | |  |
| **National Zones:** | Wakkerstroom Montane Grassland; South Eastern Escarpment Priority Areas; Proposed Mabola Protected Environment; Wakkerstroom/Luneburg Threatened Ecosystems; MTPA CBA Irreplaceable & Optimal Areas | | |
| **Estimated Woody Height:** | Varied between 1- 2.5m | **Estimated ground cover:** | Approximately 55-60%. Remaining rock cover |
| **Condition:** | Outcrops and kloof regions in a relatively natural state. Alien wooded species are scattered along the outcrops and in the kloofs and mainly include: *Acacia mearnsii**[2], and *Acacia melanoxylon**[1b]. Herbaceous species mainly include *Bidens pilosa*, *Tagetes minuta* and *Verbena bonariensis** | | |
| **CI Species:** | - *Merwilla plumbea* (NT)<br>- *Agapanthus campanulatus (P)*<br>- *Eucomus autumnalis* (Dec – MTPA)<br>- *Cussonia spicata* (P)<br>- *Haemanthus humulis* (P)<br>- *Scadoxus puniceus* (P)<br>- *Kniphofia* spp<br>- *Brunsvigia radulosa* (P) | | - *Dierama erectum* (P)<br>- *Aloe ecklonis* (P)<br>- *Boophone disticha* (Dec)<br>- *Scilla nervosa*<br>- *Gladiolus sp.*<br>- *Pellaea calomelanos* (P)<br>- *Pittosporum viridifolium* (DWA, P)<br>- *Dioscorea* spp.<br>- *Brachystelma rubellum* (P) |

| **Searsia – Diospyros – Athrixia Protected Outcrops & Kloof Community** | | |
|---|---|---|
| | *Cyrtanthus tuckii (P)* | |
| **CI Faunal Species** | Bush Blackcap *(Lioptilus nigricapillus)* - NT | |
| **Common species:** | *Aristida junciformis*<br>*Athrixia phylicoides*<br>*Berkheya erysithales*<br>*Berkheya setifera*<br>*Crassula alba*<br>*Cussonia spicata*<br>*Cymbopogon pospischilii*<br>*Dicoma anomala*<br>*Dierama erectum*<br>*Diospyros lycioides*<br>*Elephantorrhiza elephantina*<br>*Euclea undulata*<br>*Euphorbia pulvinata*<br>*Gerbera piloselloides*<br>*Hermannia transvaalensis*<br>*Hyparrhenia hirta*<br>*Kalanchoe rotundifolia*<br>*Ledebouria sp.* | *Melinis nerviglumis*<br>*Melinis repens*<br>*Microchloa sp.*<br>*Monocymbium ceresiiforme*<br>*Olea europaea*<br>*Oxalis obliquifolia*<br>*Pelargonium alchemoides*<br>*Pellaea calomelanos*<br>*Rhamnus prinoides*<br>*Searsia dentata*<br>*Searsia discolor*<br>*Searsia montana*<br>*Selaginella dregei*<br>*Sonchus dregeanus*<br>*Sporobolus africana*<br>*Tristachya leucothrix*<br>*Uryletrum agropyroides*<br>*Xerophyta retinervis* |
| **Species Examples:** | <br>*Brachystelma rubellum* | <br>*Euphorbia pulvinata* |
| **Current Conservation Status** | | **Very High** |

* Alien Species; *[1] Category 1 Alien Invasive; *[2] Category 2; Dec: Declining TSP; NT: Near Threatened – MTPA; DWA (P) Protected Species –Forest Act

Table 3-5 Unit C *Hyparrhenia – Microchloa – Helichrysum* Plateau Grassland Community

| ***Hyparrhenia – Microchloa – Helichrysum Plateau Grassland Community*** | | | |
|---|---|---|---|
| **Photographic representation** |  | |  |
| **National Zones:** | Wakkerstroom Montane Grassland; South Eastern Escarpment Priority Areas; Proposed Mabola Protected Environment; Wakkerstroom/Luneburg Threatened Ecosystems; **MTPA CBA Irreplaceable** | | |
| **Estimated Herbaceous Height:** | Approximately 0.6-1m | **Estimated ground cover:** | Approximately 70-75% (some rock and bare soil evident) |
| **Condition:** | Limited alien weedy species present (e.g. *Bidens pilosa*, Tagetes minuta**). These are normally found along the gravel tracks on the plateau. Harvesting of *Hyparhennia* also present | | |
| **CI Species:** | • *Gladiolus sp* (P)<br>• *Aloe maculata* (P) | | • *Eucomis autumnalis* (Dec-MTPA) |
| **CI Faunal Species:** | • *Cape grass lizard (Chamaesaura anguina)* – NT | | |
| **Common species:** | • *Andropogon appendiculatus Nees*<br>• *Andropogon schirensis Hochst. ex A.Rich.*<br>• *Berkheya setifera DC.*<br>• *Crassula alba Forssk*<br>• *Ctenium concinnum Nees*<br>• *Cymbopogon pospischilii (K.Schum.) C.E.Hubb*<br>• *Digitaria monodactyla (Nees) Stapf*<br>• *Diheteropogon amplectens (Nees) Clayton*<br>• *Eragrostis chloromelas Steud.*<br>• *Eragrostis gummiflua Nees*<br>• *Eragrostis racemosa (Thunb.) Steud.*<br>• *Eragrostis rigidior Pilg.*<br>• *Geigeria burkei Harv.*<br>• *Helichrysum nudifolium (L.)* | | • *Hilliardiella aristata (DC.) H.Rob*<br>• *Hyparrhenia filipendula (Hochst.) Stapf*<br>• *Ipomoea purpurea (L.) Roth*<br>• *Ledebouria sp.*<br>• *Melinis repens (Willd.) Zizka*<br>• *Microchloa sp.*<br>• *Monocymbium ceresiiforme (Nees) Stapf*<br>• *Oxalis sp.*<br>• *Pogonarthria squarrosa (Roem. & Schult.) Pilg.*<br>• *Psammotropha myriantha Sond.*<br>• *Schistostephium crataegifolium (DC.) Fenzl ex Harv*<br>• *Searsia dentata (Thunb.) F.A.Barkley*<br>• *Senecio sp.*<br>• *Sporobolus africanus (Poir.) Robyns & Tournay*<br>• *Themeda triandra Forssk.* |

| ***Hyparrhenia – Microchloa – Helichrysum Plateau Grassland Community*** | | |
|---|---|---|
| | *Less.*<br>▪ *Heteropogon contortus (L.) Roem. & Schult.* | ▪ *Tricholaena monachne (Trin.) Stapf & C.E.Hubb.*<br>▪ *Tristachya leucothrix Trin. ex Nees* |
| **Species Examples:** | <br>*Pentanisia prunelloides* | <br>*Ipomoea cf crassipes* |
| **Current Conservation Status** | | **Medium** |

* Alien Species; NT: Near Threatened; Dec- Declining MTPA; P: Protected

**Table 3-6 Unit D *Hyparrhenia – Cymbopogon – Monocymbium* Slope Grassland Community**

| ***Hyparrhenia – Cymbopogon – Monocymbium Mid to Upper slopes Grassland Community*** | | | |
|---|---|---|---|
| **Photographic representation** |  | |  |
| **National Zones:** | Wakkerstroom Montane Grassland; Paulpietersburg Moist Grassland; South Eastern Escarpment Priority Areas; Proposed Mabola Protected Environment; Wakkerstroom/Luneburg Threatened Ecosystems; MTPA CBA Irreplaceable & Optimal Areas | | |
| **Estimated Height:** | Approximately 0.4 – 1m | **Estimated ground cover:** | Approximately 55-60%, rocky in nature |
| **Condition:** | Limited alien weedy species present, over grazing evident in certain areas. *Hyparrhenia* and *Cymbopogon* dominant | | |
| **CI Species:** | ▪ *Agapanthus inapertus* (P)<br>▪ *Aloe ecklonis* (P)<br>▪ *Boophone disticha* (Dec) | | ▪ *Gladiolus permeabilis* (Patrysuintjie) (P)<br>▪ *Habenaria epipactidea (P)* |
| **CI Faunal Species:** | ▪ White Bellied Korhaan (*Eupodotis senegalensis*) – VU<br>▪ Black Bellied Bustard (*Lissotis melanogaster)* - NT | | |
| **Common species:** | ▪ *Alloteropsis semialata*<br>▪ *Aloe ecklonis*<br>▪ *Andropogon appendiculatus* | | ▪ *Haplocarpa scaposa*<br>▪ *Harpochloa falx*<br>▪ *Helichrysum nudifolium* |

<table>
<tr><th colspan="3">Hyparrhenia – Cymbopogon – Monocymbium Mid to Upper slopes Grassland Community</th></tr>
<tr><td></td><td>Nees<br>▪ Andropogon schirensis<br>▪ Aristida junciformis<br>▪ Berkheya erysithales<br>▪ Berkheya setifera DC.<br>▪ Crabbea acaulis<br>▪ Ctenium concinnum Nees<br>▪ Cymbopogon pospischilii (K.Schum.) C.E.Hubb<br>▪ Dicoma anomala<br>▪ Digitaria eriantha<br>▪ Digitaria monodactyla (Nees) Stapf<br>▪ Diheteropogon amplectens (Nees) Clayton<br>▪ Eragrostis chloromelas Steud.<br>▪ Eragrostis curvula<br>▪ Eragrostis plana<br>▪ Eragrostis racemosa (Thunb.) Steud.<br>▪ Gazania sp</td><td>▪ Hilliardiella aristata (DC.) H.Rob.<br>▪ Hyparrhenia filipendula (Hochst.) Stapf<br>▪ Hyparrhenia hirta<br>▪ Hypericum aethiopicum<br>▪ Ipomoea ommaneyi<br>▪ Melinis repens (Willd.) Zizka<br>▪ Microchloa caffra<br>▪ Monocymbium ceresiiforme (Nees) Stapf<br>▪ Nidorella anomala<br>▪ Panicum natalense<br>▪ Schistostephium crataegifolium (DC.) Fenzl ex Harv<br>▪ Searsia discolor<br>▪ Selago densiflora<br>▪ Setaria sphacelata<br>▪ Sporobolus africanus (Poir.) Robyns & Tournay<br>▪ Themeda triandra Forssk.<br>▪ Tristachya leucothrix Trin. ex Nees<br>▪ Vernonia hirsuta</td></tr>
<tr><td>Species Examples:</td><td><br>Boophone disticha</td><td><br>Crassula alba</td></tr>
<tr><td colspan="2">Current Conservation Status</td><td>Medium-High</td></tr>
</table>

* Alien Species; *[1] Category 1 Alien Invasive

**Table 3-7 Unit E *Andropogon – Hyparrhenia* (temporary seeps) Hydromorphic Grasslands Community**

| ***Andropogon – Hyparrhenia (temporary seeps) Hydromorphic Grasslands Community*** | | | |
|---|---|---|---|
| **Photographic representation** |   | | |
| **National Zones:** | Wakkerstroom Montane Grassland; Paulpietersburg Moist Grassland; South Eastern Escarpment Priority Areas; Proposed Mabola Protected Environment; Wakkerstroom/Luneburg Threatened Ecosystems; MTPA CBA Irreplaceable & Optimal Areas | | |
| **Estimated Height:** | Approximately 0.3 - 1.2m (patchy) | **Estimated ground cover:** | Approximately 65-70% |
| **Condition:** | Limited impacts apart from grazing and scattered weedy species. Frequent fires could also play a role. Alien invasives were minimal with the scattered herbaceous species and *Acacia melanoxylon* [1b] | | |
| **CI Species:** | - *Crinum bulbispermum* (Dec)<br>- *Brunsvigia radulosa* (P)<br>- *Eucomis autumnallis* (Dec-MTPA)<br>- *Eulophia ovalis* (P)<br>- *Eulophia welwitschii* (P)<br>- *Satyrium cristatum* (P) | | |
| **CI Faunal Species** | - Grass Owl (*Tyto capensis*) - VU<br>- Secretarybird (*Sagittarius serpentarius*) - NT | | |
| **Common species:** | - *Sporobolus africanus (Poir.) Robyns & Tournay*<br>- *Andropogon appendiculatus Nees*<br>- *Aristida junciformis Trin. & Rupr.*<br>- *Bidens pilosa L.*<br>- *Centella asiatica (L.) Urb*<br>- *Cussonia spicata Thunb.*<br>- *Diheteropogon amplectens (Nees) Clayton*<br>- *Elephantorrhiza elephantina (Burch.) Skeels*<br>- *Eragrostis chloromelas Steud.*<br>- *Eragrostis racemosa (Thunb.) Steud.*<br>- *Helichrysum aureonitens*<br>- *Hilliardiella aristata (DC.) H.Rob.*<br>- *Hyparrhenia filipendula (Hochst.) Stapf*<br>- *Ipomoea spp.*<br>- *Ledebouria cf. revoluta.*<br>- *Microchloa caffra*<br>- *Monocymbium ceresiiforme (Nees) Stapf*<br>- *Paspalum scrobiculatum L.*<br>- *Plantago lanceolata L.*<br>- *Senecio sp.*<br>- *Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss*<br>- *Tristachya leucothrix Trin. ex Nees* | | |

| *Andropogon – Hyparrhenia (temporary seeps) Hydromorphic Grasslands Community* | | |
|---|---|---|
| **Species Examples:** |  *Alepidea peduncularis* |  *Helichrysum aureonitens* |
| **Current Conservation Status** | **High** | |

* Alien Species; *[1] Category 1 Alien Invasive; Dec: Declining TSP Listing

**Table 3-8 Unit F *Andropogon – Helichrysum- Bulbostylis* (seasonal seeps) Hydromorphic Grasslands Community**

| *Andropogon – Helichrysum- Bulbostylis (seasonal seeps) Hydromorphic Grasslands Community* | | | |
|---|---|---|---|
| **Photographic representation** |  |  | |
| **National Zones:** | Wakkerstroom Montane Grassland; Paulpietersburg Moist Grassland; South Eastern Escarpment Priority Areas; Proposed Mabola Protected Environment; Wakkerstroom/Luneburg Threatened Ecosystems; MTPA CBA Irreplaceable & Optimal Areas | | |
| **Estimated Height:** | Approximately 0.5-0.8m | **Estimated ground cover:** | Approximately 80-90% |
| **Condition:** | Weedy species included *Verbena bonariensis* and *V brasilliensis* (now proposed as a Category 1b) other weedy species found within the seeps included *Oenothera rosea* and *Paspalum dilatatum.* | | |
| **CI Species:** | *Crinum bulbispermum* (Dec)<br>*Eucomis autumnallis* (Dec-MTPA)<br>*Eulophia hians var.nutans* (P)<br>*Eulophia ovalis* (P) | *Eulophia welwitschii* (P)<br>*Gladiolus permeabilis* (P)<br>*Gunnera perpensa* (Dec)<br>*Habenaria filicornis* (P)<br>*Satyrium cristatum* (P) | |
| **CI Faunal Species (MTPA records)** | Grass Owl *(Tyto capensis)* – *VU*<br>Marsh Sylph *(Metisella meninx) - VU*<br>Swamp musk shrew *(Crocidura mariquensis)* – *DD* | | |

| Andropogon – Helichrysum- Bulbostylis (seasonal seeps) Hydromorphic Grasslands Community | | |
|---|---|---|
| | ▪ Serval *(Leptailurus serval) - NT* | |
| **Common species:** | ▪ *Agrostic lachnantha*<br>▪ *Andropogon appendiculatus Nees*<br>▪ *Andropogon eucomus*<br>▪ *Aristida junciformis Trin. & Rupr.*<br>▪ *Berkheya erysithales*<br>▪ *Berkheya setifera DC.*<br>▪ *Cymbopogon pospischilii (K.Schum.) C.E.Hubb*<br>▪ *Cyperus compressus*<br>▪ *Cyperus congestus*<br>▪ *Cyperus heamtocephala*<br>▪ *Eragrostis plana*<br>▪ *Helichrysum aureonitens* | ▪ *Hyparrhenia filipendula (Hochst.) Stapf*<br>▪ *Hyparrhenia tamba*<br>▪ *Hypoxis sp.*<br>▪ *Juncus oxycarpus*<br>▪ *Leersia hexandra*<br>▪ *Lobelia flaccida*<br>▪ *Monocymbium ceresiiforme (Nees) Stapf*<br>▪ *Pycreus spp*<br>▪ *Sporobolus africanus (Poir.) Robyns & Tournay*<br>▪ *Verbena bonariensis L.*<br>▪ *Wahlenbergia undulata*<br>▪ *Xyris capensis* |
| **Species Examples:** |  |  |
| | *Xyris capensis* | *Lobelia flaccida* |
| **Current Conservation Status** | | **Very-High** |

* Alien Species; *[1] Category 1 Alien Invasive; *[2] Category 2 Alien Invasive VU: Vulnerable TSP; MTPA Dec: Declining

## 3.2. Conservation Important Species

It is well documented that heterogeneous landscapes, diverse geology and a range of environmental conditions, provide a diverse number of habitats for plant species (Pickett, *et.al*. 1997; O'Farrell, 2006; KNNCS, 1999). These areas are normally associated with high levels of species endemism and richness. For example, at least 74% of the 23 threatened highveld plant taxa occur on the crests and slopes of ridges and hills (Pfab & Victor 2002). Furthermore, Mpumalanga has three main recognised centres of endemism in the province, all within heterogeneous landscapes (Barberton, Sekhukhuneland and Wolkberg). However, homogenous landscapes that have been transformed through historical farming practices and infrastructural development contain minimal diversity and endemism.

The mining rights boundary and surface areas location is situated in an area that is largely natural, rural and utilised for livestock farming. The site is considered heterogenous with river floodplains, seepage areas and rocky outcrops, kloof areas, slope grassland sand plateau areas. It must be noted that depending on the extent of the drawdown cone from groundwater abstraction, wetland habitats beyond this area may also be affected.

The Threatened Plant Species Programme (TSP) is currently revising all threatened plant species assessments made by Craig Hilton-Taylor (1996), using IUCN Red Listing Criteria modified from Davis *et al.* (1986). According to the TSP interim Red Data list of South African plant taxa (updated February 2009), there are 273 Red Data listed species (**Table 3-9**) within Mpumalanga Province (including Data Deficient species) of which 11 species are Critically Endangered (CR), 29 Endangered (EN) and 75 are Vulnerable (VU).

**Table 3-9 Numbers of conservation important plant species per Red Data category within South Africa and Mpumalanga**

| Threat Status | South Africa | Mpumalanga |
|---|---|---|
| EX (Extinct) | 28 | 1 |
| EW (Extinct in the wild) | 7 | |
| CR PE (Critically Endangered, Possibly Extinct) | 57 | 1 |
| CR (Critically Endangered) | 332 | 11 |
| EN (Endangered) | 716 | 29 |
| VU (Vulnerable) | 1 217 | 75 |
| NT (Near Threatened) | 402 | 35 |
| Critically Rare (known to occur only at a single site) | 153 | 2 |
| Rare (Limited population but not exposed to any direct or potential threat) | 1 212 | 43 |
| Declining (not threatened but processes are causing a continuing decline in the population) | 47 | 22 |
| LC (Least Concern) | 13 856 | 3 799 |
| DDD (Data Deficient - Insufficient Information) | 348 | 20 |
| DDT (Data Deficient - Taxonomically Problematic) | 904 | 34 |
| **Total spp (including those not evaluated)** | **23 399** | **5 226** |

**Date accessed – May 2013

From the POSA website (QDS 2730AB) and the data supplied by MTPA for the surrounding farms, 19 CI species have been recorded in the region (examples of some of these species are illustrated in **Figure 3-6**). Species such as the VU *Aspidonepsis shebae* is known from four locations to the north of the study area, and is potentially threatened by afforestation and alien plant invasion. The possibility of this species occurring on site is relatively small. The EN *Gerbera aurantiaca* typically occurs in rocky grassland between 900 and 1 500 m, on warm slopes in well-drained, shallow soils associated with doleritic formations. This species has been recorded by NSS to the northwest of the study area, close to Heyshope Dam. For most species, habitat loss and alien plant invasion are the main threats. For species such as *Protea subvestita*, over-harvesting for firewood, too-frequent fire, over-harvesting for carving and curios are the main threats. Regeneration from the serotinous seed occurs after fire. However, adults are killed by fire and seedlings require up to five years to establish before flowering, consequently confined to infrequently burned habitats, often associated with gulleys, scarps and forest margins (Rebelo *et al*, 2009). Other species that have not yet been evaluated or re-evaluated in the QDS 2730AB included:

- *Dioscorea sylvatica* Eckl. var. *sylvatica*
- *Nesaea sagittifolia* (Sond.) Koehne var. *ericiformis* Koehne forma *swaziensis* Immelman
- *Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm. subsp. *cuneifolia* (Eckl. & Zeyh.) Urton

The conservation status of species, their habitat preferences and the possibility of occurring on site has also been provided in **Table 3.10** below.

**Table 3-10 Species recorded in the surrounding farms (supplied by MTPA, 2013) and QDG (PRECIS Data)**

| Family | Scientific Name | | Flowering Time | RSA | MTPA | Farm name | Possibility of occurring |
|---|---|---|---|---|---|---|---|
| APOCYNACEAE | *Aspidonepsis shebae* | | | VU | | QDG 2730AB | |
| APIACEAE | *Alepidea peduncularis* | Montane grassland | Dec-Mar | DDT | DDT | QDG 2730AB | Yes – located on site |
| ASPHODELACEAE | *Aloe kniphofioides #* | Montane grassland | Nov-Jan | VU | VU | CHANCE 106 HT<br>NAUWGEVONDEN 131 HT | Possible |
| | *Aloe modesta #* | Montane grassland, 1600-2000 m | Feb - Mar | VU | VU | CHANCE 106 HT<br>RUST-FONTEIN 129 HT | Yes, Rarely recorded mainly because it is inconspicuous unless in flower and the flowering season is very short |
| AMARYLLIDACEAE | *Boophone disticha* | Dry and rocky Grassland | Jul-Oct | Declining | Declining | YZERMYN 96 HT<br>ZANDKRAAL 99 HT<br>LOSKOP 105 HT | Yes – located on site |
| SCROPHULARIACEAE | *Bowkeria citrina#* | Found along streambanks and forest margins in mountainous areas | Nov-Jun | Rare | Rare | SCHOONDERZIGT 68 HT | Possible |
| HYACINTHACEAE | *Eucomis autumnalis* | Damp Grassland | Dec-Feb | NE | Declining | GOUD-HOEK 124 HT<br>TAFELKOP 126 HT | Yes – located on site |
| | *Eucomis montana* | Rocky montane grassland. | Jan-Mar | Declining | Declining | MORESON 89 HT<br>NAUWGEVONDEN 131 HT<br>RUST-FONTEIN 129 HT<br>TAFELKOP 126 HT<br>TWEEHOEK 128 HT | Possible |
| ORCHIDACEAE | *Eulophia meleagris* | Found in shade of thickets such as *Leucosidea* | | LC | Rare | access Rd from Wakkerstroom to Luneburg(Horst | Highly possible |
| ASTERACEAE | *Gerbera aurantiaca* | rocky grassland between 900 & 1500 m, on warm slopes in well-drained, shallow soils associated with | Sep-Nov | EN | EN | QDG 2730AB<br>NSS fieldwork confirmed further north | Possible |

| Family | Scientific Name | | Flowering Time | RSA | MTPA | Farm name | Possibility of occurring |
|---|---|---|---|---|---|---|---|
| | | doleritic formations | | | | | |
| IRIDACEAE | *Gladiolus appendiculatus* (Wakkerstroom Form) | Grassland – Mountain Slopes | Feb - Mar | VU | VU | TAFELKOP 126 HT | Highly Possible, missed flowering time |
| GUNNERACEAE | *Gunnera perpensa* | Seep zones and along riparian areas within grasslands | Sep-Feb | Declining | Declining | MORESON 89 HT<br>RUST-FONTEIN 129 HT<br>TAFELKOP 126 HT<br>TWEEHOEK 128 HT | Yes, located on site |
| ASTERACEAE | *Helichrysum aureum var. argenteum* | Montane grassland, 1800-2000 m. | | VU | VU | TWEEHOEK 128 HT | Highly possible |
| FABACEAE | *Indigofera hybrida* | Dry Highveld Grassland | | VU | VU | QDG 2730AB | Possible |
| HYACINTHACEAE | *Merwilla plumbea (=Scilla natalensis)#* | Montane mistbelt and Ngongoni grassland, rocky areas on steep, well drained slopes. 300-2500 m. | Oct-Dec | NT | NT | LOSKOP 105 HT<br>MORESON 89 HT | Yes, located within the steep slopes |
| PROTEACEAE | *Protea subvestita#* | Grassland - Confined to infrequently burned habitats, often associated with gullies, scarps and forest margins | Dec-Mar | VU | VU | SE CORNER OF FARM GOEDGEVONDEN | Possible |
| PROTEACEAE | *Protea parvula* | Montane Grassland | Dec-Mar | NT | NT | QDG 2730AB | Possible |
| COLCHICACEAE | *Sandersonia aurantiaca* | Cool, moist slopes with minimal herbivory and fire, 200-1800 m | Nov-Jan | Declining | Declining | QDG 2730AB | Highly possible |
| IRIDACEAE | *Watsonia latifolia* | Open montane grassland in rocky soil or around the bases of granite outcrops | Dec-Feb | LC | Rare | CHANCE 106 HT<br>MORESON 89 HT<br>NAUWGEVONDEN 131 HT<br>RUST-FONTEIN 129 HT<br>TAFELKOP 126 HT | Possible |

Highlighted in green – found on site; # also recorded for the QDS; NE = Not Yet Evaluated; LC = Least Concern; VU = Vulnerable; NT = Near Threatened; EN = Endangered

*Bowkeria citrina*
(Ref: www.plantzafrica.com)

*Aloe kniphofioides*
(Ref: redlist.sanbi.org)

*Eucomis montana*
(Ref: www.ispot.co.za ; Gerhard Diedericks)

*Gerbera aurantiaca*
(Ref: www.plantzafrica.com)

**Figure 3-6 Species to look out for in the study area**

Six floral CIS species that are TSP (Threatened Species Programme) listed were located during the surveys. In addition to this, according to the schedule of Protected Species [Mpumalanga Conservation Act, 1998 (Act 10 of 1998)], which was adapted from the Old Transvaal Nature Conservation Ordinance (1983) **30 species** were identified during the surveys. Those found during the field visit are represented in **Table 3-11** and **Figure 3-7** and displayed in **Figure 3-8.**

**Table 3-11 CI Species found during the surveys on site and in the underground mining area**

| SPECIES | FLOWERING TIME | PROTECTED STATUS | HABITAT |
|---|---|---|---|
| *Agapanthus inapertus* (Drakensberg Agapanthus) | Jan-Mar | Prote3cted[3] | Open Grassland and on Forest Margins |
| *Alepidea peduncularis* | Dec-Mar | DDT | Montane Grassland |
| *Aloe ecklonis* (Grass Aloe) | Nov-Jan | Protected[3] | Spongy Wetland |
| *Aloe maculata* | | Protected[3] | Rocky Grasslands |
| *Bonatea boltoni* | Jan-Feb | Protected[3] | Rocky sunny grassland |
| *Boophone disticha* (Tumbleweed/Gifbol) | Jul-Oct | **Declining**[2] Protected[3,] | Short Montane Grassland |
| *Brunsvigia radulosa* (Candelabra Flower) | Dec-Feb | Protected[3] | Short Montane Grassland; Spongy Wetland |
| *Crinum bulbispermum* (Orange River Lily) | | **Declining**[2] Protected[3] | Seasonally flooded habitats |
| *Cussonia spicata* (Common Cabbage Tree) | Apr-Jun | Protected[1] | Forest Area & Bushclumps |
| *Cyrtanthus tuckii* (Fire lily) | | Protected[3] | |
| *Dioscorea sylvatica* (Elephants Foot) | May-Jun | TSP – NE Protected[3] | Forest Area & Bushclumps |
| *Dierama erectum* | April | Protected[3] | Wet grassland near streams |
| *Eucomis autumnallis* (Pineapple Flower) | Dec-Feb | Protected[3] | Grasslands |
| *Eulophia hians var.nutans* (Ground Orchid) | | Protected3 | Grasslands |
| *Eulophia ovalis* (Oval Eulophia) | | Protected[3] | Dry or marshy grassland and bushveld |
| *Eulophia welwitschii* | Nov-Jan | Protected[3] | Dry or seasonally flooded grassland and marshes |
| *Gladiolus dalenii* (African Gladiolus) | Dec-Feb | Protected[3] | Open grassland, woodland and scrub and in rocky areas, often among rocks along streams. |
| *Gladiolus permeabilis* (Patrysuintjie) | Aug-Sep | Protected[3] | Shale slopes and stony ground. |
| *Gunnera perpensa* (Wild Rhubarb) | Sep-Feb | **Declining**[2] Protected[3] | Edge of pools in marshy areas or along streams. |
| *Habenaria dives* | | Protected[3] | Well drained grasslands |
| *Habenaria epipactidea* | Jan-Mar | Protected[3] | Grassland and open woodland |
| *Habenaria filicornis* | Dec-Apr | Protected[3] | Grassland, often poorly drained marshy ground, peat on gravel |
| *Habenaria pseudociliosa* | Jan-Mar | Protected[3] | Well drained montane grassland |
| *Haemanthus humilis (Rabbit's Ears)* | Nov-Dec; Sep-Feb | Protected[3] | Forest Area & Bushclumps |
| *Hesperantha coccinea* (River Lily) | Dec-April | Protected[3] | Wetlands |
| *Kniphofia* sp. | | Protected[3] | Wetlands/ moist rocky grasslands |
| *Merwilla plumbea* (=*Scilla natalensis*) (Wild Squill) | Oct-Dec | **NT**[2] | Sunny slopes, rocky hills, cliffs and ledges, to damp |

| SPECIES | FLOWERING TIME | PROTECTED STATUS | HABITAT |
|---|---|---|---|
| | | | cliff faces, near waterfalls, in moist depressions, on the edges of streams and vleis (wetlands) to coastal areas. |
| *Pittosporum viridifolium* | Nov-Dec | DWA Protected | tall forest and in scrub on the forest margin, kloofs and on stream banks |
| *Satyrium cristatum* (Crested Satyrium) | Jan-May | Protected[3] | Moist grassy flats |
| *Scadoxus puniceus* (Paintbrush) | Oct-Nov | Protected[3] | Shady areas in coastal bush, ravines and forest. |
| *Watsonia pulchra* | Jul-Sep | Protected[3] | Open grassland or light woodland |
| *Zantedeschia aethiopica* (White or Common Arum Lily) | Aug-Jan | Protected[3] | Stream banks, damp areas. |

Source: [1]Old Transvaal Ordinance; [2]PRECIS database; [3]Schedule 11: Protected Plants.

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*Agapanthus inapertus*
Drakensberg Agapanthus

*Aloe ecklonis*
Grass Aloe

*Boophone disticha*
Tumbleweed/Gifbol

*Brunsvigia radulosa*
Candelabra Flower

*Cussonia spicata*
Common Cabbage Tree

*Crinum bulbispermum*
Orange River Lily

*Dioscorea cf. sylvatica*
Elephants Foot

*Eucomis autumnallis*
Pineapple Flower

*Hesperantha coccinea*
River Lily

*Eulophia ovalis*
Oval Eulophia

*Eulophia welwitschii*

*Gladiolus dalenii*
African Gladiolus

*Gladiolus permeabilis*
Patrysuintjie

*Gunnera perpensa*
Wild Rhubarb

*Habenaria dives*

*Habenaria epipactidea*

*Habenaria filicornis*

*Haemanthus humilis*
Rabbit's Ears

*Merwilla plumbea (=Scilla natalensis)*
Wild Squill

*Satyrium cristatum*
Crested Satyrium

*Scadoxus puniceus*
Paintbrush

*Watsonia pulchra*

**Figure 3-7 Examples of the CI species located within the study area**

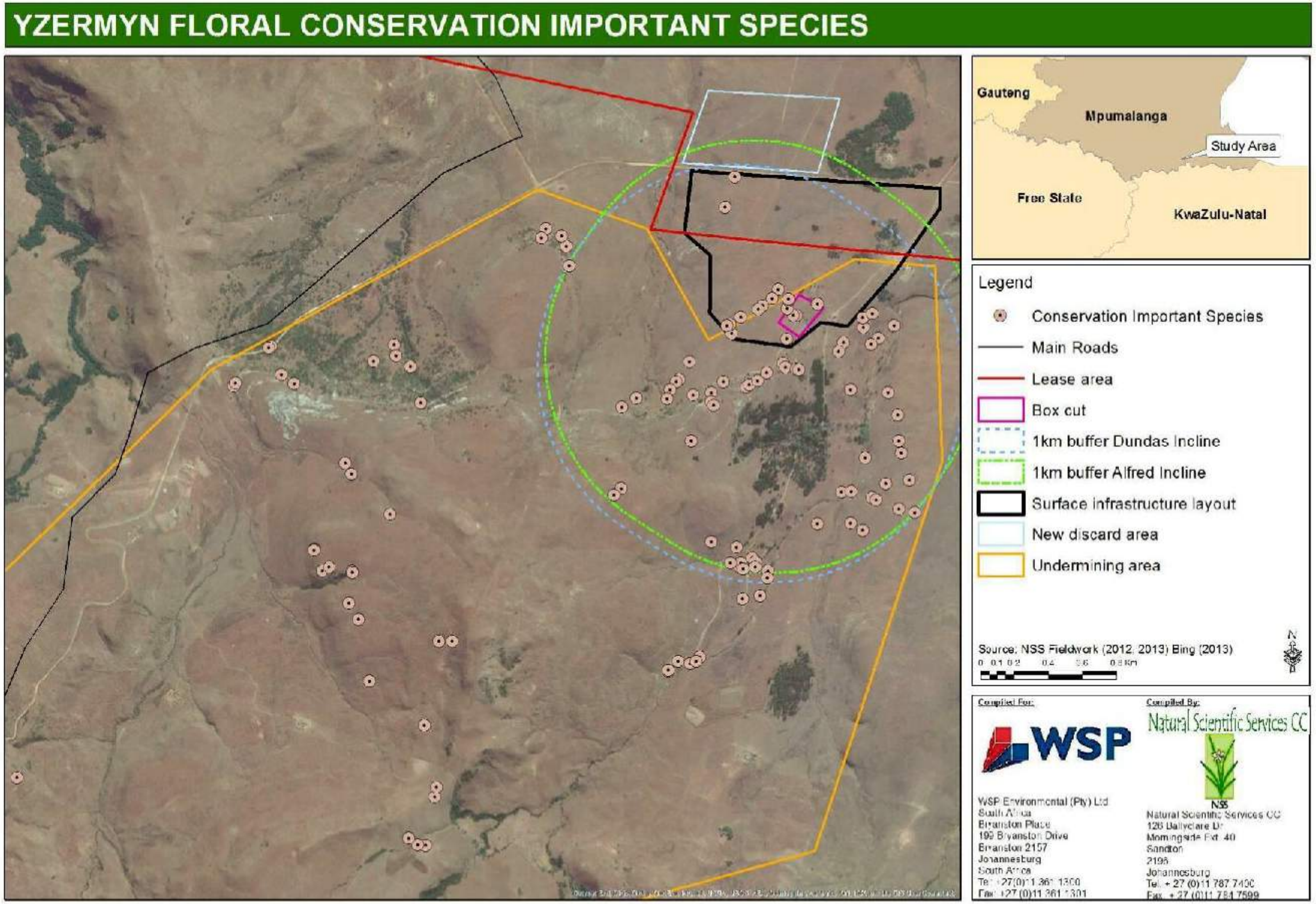


Figure 3-8 CI Species Distributions (from the surveys conducted)

### 3.3. Alien Invasives within the Vegetation Units

Alien species, especially invasive species, are a major threat to the ecological functioning of natural systems and to the productive use of land. These plants can have the following negative impacts on our natural systems:

- A loss of biodiversity and ecosystem resilience as alien species out-compete indigenous flora and in doing so reduce complex ecosystems to mono-cultures therefore destroying habitats for both plant and animals;
- Through increased evaporative transpiration rates 'alien thickets', reduce the amount of groundwater thus reducing the volume of water entering our river systems;
- Alien invasive species dry out wetlands and riparian areas thereby increasing the potential for erosion in these areas;
- The loss of potentially productive land, and the loss of grazing potential and livestock production;
- Poisoning of humans and livestock;
- An increase in the cost of fire protection and damage in wildfires due to alien invasive stands being denser than natural vegetation and the wood more resinous, creating hotter fires;
- An increased level of erosion, following fires in heavily invaded areas, as well as the siltation of dams.

Two main pieces of legislation are applicable to this section:

- Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983) (CARA)
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) (NEM:BA)
    - Draft NEM:BA Regulations April 2009 -Government Gazette Vol 526, No. 32090

In terms of the amendments to the regulations under CARA, landowners are legally responsible for the control of alien species on their properties. Declared weeds and invasive species had been divided into three categories in accordance with the Act.

These categories are as follows:

Category 1: Declared weeds that are prohibited on any land or water surface in South Africa. These species must be controlled, or eradicated where possible.

Category 2: Declared invader species that are only allowed in demarcated areas under controlled conditions and prohibited within 30m of the 1:50 year flood line of any watercourse or wetland.

Category 3: Declared invader species that may remain, but must be prevented from spreading. No further planting of these species are allowed.

The protection of our natural systems from invasive species is further strengthened within Sections 70-77 of NEM:BA. Chapter 5 of this Act specifically deals with Species and

Organisms Posing Potential Threats to Biodiversity. To summarise, the purpose of Chapter 5 is to:

- Prevent the unauthorised introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur.
- To manage and control alien species and invasive species to prevent or minimise harm to the environment and to biodiversity in particular.
- To eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Furthermore Section 73 (2) states that a person who is the owner of land on which a listed invasive species occurs must:

- Notify any relevant competent authority, in writing, of the listed invasive species occurring on that land;
- Take steps to control and eradicate the listed invasive species and to prevent it from spreading; and
- Take all the required steps to prevent or minimise negative impacts to biodiversity.

The regulations for this Act were issued for public comment on 3 April, 2009 (Government Gazette Vol 526, No. 32090). The regulations and lists are not yet promulgated into law, however, it is relevant to point out that Section 21 of the regulations lists the categories for alien and listed invasive species. These are:

- Exempted species being alien species listed in List 1 of the Notice
- Prohibited species being alien species listed in List 2 of the Notice
- Listed invasive species being invasive species listed in List 3 of the Notice as –
- Species requiring compulsory control (1a):
- Invasive species controlled by an invasive species management programme (1b);
- Invasive species controlled by area (2); and
- Invasive species controlled by activity (3)
- A species may be listed in different categories for different parts of the country

The 1km radial surface infrastructural zone is generally in good condition with limited alien species present . Alien bushclumps did, however, dominate certain areas to the east of the proposed adit area constituting almost 8% of the 1km boundary. Within the undergrowth, weedy species such as *Bidens pilosa* and *Tagetes minuta* were prevalent. For the entire area surveyed, the majority of alien species identified were weedy species (**Table 3-12**, examples provided in **Figure 3-9**). However, the presence of a number of Category 1 and 2 species was detected. The proposed NEMBA Category 1 species *Acacia melanoxylon*, was located within the kloof and headwaters of the river systems as well as along the river to the east of the adits.

**Table 3-12 Main Alien Invasive Species found within the Study Area**

* Highlights in orange represent category species

| FAMILY | SPECIES | COMMON NAME | CARA | NEM:BA |
|---|---|---|---|---|
| AMARANTHACEAE | *Achyranthes aspera* | Bur weed | 1 | 1b |
| APIACEAE | *Centella asiatica* | Marsh Pennywort | Weed | Weed |
| ASTERACEAE | *Bidens pilosa* | Black Jacks | Weed | Weed |
| ASTERACEAE | *Tagetes minuta* | Khakibos | Weed | Weed |
| CACTACEAE | *Opuntia ficus-indica* | Prickly Pear | 1 | 1b |
| CONVOLVULACEAE | *Cuscuta sp.* | Dodder | 1 | 1b |
| CONVULVULACEAE | *Ipomoea purpurea* | Morning Glory | 3 | 1b |
| CYPERACEAE | *Cyperus esculentus* | Yellow Nutsedge | Naturalised | Naturalised |
| EUPHORBIACEAE | *Ricinus communis* | Castor Oil Plant | 2 | 1b |
| FABACEAE | *Acacia mearnsii* | Wattle Tree | 2 | 2 |
| FABACEAE | *Acacia melanoxylon* | Black Ironwood | 2 | 1b |
| ONAGRACEAE | *Oenothera rosea* | Rose Evening Primrose | 3 | - |
| PLANTAGINACEAE | *Plantago major* | Broadleaved Ribwort | Weed | Weed |
| SOLANACEAE | *Datura stramonium* | Common Thornapple | 1 | 1b |
| SOLANACEAE | *Physalis viscosa* | Wild Gooseberry | Weed | Weed |
| SOLANACEAE | *Solanum sisymbriifolium* | Dense-thorn Bitter Apple | 1 | 1b |
| ASTERACEAE | *Schkuhria pinnata* | Dwarf Marigold | Weed | Weed |
| ASPARAGACEAE | *Agave americana L.* | American Agave | Weed | Weed |
| ASTERACEAE | *Cosmos bipinnatus Cav.* | Cosmos | Weed | Weed |
| MYRTACEAE | *Eucalyptus camaldulensis Dehnh.* | Red River Gum | 2 | 1b (rivers) |
| POACEAE | *Paspalum dilatatum* | Dallis Grass | Weed | Weed |
| POACEAE | *Paspalum scrobiculatum L.* | Rice Grass | Weed | Weed |
| POACEAE | *Pennisetum clandestinum Hochst. ex Chiov.* | Kikuyu | Weed | Weed |
| SALICACEAE | *Populus deltoides Bartram ex Marshall* | Match Poplar | Weed | Weed |
| SALICACEAE | *Populus x canescens (Aiton) Sm* | Grey Poplar | 2 | 2 |
| SALICACEAE | *Salix babylonica L.* | Weeping Willow | 2 | - |
| VERBENACEAE | *Verbena bonariensis L.* | Tall Verbena | Weed | 1b |
| VERBENACEAE | *Verbena rigida Spreng.* | Coarse Verbena | Weed | Weed |

*Acacia melanoxylon*

*Acacia mearnsii* – *Eucalyptus* clumps

*Tagetes minuta*

*Eucalyptus* and *Populus x canescens*

*Ipomoea purpurea*

*Opuntia ficus-indica*

**Figure 3-9 Evidence of Alien species found within the study area**

# 4. Areas of Conservation Importance

These areas are discussed in further details within **Section F**, however, a summary is provided below (**Table 4-1**).

**Table 4-1 Summary of the different vegetation communities within the 1km surface infrastructure zone**

| UNIT | HABITAT & VEGETATION COMMUNITIES | CONDITION | CI SPECIES | AOCI |
|---|---|---|---|---|
| | **Wooded / Open Thicket Areas** | | | |
| A | *Leucosidea – Merxmuellera* Riverine Community | Natural State and Restricted Habitat, Some Alien Invasives along the systems, particularly in the eastern component. Limited erosion evident, mainly at cattle crossings | A number of TSP and MTPA listed species (both floral and faunal) | **Very High** |
| B | *Searsia – Diospyros – Athrixia* Protected Outcrops & Kloof Community | Natural State and unique / restricted habitat. High diversity, Some Alien Invasives present. | The highest number of TSP and MTPA listed species (floral species, including NT spp) | **Very High** |
| | **Upper Slope / Plateau Grasslands** | | | |
| C | *Hyparrhenia – Microchloa – Helichrysum* Plateau | Relatively in a natural state. Impacted upon by grazing, some areas harvested for thatching grass. Medium Diversity | A number of MTPA listed species and potential National listed species (both floral and faunal) | **Medium** |
| D | *Hyparrhenia – Cymbopogon – Monocymbium* Slope Community | Relatively in a natural state Grassland – Impacted upon by grazing. Medium-High Diversity. Rocky areas scattered in between yielding a small change in species composition | A number of MTPA and National listed species (both floral and faunal) | **Medium-High** |
| | **Hydromorphic Grasslands** | | | |
| E | *Andropogon – Hyparrhenia* temporary seeps | Relatively in a natural state, Alien Invasives – heavy within the eastern section as well as past farming activities but limited in other areas. Moderate diversity | TSP and MTPA listed species (floral species) and CI Faunal species recorded (VU; NT) | **High** |
| F | *Andropogon – Helichrysum- Bulbostylis* seasonal seeps | Complete change in species diversity from unit A-D Relatively in a natural state, Alien Invasives – heavy within the eastern section, but limited in others | High number of TSP and MTPA listed species (floral species). CI Faunal species | **Very High** |

| UNIT | HABITAT & VEGETATION COMMUNITIES | CONDITION | CI SPECIES | AOCI |
|---|---|---|---|---|
| | | | recorded (VU; NT) | |
| | **Transformed** | | | |
| | Settlement Areas & Alien Bushclumps | Transformed habitats with limited diversity | None to date | **Low** |

AOCI: Areas of Conservation Importance

# 5. Appendices

## 5.1. Appendix 1 Twinspan

```
TWINSPAN category:          111110000000000000000000
                            110001111111111111111110
                            --1101111111111000000000-
                            -----111000000011111000-
                            ------------------------
                            ------------------------
Releves 24
Species 94

Aca mea    0    .........+.............+
Aca mel    0    .......................+
Aga ame    0    .......................+
Alo eck    0    ........................
And app    0    .....222+1.2.122...+....
And sch    0    ....................+.+.
And spp    0    ................111.....
Ari jun    0    .....+...+...11.......2.
Ath phy    0    ..2+2...................
Ber set    0    ....+....+.....++..++1..
Ber ere    0    ++......................
Bid pil    0    .....+..++2..+..+..+.+.+
Boo dis    0    ........................
Bru rad    0    ........................
Bul his    0    .............+.+.+......
Bul his    0    ..............1.........
Cen asi    0    ......++................
Cos bip    0    .......................+
Cra alb    0    ................+...++..
Cte con    0    ...............1+++++11.
Cuc zey    0    .............+..........
Cus spi    0    ..+++.+.................
Cym pos    0    ..+++....+....1+11+2..1.
Cyn dac    0    ........................
Cyp com    0    ........+.....+.........
Cyp con    0    ++......................
Cyp dig    0    11......................
Dig dia    0    ........+...............
Dig mon    0    ...............+++.+.++.
Dih amp    0    ......+.........+.+.11..
Dio lyc    0    ..222...................
Ele ele    0    ..+.++....+.............
Era chl    0    .....+.++++++++...++1.+.
Era rig    0    ....................+.+.
Euc cam    0    .......................+
Euc und    0    ..+11...................
Euc aut    0    ................+.......
Eup cla    0    ........................
Fal rep    0    ++......................
Gaz sp     0    ............+.....+.....
Gei bur    0    ....................+.+.
Gla sp.    0    .....+............+.++..
Hel aur    0    .....1...1...++1........
Hel nud    0    ....................+++.
Het con    0    ....................11..
Hil ari    0    ......+2...........+.1..
Hyp fil    0    11...222222122221222222.
Hyp hir    0    ...++...22.2...........+
Hyp tam    0    ..........1.............
Hyp sp.    0    ............+...........
Imp cyl    0    ..........2.............
Ind sp.    0    .............+..........
Ipo pur    0    .......+........+..+...+
Jun oxy    0    11......................
Led sp.    0    .....+.+........+...+...
Leo ocy    0    ...............+........
Leu ser    0    22......+...............
Lou sim    0    .................+......
Mel rep    0    ............+..++..+++++
Mer dis    0    22......................
Mic sp.    0    ...+++.+.++.+..++.+1212.
Mon cer    0    ......+.+..+.+11.+.+.++.
Old her    0    ........................
Ole eur    0    ..1+1...................
Oxa sp.    0    .............+..+.......
Pas dig    0    ++......................
```

| | | |
|---|---|---|
| Pas dis | 0 | ........+............... |
| Pas scr | 0 | .....+...+.............. |
| Pen cla | 0 | .......................+ |
| Pla lan | 0 | ......+.++1............. |
| Pog squ | 0 | ..........+..........++. |
| Pop del | 0 | .......................+ |
| Pop x c | 0 | .......................+ |
| Psa myr | 0 | ......................+. |
| Rha pri | 0 | ..+11................... |
| Rho tri | 0 | ........................ |
| Sal bab | 0 | .......................+ |
| Sch cra | 0 | ............++++..+..+.. |
| Sea den | 0 | 11112...........+....... |
| Seb gra | 0 | ...........+++.......... |
| Sel dre | 0 | ..+.1................... |
| Sen sp. | 0 | .....++..+.....+....++.. |
| Set sph | 0 | .....+.................. |
| Spo afr | 0 | .....1+++.+.+2+...+..+.. |
| Tag min | 0 | ........++...........++. |
| The tri | 0 | ..............++...2..1. |
| Tri mon | 0 | ....................+.+. |
| Tri leu | 0 | ++++++.+++.+2...+++..... |
| Ure agr | 0 | .................+...... |
| Ver bon | 0 | ........+.....+......... |
| Ver rig | 0 | ........+++..++......... |
| Ziz muc | 0 | .......................+ |

## 5.2. Appendix 2 PRECIS List for 2730AB

| Family | Species | Threat status |
|---|---|---|
| ACANTHACEAE | *Justicia anagalloides (Nees) T.Anderson* | LC |
| ACANTHACEAE | *Thunbergia atriplicifolia E.Mey. ex Nees* | LC |
| AMARYLLIDACEAE | *Cyrtanthus tuckii Baker var. transvaalensis I.Verd.* | LC |
| ANACARDIACEAE | *Searsia dentata (Thunb.) F.A.Barkley* | LC |
| ANACARDIACEAE | *Searsia discolor (E.Mey. ex Sond.) Moffett* | LC |
| ANACARDIACEAE | *Searsia pyroides (Burch.) Moffett var. pyroides* | LC |
| ANACARDIACEAE | *Searsia tomentosa (L.) F.A.Barkley* | LC |
| ANEMIACEAE | *Mohria vestita Baker* | LC |
| APIACEAE | *Alepidea peduncularis A.Rich.* | DDT |
| APOCYNACEAE | *Asclepias aurea (Schltr.) Schltr.* | LC |
| APOCYNACEAE | *Asclepias brevicuspis (E.Mey.) Schltr.* | LC |
| APOCYNACEAE | *Asclepias cucullata (Schltr.) Schltr. subsp. cucullata* | LC |
| APOCYNACEAE | *Asclepias cultriformis (Harv. ex Schltr.) Schltr.* | LC |
| APOCYNACEAE | *Asclepias eminens (Harv.) Schltr.* | LC |
| APOCYNACEAE | *Asclepias multicaulis (E.Mey.) Schltr.* | LC |
| APOCYNACEAE | *Aspidoglossum dissimile (N.E.Br.) Kupicha* | LC |
| APOCYNACEAE | *Aspidoglossum ovalifolium (Schltr.) Kupicha* | LC |
| APOCYNACEAE | *Aspidonepsis diploglossa (Turcz.) Nicholas & Goyder* | LC |
| APOCYNACEAE | *Aspidonepsis shebae Nicholas & Goyder* | VU |
| APOCYNACEAE | *Pachycarpus campanulatus (Harv.) N.E.Br. var. campanulatus* | LC |
| APOCYNACEAE | *Pachycarpus scaber (Harv.) N.E.Br.* | LC |
| APOCYNACEAE | *Schizoglossum atropurpureum E.Mey. subsp. atropurpureum* | LC |
| APOCYNACEAE | *Sisyranthus huttoniae (S.Moore) S.Moore* | LC |
| APOCYNACEAE | *Sisyranthus imberbis Harv.* | LC |
| APOCYNACEAE | *Xysmalobium involucratum (E.Mey.) Decne.* | LC |
| APOCYNACEAE | *Xysmalobium parviflorum Harv. ex Scott-Elliot* | LC |
| ASPARAGACEAE | *Asparagus buchananii Baker* | LC |
| ASPARAGACEAE | *Asparagus cooperi Baker* | LC |
| ASPARAGACEAE | *Asparagus virgatus Baker* | LC |
| ASPHODELACEAE | *Aloe ecklonis Salm-Dyck* | LC |
| ASPHODELACEAE | *Kniphofia albescens Codd* | LC |
| ASPHODELACEAE | *Kniphofia laxiflora Kunth* | LC |
| ASPHODELACEAE | *Kniphofia linearifolia Baker* | LC |
| ASPLENIACEAE | *Asplenium adiantum-nigrum L. var. adiantum-nigrum* | LC |
| ASPLENIACEAE | *Asplenium varians Wall. ex Hook. & Grev. subsp. fimbriatum (Kunze) Schelpe* | LC |
| ASTERACEAE | *Acanthospermum australe (Loefl.) Kuntze** | Not Evaluated |
| ASTERACEAE | *Adenanthellum osmitoides (Harv.) B.Nord.* | LC |
| ASTERACEAE | *Aster bakerianus Burtt Davy ex C.A.Sm.* | LC |
| ASTERACEAE | *Aster harveyanus Kuntze* | LC |
| ASTERACEAE | *Berkheya echinacea (Harv.) O.Hoffm. ex Burtt Davy subsp. echinacea* | LC |
| ASTERACEAE | *Berkheya insignis (Harv.) Thell.* | LC |
| ASTERACEAE | *Berkheya radula (Harv.) De Wild.* | LC |
| ASTERACEAE | *Berkheya rhapontica (DC.) Hutch. & Burtt Davy subsp. rhapontica* | LC |
| ASTERACEAE | *Berkheya setifera DC.* | LC |
| ASTERACEAE | *Berkheya speciosa (DC.) O.Hoffm. subsp. lanceolata Roessler* | LC |
| ASTERACEAE | *Conyza scabrida DC.* | LC |
| ASTERACEAE | *Crassocephalum x picridifolium (DC.) S.Moore* | Not Evaluated |
| ASTERACEAE | *Euryops gilfillanii Bolus* | LC |
| ASTERACEAE | *Garuleum woodii Schinz* | LC |
| ASTERACEAE | *Gerbera aurantiaca Sch.Bip.* | EN |
| ASTERACEAE | *Helichrysum adenocarpum DC. subsp. adenocarpum* | LC |
| ASTERACEAE | *Helichrysum athrixiifolium (Kuntze) Moeser* | LC |

| Family | Species | Threat status |
|---|---|---|
| ASTERACEAE | *Helichrysum aureonitens Sch.Bip.* | LC |
| ASTERACEAE | *Helichrysum callicomum Harv.* | LC |
| ASTERACEAE | *Helichrysum herbaceum (Andrews) Sweet* | LC |
| ASTERACEAE | *Helichrysum melanacme DC.* | LC |
| ASTERACEAE | *Helichrysum mixtum (Kuntze) Moeser var. mixtum* | LC |
| ASTERACEAE | *Helichrysum monticola Hilliard* | LC |
| ASTERACEAE | *Helichrysum nudifolium (L.) Less. var. nudifolium* | LC |
| ASTERACEAE | *Helichrysum opacum Klatt* | LC |
| ASTERACEAE | *Hilliardiella aristata (DC.) H.Rob.* | LC |
| ASTERACEAE | *Hilliardiella hirsuta (DC.) H.Rob.* | LC |
| ASTERACEAE | *Hypochaeris radicata L.** | Not Evaluated |
| ASTERACEAE | *Lopholaena segmentata (Oliv.) S.Moore* | LC |
| ASTERACEAE | *Macledium zeyheri (Sond.) S.Ortíz subsp. zeyheri* | LC |
| ASTERACEAE | *Nidorella anomala Steetz* | LC |
| ASTERACEAE | *Senecio affinis DC.* | LC |
| ASTERACEAE | *Senecio barbatus DC.* | LC |
| ASTERACEAE | *Senecio deltoideus Less.* | LC |
| ASTERACEAE | *Senecio glaberrimus DC.* | LC |
| ASTERACEAE | *Senecio glanduloso-pilosus Volkens & Muschl.* | LC |
| ASTERACEAE | *Senecio inaequidens DC.* | LC |
| ASTERACEAE | *Senecio lydenburgensis Hutch. & Burtt Davy* | LC |
| ASTERACEAE | *Senecio oxyriifolius DC. subsp. oxyriifolius* | LC |
| ASTERACEAE | *Senecio polyodon DC. var. polyodon* | LC |
| ASTERACEAE | *Senecio scitus Hutch. & Burtt Davy* | LC |
| ASTERACEAE | *Sonchus nanus Sond. ex Harv.* | LC |
| ASTERACEAE | *Ursinia alpina N.E.Br.* | LC |
| ASTERACEAE | *Vernonia galpinii Klatt* | LC |
| ASTERACEAE | *Vernonia thodei E.Phillips* | LC |
| ASTERACEAE | *Xanthium strumarium L.** | Not Evaluated |
| BLECHNACEAE | *Blechnum australe L. subsp. australe* | LC |
| BORAGINACEAE | *Cynoglossum lanceolatum Forssk.* | LC |
| BUDDLEJACEAE | *Buddleja auriculata Benth.* | LC |
| BUDDLEJACEAE | *Nuxia congesta R.Br. ex Fresen.* | LC |
| CAMPANULACEAE | *Craterocapsa tarsodes Hilliard & B.L.Burtt* | LC |
| CAMPANULACEAE | *Wahlenbergia huttonii (Sond.) Thulin* | LC |
| CAPPARACEAE | *Cleome monophylla L.* | LC |
| CARYOPHYLLACEAE | *Dianthus basuticus Burtt Davy subsp. basuticus var. basuticus* | LC |
| CARYOPHYLLACEAE | *Dianthus transvaalensis Burtt Davy* | LC |
| CARYOPHYLLACEAE | *Pollichia campestris Aiton* | LC |
| CELASTRACEAE | *Gymnosporia buxifolia (L.) Szyszyl.* | LC |
| CELASTRACEAE | *Maytenus acuminata (L.f.) Loes. var. acuminata* | LC |
| CELASTRACEAE | *Maytenus undata (Thunb.) Blakelock* | LC |
| CELASTRACEAE | *Pterocelastrus echinatus N.E.Br.* | LC |
| COLCHICACEAE | *Colchicum melanthoides (Willd.) J.C.Manning & Vinn. subsp. transvaalense (U.& D.Müll.-Doblies) J.C.Manning & Vinn.* | LC |
| COLCHICACEAE | *Gloriosa modesta (Hook.) J.C.Manning & Vinn.* | LC |
| COLCHICACEAE | *Sandersonia aurantiaca Hook.* | Declining |
| COMBRETACEAE | *Combretum kraussii Hochst.* | LC |
| COMMELINACEAE | *Commelina africana L. var. krebsiana (Kunth) C.B.Clarke* | LC |
| COMMELINACEAE | *Cyanotis lapidosa E.Phillips* | LC |
| CONVOLVULACEAE | *Ipomoea crassipes Hook. var. crassipes* | LC |
| CONVOLVULACEAE | *Ipomoea oblongata E.Mey. ex Choisy* | LC |
| CUCURBITACEAE | *Cucumis hirsutus Sond.* | LC |
| CYPERACEAE | *Cyperus obtusiflorus Vahl var. obtusiflorus* | LC |
| CYPERACEAE | *Fimbristylis complanata (Retz.) Link* | LC |
| CYPERACEAE | *Isolepis sepulcralis Steud.* | LC |
| CYPERACEAE | *Kyllinga erecta Schumach. var. erecta* | LC |

| Family | Species | Threat status |
|---|---|---|
| CYPERACEAE | *Pycreus nitidus (Lam.) J.Raynal* | LC |
| CYPERACEAE | *Rhynchospora brownii Roem. & Schult.* | LC |
| CYPERACEAE | *Schoenoplectus brachyceras (Hochst. ex A.Rich.) Lye* | LC |
| DIOSCOREACEAE | *Dioscorea sylvatica Eckl. var. sylvatica* | Not Evaluated |
| DIPSACACEAE | *Cephalaria zeyheriana Szabó* | LC |
| DIPSACACEAE | *Scabiosa columbaria L.* | LC |
| DRYOPTERIDACEAE | *Dryopteris athamantica (Kunze) Kuntze* | LC |
| DRYOPTERIDACEAE | *Dryopteris pentheri (Krasser) C.Chr.* | LC |
| ERICACEAE | *Erica caffrorum Bolus var. caffrorum* | LC |
| ERICACEAE | *Erica reenensis Zahlbr.* | LC |
| ERIOCAULACEAE | *Eriocaulon sonderianum Körn.* | LC |
| EUPHORBIACEAE | *Acalypha depressinerva (Kuntze) K.Schum.* | LC |
| EUPHORBIACEAE | *Acalypha wilmsii Pax ex Prain & Hutch.* | LC |
| EUPHORBIACEAE | *Clutia affinis Sond.* | LC |
| EUPHORBIACEAE | *Clutia hirsuta (Sond.) Müll.Arg. var. hirsuta* | LC |
| EUPHORBIACEAE | *Clutia monticola S.Moore var. monticola* | LC |
| EUPHORBIACEAE | *Euphorbia epicyparissias E.Mey. ex Boiss.* | LC |
| FABACEAE | *Acacia dealbata Link** | Not Evaluated |
| FABACEAE | *Eriosema distinctum N.E.Br.* | LC |
| FABACEAE | *Eriosema kraussianum Meisn.* | LC |
| FABACEAE | *Indigofera hybrida N.E.Br.* | VU |
| FABACEAE | *Melilotus albus Medik.** | Not Evaluated |
| FABACEAE | *Otholobium nigricans C.H.Stirt.* | LC |
| FABACEAE | *Rhynchosia monophylla Schltr.* | LC |
| FABACEAE | *Zornia milneana Mohlenbr.* | LC |
| GENTIANACEAE | *Enicostema axillare (Lam.) A.Raynal subsp. axillare* | LC |
| GENTIANACEAE | *Sebaea leiostyla Gilg* | LC |
| GENTIANACEAE | *Sebaea natalensis Schinz* | LC |
| GERANIACEAE | *Pelargonium luridum (Andrews) Sweet* | LC |
| GESNERIACEAE | *Streptocarpus pentherianus Fritsch* | LC |
| GREYIACEAE | *Greyia radlkoferi Szyszyl.* | LC |
| GREYIACEAE | *Greyia sutherlandii Hook. & Harv.* | LC |
| HYACINTHACEAE | *Ledebouria cooperi (Hook.f.) Jessop* | LC |
| HYACINTHACEAE | *Ledebouria marginata (Baker) Jessop* | LC |
| HYACINTHACEAE | *Ledebouria revoluta (L.f.) Jessop* | LC |
| HYACINTHACEAE | *Merwilla plumbea (Lindl.) Speta* | NT |
| HYPERICACEAE | *Hypericum aethiopicum Thunb. subsp. aethiopicum* | LC |
| HYPERICACEAE | *Hypericum aethiopicum Thunb. subsp. sonderi (Bredell) N.Robson* | LC |
| HYPOXIDACEAE | *Hypoxis filiformis Baker* | LC |
| HYPOXIDACEAE | *Hypoxis rigidula Baker var. rigidula* | LC |
| HYPOXIDACEAE | *Rhodohypoxis baurii (Baker) Nel var. baurii* | LC |
| IRIDACEAE | *Aristea torulosa Klatt* | LC |
| IRIDACEAE | *Dierama insigne N.E.Br.* | LC |
| IRIDACEAE | *Dierama pauciflorum N.E.Br.* | LC |
| IRIDACEAE | *Freesia laxa (Thunb.) Goldblatt & J.C.Manning subsp. laxa* | LC |
| IRIDACEAE | *Gladiolus appendiculatus G.J.Lewis* | LC |
| IRIDACEAE | *Gladiolus crassifolius Baker* | LC |
| IRIDACEAE | *Hesperantha coccinea (Backh. & Harv.) Goldblatt & J.C.Manning* | LC |
| IRIDACEAE | *Tritonia disticha (Klatt) Baker subsp. rubrolucens (R.C.Foster) M.P.de Vos* | LC |
| IRIDACEAE | *Watsonia pulchra N.E.Br. ex Goldblatt* | LC |
| IRIDACEAE | *Watsonia watsonioides (Baker) Oberm.* | LC |
| JUNCACEAE | *Juncus dregeanus Kunth subsp. dregeanus* | LC |
| JUNCAGINACEAE | *Triglochin bulbosa L.* | LC |
| LAMIACEAE | *Acrotome hispida Benth.* | LC |
| LAMIACEAE | *Ajuga ophrydis Burch. ex Benth.* | LC |

| Family | Species | Threat status |
|---|---|---|
| LAMIACEAE | *Pycnostachys reticulata (E.Mey.) Benth.* | LC |
| LAMIACEAE | *Syncolostemon concinnus N.E.Br.* | LC |
| LAMIACEAE | *Syncolostemon parviflorus E.Mey. ex Benth. var. parviflorus* | LC |
| LOBELIACEAE | *Cyphia elata Harv. var. glabra Harv.* | LC |
| LYTHRACEAE | *Nesaea sagittifolia (Sond.) Koehne var. ericiformis Koehne forma swaziensis Immelman* | Not Evaluated |
| LYTHRACEAE | *Nesaea sagittifolia (Sond.) Koehne var. sagittifolia* | LC |
| MALVACEAE | *Corchorus junodii (Schinz) N.E.Br.* | LC |
| MALVACEAE | *Hermannia cristata Bolus* | LC |
| MALVACEAE | *Hibiscus aethiopicus L. var. ovatus Harv.* | LC |
| MALVACEAE | *Pavonia columella Cav.* | LC |
| MALVACEAE | *Sida dregei Burtt Davy* | LC |
| MALVACEAE | *Sparrmannia ricinocarpa (Eckl. & Zeyh.) Kuntze var. ricinocarpa* | LC |
| MELIANTHACEAE | *Melianthus dregeanus Sond. subsp. insignis (Kuntze) S.A.Tansley* | LC |
| OCHNACEAE | *Ochna serrulata (Hochst.) Walp.* | LC |
| ONAGRACEAE | *Oenothera rosea L'Hér. ex Aiton** | Not Evaluated |
| ORCHIDACEAE | *Corycium dracomontanum Parkman & Schelpe* | LC |
| ORCHIDACEAE | *Eulophia hians Spreng. var. nutans (Sond.) S.Thomas* | LC |
| ORCHIDACEAE | *Eulophia welwitschii (Rchb.f.) Rolfe* | LC |
| ORCHIDACEAE | *Habenaria dregeana Lindl.* | LC |
| ORCHIDACEAE | *Habenaria epipactidea Rchb.f.* | LC |
| ORCHIDACEAE | *Satyrium cristatum Sond. var. longilabiatum A.V.Hall* | LC |
| ORCHIDACEAE | *Satyrium hallackii Bolus subsp. ocellatum (Bolus) A.V.Hall* | LC |
| ORCHIDACEAE | *Satyrium neglectum Schltr. subsp. neglectum var. neglectum* | LC |
| OXALIDACEAE | *Oxalis corniculata L.** | Not Evaluated |
| OXALIDACEAE | *Oxalis obliquifolia Steud. ex A.Rich.* | LC |
| PHYLLANTHACEAE | *Phyllanthus glaucophyllus Sond.* | LC |
| POACEAE | *Brachiaria brizantha (A.Rich.) Stapf* | LC |
| POACEAE | *Ctenium concinnum Nees* | LC |
| POACEAE | *Eragrostis capensis (Thunb.) Trin.* | LC |
| POACEAE | *Eragrostis curvula (Schrad.) Nees* | LC |
| POACEAE | *Eragrostis racemosa (Thunb.) Steud.* | LC |
| POACEAE | *Eulalia villosa (Thunb.) Nees* | LC |
| POACEAE | *Festuca scabra Vahl* | LC |
| POACEAE | *Helictotrichon longifolium (Nees) Schweick.* | LC |
| POACEAE | *Hyparrhenia filipendula (Hochst.) Stapf var. filipendula* | LC |
| POACEAE | *Koeleria capensis (Steud.) Nees* | LC |
| POACEAE | *Lophacme digitata Stapf* | LC |
| POACEAE | *Miscanthus junceus (Stapf) Pilg.* | LC |
| POACEAE | *Panicum aequinerve Nees* | LC |
| POACEAE | *Panicum ecklonii Nees* | LC |
| POACEAE | *Rendlia altera (Rendle) Chiov.* | LC |
| POACEAE | *Rottboellia cochinchinensis (Lour.) Clayton* | LC |
| PODOCARPACEAE | *Podocarpus latifolius (Thunb.) R.Br. ex Mirb.* | LC |
| POLYGALACEAE | *Polygala gracilenta Burtt Davy* | LC |
| POLYGONACEAE | *Rumex woodii N.E.Br.* | LC |
| PROTEACEAE | *Protea parvula Beard* | NT |
| PROTEACEAE | *Protea subvestita N.E.Br.* | VU |
| PTERIDACEAE | *Pteris cretica L.* | LC |
| RANUNCULACEAE | *Ranunculus multifidus Forssk.** | |
| ROSACEAE | *Rubus rigidus Sm.* | LC |
| RUBIACEAE | *Cephalanthus natalensis Oliv.* | LC |
| RUBIACEAE | *Pachystigma macrocalyx (Sond.) Robyns* | LC |
| RUBIACEAE | *Pachystigma thamnus Robyns* | LC |

| Family | Species | Threat status |
|---|---|---|
| RUBIACEAE | *Pavetta gardeniifolia A.Rich. var. gardeniifolia* | LC |
| RUBIACEAE | *Psydrax obovata (Eckl. & Zeyh.) Bridson subsp. obovata* | LC |
| SANTALACEAE | *Thesium costatum A.W.Hill var. costatum* | LC |
| SANTALACEAE | *Thesium spartioides A.W.Hill* | LC |
| SCROPHULARIACEAE | *Bowkeria citrina Thode* | Rare |
| SCROPHULARIACEAE | *Nemesia caerulea Hiern* | LC |
| SELAGINELLACEAE | *Selaginella mittenii Baker* | LC |
| SINOPTERIDACEAE | *Cheilanthes pentagona Schelpe & N.C.Anthony* | LC |
| SINOPTERIDACEAE | *Cheilanthes quadripinnata (Forssk.) Kuhn* | LC |
| SINOPTERIDACEAE | *Cheilanthes viridis (Forssk.) Sw. var. viridis* | LC |
| SOLANACEAE | *Solanum rigescens Jacq.* | Not Evaluated |
| THYMELAEACEAE | *Dais cotinifolia L.* | LC |
| THYMELAEACEAE | *Gnidia burchellii (Meisn.) Gilg* | LC |
| THYMELAEACEAE | *Gnidia microcephala Meisn.* | LC |
| VALERIANACEAE | *Valeriana capensis Thunb. var. capensis* | LC |
| VERBENACEAE | *Verbena bonariensis L.** | Not Evaluated |
| VERBENACEAE | *Verbena brasiliensis Vell.** | Not Evaluated |
| VERBENACEAE | *Verbena rigida Spreng.* | Not Evaluated |
| VITACEAE | *Cissus diversilobata C.A.Sm.* | LC |
| VITACEAE | *Rhoicissus tridentata (L.f.) Wild & R.B.Drumm. subsp. cuneifolia (Eckl. & Zeyh.) Urton* | Not Evaluated |
| WOODSIACEAE | *Woodsia angolensis Schelpe* | LC |
| XYRIDACEAE | *Xyris obscura N.E.Br.* | LC |

# Section C: Faunal Assessment

NATURAL SCIENTIFIC SERVICES

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# SECTION C: FAUNAL ASSESSMENT

# 1. Introduction

Natural Scientific Services CC (NSS) was contracted by WSP Environmental (Pty) Ltd (WSP) to perform Biodiversity Scoping, Baseline and Impact Assessments for selected aspects of the proposed ATHA Yzermyn Coal Project (AYCP). This report **Section C** details the Baseline Faunal Assessment, which involved desktop- and field-based investigation of mammals, birds, reptiles, frogs and butterflies. For the AYCP faunal assessment, specialist avifaunal (bird) and bat input was received from Delta Environmental Consultants (DEC) and the Gauteng & Northern Regions Bat Interest Group (GNorBIG), respectively. GNorBIG assisted voluntarily but DEC was formally subcontracted by NSS, and the Specialist Baseline Avifaunal Assessment Report is appended to this **Section C**. Potential impacts on fauna of the AYCP and recommended measures to mitigate these impacts are discussed in **Section G**.

# 2. Methodology

## 2.1. Desktop Research

The Likelihood of Occurrence (LoO) of faunal species in the four quarter degree squares (QDSs) 2730AA, AB, AC and AD wherein the AYCP is situated, was evaluated for:

- Mammals using the published species distribution maps in Friedmann & Daly (2004) and Monadjem *et al*. (2010).
- Birds using online records from the second Southern African Bird Atlas Project (SABAP 2) of all species recorded during the past five years in the nine pentads (5' x 5' atlassing grid-cells; **Figure 2-1**) wherein the AYCP site is situated.
- Reptiles using the online species distribution maps of the Southern African Reptile Conservation Assessment (SARCA, 2010).
- Amphibians using the published species distribution maps in Minter *et al*. (2004), with species names updated using Du Preez & Carruthers (2009).
- Butterflies using the online species distribution maps of the Southern African Butterfly Conservation Atlas (SABCA, 2010).

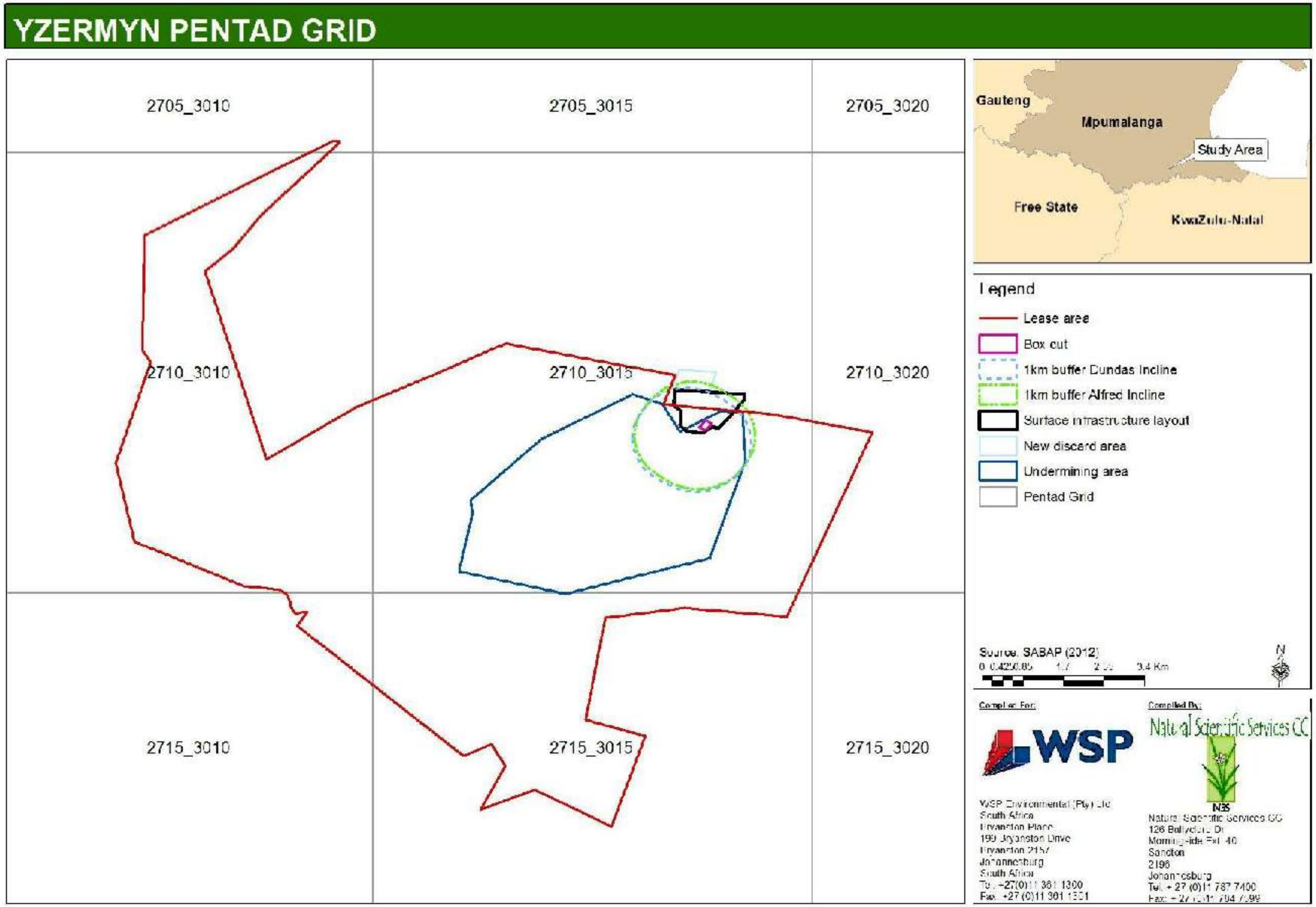



**Figure 2-1 Pentads wherein the study site is situated**

The LoO of each mammal, reptile, frog, and butterfly species was rated using the following scale:

1 Present
2 High LoO (High Likelihood of Occurrence)
3 Moderate LoO (May occur)
4 Low LoO (Low Likelihood of Occurrence)
5 May occur as a managed population

The faunal species lists and the LoO of different taxa were refined with observations by NSS and DEC during field surveys of species, signs of their presence, and available habitat in the study area. The lists were further supplemented with records of CI bird species observed by DEC in the general study area prior to the start of the SABAP 2, and with records from the MTPA (pers. comm. 2013) of CI animal species found by other specialists on farms in and around the AYCP.

## 2.2. Fieldwork

As explained in **Section A**, no detailed information on the AYCP was available until recently, and the boundaries of the lease, underground mining and surface infrastructure areas changed during the course of this Assessment. Consequently, field surveys for fauna were performed in the original (old) proposed undermining area during 2012 and in the current undermining area during 2013 (**Section A: Figure 2-1**). Surveys were performed during 26-30 March 2012, 14-18 January 2013, 13-14 April 2013 and 15-17 July 2013, and involved visual observation, grab-sampling, camera- and live-trapping of fauna, as well as mist-netting, harp-trapping and acoustic surveys for bats.

### *Visual observations & grab-sampling*

Faunal observations were made while driving and walking in and around the study area, particularly, when visiting camera-trapping sites, vegetation plots and wetland areas. During the day, micro-habitats such as under rocks and logs were investigated, and a hand net was used to sample butterflies. At night, a spotlight and torches were used to detect nocturnal fauna. Taxa were identified based on observations of dead or live animals and their spoor, droppings, burrows and any other evidence of their presence.

### *Camera-trapping*

Heat- and motion-sensitive cameras were installed at 18 locations in the study area where vertebrate activity seemed likely, and the risk of camera theft seemed low (**Figure 2-2**). Cameras were baited with assorted-flavoured cat food to specifically attract secretive, nocturnal, carnivorous mammals. When a camera did not record significant animal activity it was moved to a new location. Each camera location is described in **Table 2-1** and mapped in **Figure 2-7.**

1-NSS2 1-NSS2b

1-NSS4 2-HC01

2-HC03 2-MC1

**Figure 2-2 Examples of camera-trapping locations**

**Table 2-1 Camera-trapping locations**

| CAMERA | CO-ORDINATES* | DATES | LOCATION DESCRIPTION |
|---|---|---|---|
| 1-NSS1 | 27°13'30.90"S 30°18'25.63"E | 26-27/03/2012 | Burrow in grassland |
| 1-NSS1b | 27°14'5.14"S 30°18'26.16"E | 27-29/03/2012 | Stream in grassland |
| 1-NSS2 | 27°13'34.96"S 30°18'12.96"E | 26-27/03/2012 | Burrow in grassland |
| 1-NSS2b | 27°14'7.13"S 30°18'23.78"E | 27-29/03/2012 | Animal path & stream in grassland |
| 1-NSS3 | 27°13'2.01"S 30°17'23.06"E | 26-29/03/2012 | Animal path in savanna |
| 1-NSS4 | 27°12'59.61"S 30°17'29.92"E | 26-29/03/2012 | Animal path in savanna |
| 2-HC01 | 27°13'16.80"S 30°17'34.84"E | 14-18/01/2013 | Animal path & stream in savanna |
| 2-HC02 | 27°13'47.78"S 30°16'55.85"E | 14-18/01/2013 | Stream in grassland |
| 2-HC03 | 27°13'47.37"S 30°18'31.50"E | 14-18/01/2013 | Stream in grassland |
| 2-HC04 | 27°13'3.02"S 30°17'28.85"E | 14-18/01/2013 | Animal path & stream in savanna |

| CAMERA | CO-ORDINATES* | DATES | LOCATION DESCRIPTION |
|---|---|---|---|
| 2-MC1 | 27°13'5.10"S 30°17'31.45"E | 14-18/01/2013 | Animal path in savanna |
| 2-MC2 | 27°12'58.01"S 30°17'30.85"E | 14-15/01/2013 | Animal path & stream in savanna |
| 2-MC2b | 27°13'26.26"S 30°18'51.05"E | 15-18/01/2013 | Alien bushclump |
| 2-NSS1 | 27°13'2.86"S 30°19'3.14"E | 15-18/01/2013 | Alien bushclump |
| 2-NSS2 | 27°13'44.33"S 30°18'37.33"E | 15-18/01/2013 | Alien bushclump |
| 2-NSS3 | 27°13'5.56"S 30°19'5.95"E | 15-18/01/2013 | Stream in grassland |
| 2-NSS4 | 27°14'5.16"S 30°18'26.25"E | 15-18/01/2013 | Stream in grassland |
| 3-HC01 | 27°13'22.36"S 30°18'36.88"E | 15-17/07/2013 | Alien bushclump |

*Datum: WGS 84

***Live-trapping***

Eight live-trapping sites were installed in the study area in representative habitats including: high altitude, moist grassland; high altitude, dry grassland; low altitude, moist grassland; and savanna.

At each trap site an array trap (Campbell & Christman, 1982) was used to sample herpeto-fauna (reptiles and amphibians) and invertebrates. A schematic layout of an array trap is presented in **Figure 2-3**. An array trap consisted of three arms of plastic drift fencing (30 cm high and 8 m long). Pitfall traps (5 litre buckets sunken to ground level) were placed at the centre of the array and at the end of each drift fence. Each pitfall trap was provisioned with a stone, wet cotton wool and a raised, wooden cover board to provide shelter, moisture and shade for trapped animals. A plastic, mesh funnel trap was placed on either side of each drift fence and covered with a wooden board for shade (**Figure 2-4**). Photographs of the array trap at each trap site are shown in **Figure 2-5**.

In addition, a series of nine pairs of metal mammal traps spaced at approximately 2-4m intervals was placed to live-capture rodents in the vicinity of each array trap. Each series included one pair of multi-entry traps and eight pairs of Sherman traps (**Figure 2-4**), which were baited daily, if necessary, with peanut butter, rolled oats, raisins, sunflower oil and seeds. Each mammal trap was supplied with cotton wool and a wooden cover board to provide warmth and shade for trapped animals.

NSS surveys in a diversity of habitats have revealed that the pitfall traps are most effective at trapping small lizards, frogs, spiders, scorpions and ground-dwelling insects. The plastic mesh funnel traps are effective at trapping snakes, lizards, frogs, scorpions, solifuges (sun spiders), large beetles and millipedes. The Sherman traps are most effective at trapping small mice and shrews. Rodents are sometimes caught in the funnel traps but they often escape by chewing their way out.

Each live-trapping site was operated for five days and four nights, and checked once or twice daily (**Figure 2-5**). The location of each trap site is described in **Table 2-2** and mapped in **Figure 2-7**.

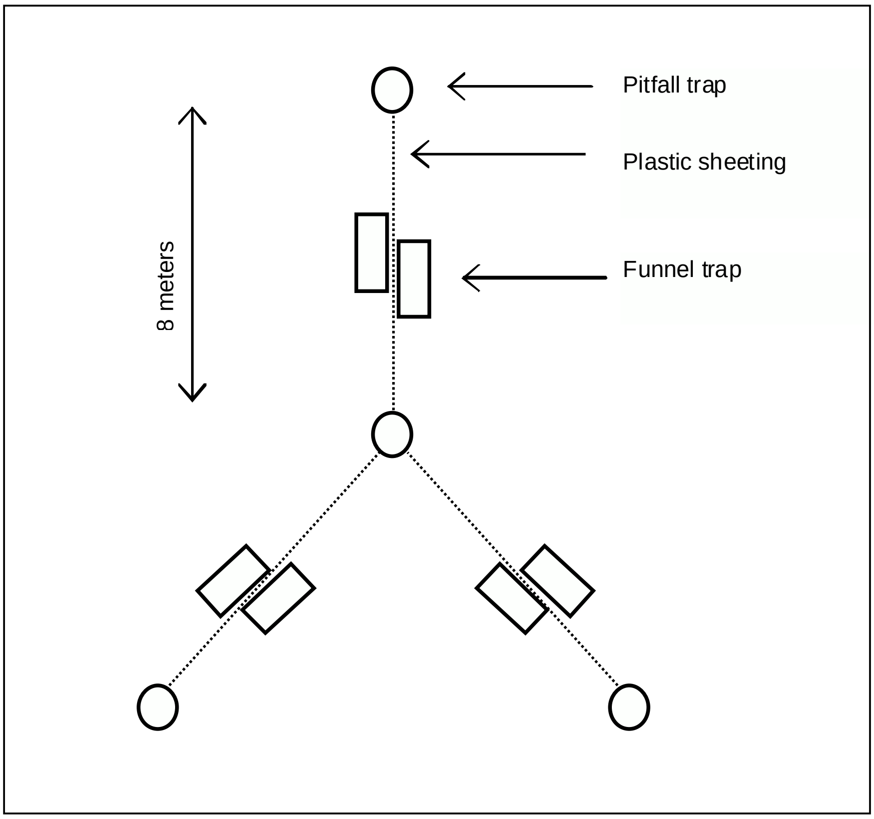



**Figure 2-3 Schematic layout of an array trap including drift fences, pitfall and funnel traps**

Pitfall trap

Funnel trap

Sherman trap

**Figure 2-4 Components of a live-trapping site**

Trap site 1-1 in high, moist grassland

Trap site 1-4 in savanna

Trap site 2-3 in low, moist grassland

Trap site 2-4 in high, dry grassland

**Figure 2-5 Examples of live-trapping sites**

**Table 2-2 Live-trapping locations**

| TRAP SITE | CO-ORDINATES* | LOCATION DESCRIPTION |
|---|---|---|
| 1-1 | 27°13'32.08"S 30°18'22.61"E | High, moist grassland |
| 1-2 | 27°13'41.60"S 30°17'59.06"E | High, dry grassland |
| 1-3 | 27°13'53.64"S 30°16'51.57"E | Low, moist grassland |
| 1-4 | 27°13'2.57"S 30°17'24.15"E | Savanna |
| 2-1 | 27°13'47.11"S 30°18'31.20"E | High, moist grassland |
| 2-2 | 27°13'3.27"S 30°17'29.10"E | Savanna |
| 2-3 | 27°13'44.65"S 30°16'53.99"E | Low, moist grassland |
| 2-4 | 27°13'3.41"S 30°18'54.96"E | High, dry grassland |

*Datum: WGS 84

***Mist-netting and acoustic surveys for bats***

Several old mine adits/shafts in the AYCP study area, which were likely to provide shelter for bats and other animals, were investigated by day on foot using torches. Mist-netting, harp-trapping and an ultra-sonic Echo Meter 3 (EM3) detector (Wildlife Acoustics, Inc., USA) were used to sample bats at selected adits by night (**Figure 2-6)**. Mist-netting and acoustic surveys were performed on 15 and 16 January 2013. Harp-trapping and acoustic surveys were performed on 13 April 2013.

Trapped bats were identified to species level based on photographs of their head, fur, and wings, measurements of their body mass and forearm length, and recordings of calls made during their sampling and/or release.

Wildlife Acoustics Compressed (.wac) files of bat calls recorded by the EM3 detector were converted to wave (.wav) and zero crossing (.zc) files using the WAC2WAV and Kaleidoscope programmes (Wildlife Acoustics Inc., USA). The converted data were subsequently processed using the BatSound Pro (Pettersson Elektronik, Sweden) programme to identify bat taxa from detailed examination of the peak frequency, duration and band width of calls.

## 2.3. Data Analysis

Records of detected faunal species were assigned to seven major habitat types including:

- Adits (AD) or shafts from previous mining in the area;
- Alien (AL) Bushclumps;
- Dry Grassland (DG);
- Scarp Forest (SF);
- Savanna (SV);
- Rocky Grassland (RG); and
- Wetlands (WT).

This enabled rough comparisons of faunal (i.e. terrestrial vertebrate and butterfly) diversity between different habitats in the AYCP underground mining area.

## 2.4. Study Limitations

- Survey work was limited to the original and current proposed underground mining areas, and was not performed in remaining parts of the AYCP lease area.
- NO survey work was performed for roads, pipelines, power lines, conveyer systems or any other infrastructure or listed activity (e.g. water extraction) beyond the boundaries of the current proposed underground mining area.
- The second site visit for faunal survey work was planned for early summer after the study area had received significant rain (i.e. November 2012). Unfortunately, due to delayed finalization of the current surface infrastructure layout the survey was delayed to January 2013 (mid-summer).

- Accumulatively less than three weeks were spent surveying fauna in the current proposed underground mining area.
- Some species, which are uncommon, migratory, inconspicuous, secretive or otherwise difficult to detect may not have been detected even though they were potentially present on site.

Exploring different adits


Mist net Harp trap Measuring a bat

**Figure 2-6 Investigating adits and sampling bats in the study are**

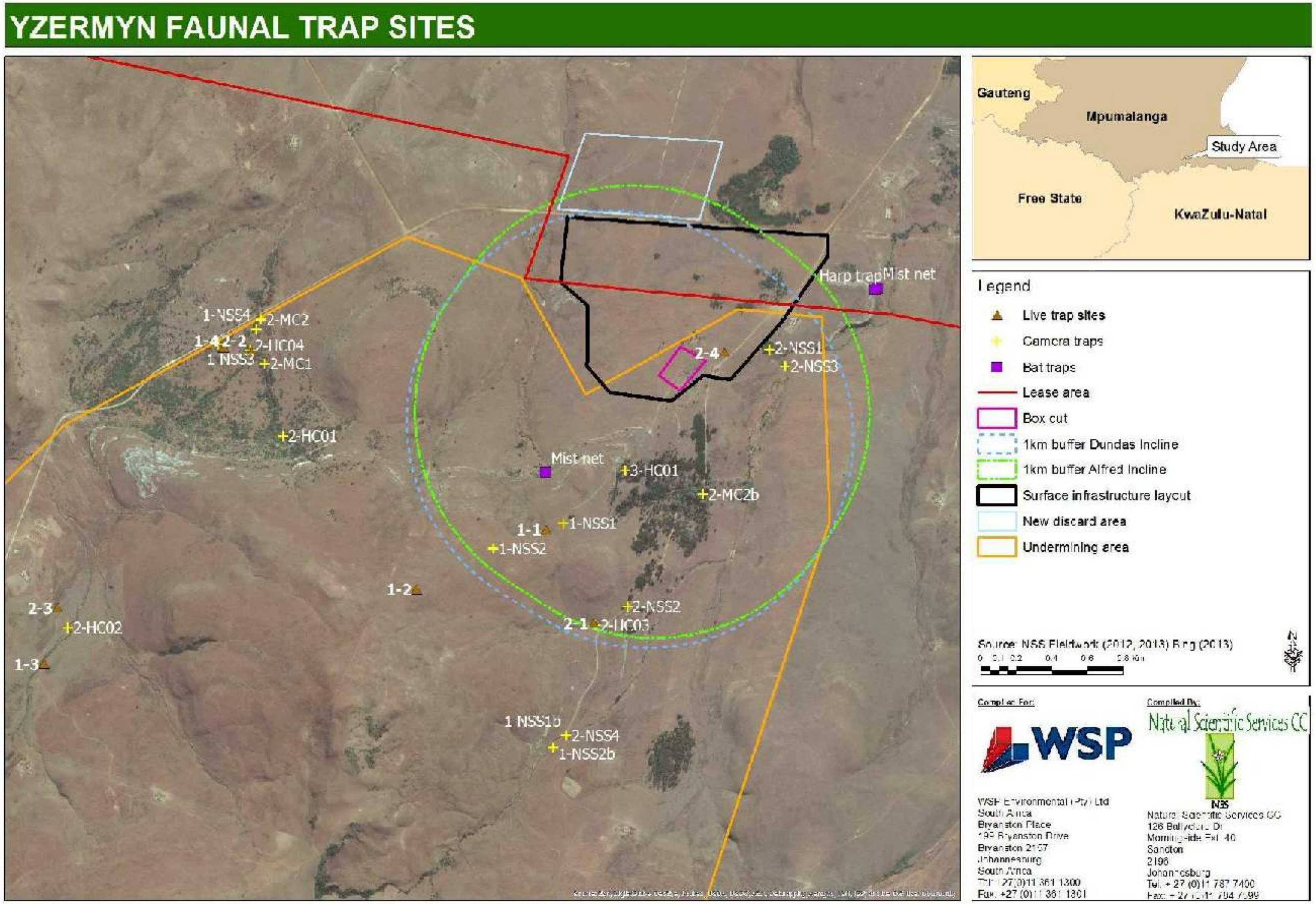



**Figure 2-7** Faunal trapping localities in the study area

# 3. Results

Presented in **Table 3-1** is a summary for the QDSs 2730AA, AB, AC and AD wherein the AYCP is situated, of the total numbers of potentially occurring and observed species belonging to different faunal taxonomic groups. The appended faunal species lists indicate, more specifically, the LoO of each mammal, bird, reptile, frog and butterfly species within the AYCP lease area, and the habitat types wherein detected species were found. Conservation Important (CI) faunal species are discussed further on in this report **Section C**. Although the surface infrastructure is only 5% of the proposed target mining area, the LoO of fauna was assessed at a QDS level because the proposed underground mining could potentially affect faunal habitat and populations beyond the lease boundaries due to impacts associated with the de-watering activities (**Section G**).

**Table 3-1 Summary of faunal diversity in the study area**

| | SPECIES RICHNESS | | |
|---|---|---|---|
| **FAUNAL GROUP** | **POTENTIAL** | **OBSERVED** | **PROPORTION (%)** |
| Mammals | 108 | 27 | 25 |
| Birds | 195 | 104 | 53 |
| Reptiles | 68 | 17 | 25 |
| Frogs | 29 | 10 | 34 |
| Butterflies | 151 | 23 | 15 |

Approximately half of all potentially occurring bird species, one third of potentially occurring frog species, and a quarter of all potentially occurring mammal and reptile species was observed by NSS and DEC in the study area. Only 15% of potentially occurring butterfly species were observed. Although it appears that many faunal species were not detected during field surveys, the lists of potentially occurring species apply to the four QDSs or nine pentads wherein the AYCP is situated. Certain habitats that occur in the larger study region may not be present on site, and for this and other reasons (e.g. human persecution), actual numbers of faunal species in the AYCP lease area are likely to be lower than the numbers of potentially occurring taxa shown in **Table 3-1**.

## 3.1. Mammals

The complete list of potentially occurring and observed mammal species for the study area is provided in **Appendix 1**. Of 81 potentially occurring mammal species that were not detected, 43 are highly likely to occur on site. The remaining species have a moderate to low LoO given their marginal distributions, specific habitat requirements and/or extirpation by humans (Friedmann & Daly, 2004).

Numbers of potentially occurring and observed species per mammalian order are summarised in **Table 3-2** using Stuart & Stuart's (1998) classification. Within the AYCP lease area 27 mammal species were detected, which represents 25% of 108 potentially occurring species. Examples of detected mammal species on site are shown in **Figure 3-1**.

**Table 3-2 Mammal diversity in the study area**

| ORDER & COMMON NAMES | SPECIES RICHNESS POTENTIAL | SPECIES RICHNESS OBSERVED | PROPORTION (%) |
|---|---|---|---|
| MACROSCELIDEA (Elephant-shrews) | 1 | 0 | 0 |
| TUBILIDENTATA (Aardvark) | 1 | 1 | 100 |
| HYRACOIDEA (Dassies) | 1 | 1 | 100 |
| LAGOMORPHA (Hares & rabbits) | 4 | 1 | 25 |
| RODENTIA (Rodents) | 24 | 4 | 17 |
| PRIMATES (Bushbabies, monkeys & baboon) | 3 | 0 | 0 |
| INSECTOVORA (Insectivores) | 14 | 2 | 14 |
| CHIROPTERA (Bats) | 17 | 7 | 41 |
| PHOLIDOTA (Pangolin) | 1 | 0 | 0 |
| CARNIVORA (Carnivores) | 24 | 6 | 25 |
| PERISSODACTYLA (Odd-toed ungulates) | 1 | 0 | 0 |
| ARTIODACTYLA (Even-toed ungulates) | 17 | 4 | 24 |
| **TOTAL** | **108** | **27** | **25** |

**Sources :** Stuart & Stuart (1998); Friedmann & Daly (2004); Monadjem *et al.* (2010)

Mammal species that are highly likely to occur in the study area, but which were not observed during field surveys, are mainly those that are secretive (e.g. small carnivores), nocturnal (e.g. bats) and inconspicuous (e.g. shrews, rats and mice). Additional camera-trapping could have increased the probability of recording more carnivore species, while live-trapping for longer periods and at more localities could have increased the probability of recording more rodents, insectivores and other small, terrestrial mammal species (spp.).

**Appendix 1** shows that Wetlands supported the highest number (8 spp.) of mammals, followed by Rocky Grasslands (7 spp.) and Dry Grasslands (7 spp.). Alien Bushclumps yielded the lowest mammal diversity (4 spp.). Mammal species characteristic of Wetlands included the African Clawless Otter (*Aonyx capensis*), Marsh Mongoose (*Atilax paludinosus*), Near Threatened Serval (*Leptailurus serval*), Pygmy Mouse (*Mus minutoides*), Reddish-grey Musk Shrew (*Crocidura cyanea*) and Swamp Musk Shrew (*Crocidura mariquensis*). Rocky Grasslands supported small herds of Mountain Reedbuck (*Redunca fulvorufula*) and in Dry Grasslands Aardvark (*Orycteropus afer*) burrows were most common. Populations of Rock Dassie (*Procavia capensis*) occurred on sandstone cliffs, and camera-trapping revealed a healthy breeding population of Bushpigs (*Potamochoerus larvatus*) in Scarp Forest.

Large-spotted Genet
(*Genetta tigrina*)

Aardvark
(*Orycteropus afer*)

Serval
(*Leptailurus Serval*)

African Clawless Otter
(*Aonyx capensis*)

Common Duiker
(*Sylvicapra grimmia*)

Bushpig
(*Potamochoerus larvatus*)

Reddish-grey Musk Shrew
(*Crocidura cyanea*)


Yellow Mongoose
(Cynictis penicillata)

Pygmy Mouse
(*Mus minutoides*)

**Figure 3-1 Examples of mammal species identified in the study area**

Visual observations, trapping and acoustic monitoring with an EM3 detector revealed the presence of seven bat species in the current proposed surface infrastructure area. Mist-netting and harp-trapping at the entrances of several disused horizontal mine shafts or adits resulted in the live-capture of Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*), Swinny's Horseshoe Bat (*Rhinolophus swinnyi*), Temminck's Hairy Bat (*Myotis tricolor*) and the Natal Clinging (or Long-fingered) Bat (*Miniopterus natalensis*). All of these bat species are Conservation Important and are discussed further on in greater detail. Examples of live-captured bats and their recorded calls are shown, respectively, in **Figure 3-2** and **Appendix 2**. Analysis of bat calls recorded on the EM3 detector at the mist-netting locations also revealed the presence of the Cape Serotine Bat (*Neoromicia capensis*), Egyptian Free-tailed Bat (*Tadarida aegyptiaca*) and Rusty Pipistrelle (*Pipistrellus rusticus*).

Swinny's Horseshoe Bat (*Rhinolophus swinnyi*) | Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*) | Temminck's Hairy Bat (*Myotis tricolor*) | Natal Clinging Bat (*Miniopterus natalensis*)

**Figure 3-2 Examples of bat species captured in the study area**

## 3.2. Birds

Data from the SABAP 2 indicated that 195 bird species have been previously recorded during surveys in the nine pentads wherein the AYCP is situated. Of these 195 species, 104 species (53%) were detected by DEC and NSS in the study area.

Local habitats support a wide spectrum of bird species including wetland, grassland, savanna, forest and rupicolous species (**Figure 3-3**). The Vulnerable African Grass-owl (*Tyto capensis*) was detected in Wetland habitat, and the Vulnerable White-bellied Korhaan (*Eupodotis senegalensis*), Near Threatened Black-bellied Bustard (*Lissotis melanogaster*), Near Threatened Secretarybird and endemic Pied Starling (*Spreo bicolor*) were encountered in Dry Grassland. Hillslope Rocky Grasslands supported rupicolous species such as Mountain Wheatear (*Oenanthe monticola*) and Buff-streaked Chat (*Oenanthe bifasciata*). A wealth of bird species was found in the Savanna and Scarp Forest habitat including the Near Threatened Bush Blackcap (*Lioptilus nigricapillus*).

Bush Blackcap (*Lioptilus nigricapillus*) | Secretarybird (*Sagittarius serpentarius*) | African Grass-owl (*Tyto capensis*) nest

**Figure 3-3 Evidence of bird species in the study area**

The relative abundance of bird species, which were classified according to a modified version of Newman's (2002) 12 bird categories (**Table 3-3**), is shown in **Figure 3-4**. The data provide a comparison of all bird species observed by DEC and NSS during field surveys in the study area, with all bird species recorded in local pentads by other observers for the SABAP 2.

Similar percentages of birds in different categories were observed by DEC and NSS in the AYCP study area, compared with that observed during surveys in the greater study region for the SABAP 2 with one main exception. Considerably smaller percentages of ducks and waders, and inland water birds (categories 2 and 3) were observed by DEC and NSS in the AYCP study area. This was because the SABAP 2 data included records of various water bird species at the nearby Heyshope Dam (pentad 2705_3020).

**Table 3-3 Newman's (2002) modified bird categories**

| CATEGORY | DESCRIPTION |
|---|---|
| 1. Ocean birds | Albatrosses, gannets/boobies, gulls, penguins, petrels, prions, shearwaters, skimmer, skuas, subAntartctic birds, terns, & tropic-/frigatebirds. |
| 2. Inland water birds | Pelicans, cormorants, herons, egrets, storks, hamerkop, flamingos, spoonbill, ibises & finfoot. |
| 3. Ducks & wading birds | Ducks, geese, grebes, coot, gallinules, crakes, flufftails, snipes, plovers, lapwings, waders, jacanas, oystercatchers, curlews, avocet & stilts. |
| 4. Large terrestrial birds | Thicknees, pratincoles, coursers, korhaans, bustards, cranes, quail, francolins, spurfowl, buttonquail, guineafowl, ostrich & secretarybird. |
| 5. Raptors | Vultures, kites, eagles, buzzards, sparrowhawks, hawks, harriers, falcons |

| CATEGORY | DESCRIPTION |
|---|---|
| | & kestrels. |
| 6. Sandgrouse, doves, etc | Sandgrouse, doves, pigeons, parrots, lovebirds, trogon, turacos & go-away birds (louries), cuckoos & coucals. |
| 7. Owls & nightjars | Owls & nightjars. |
| 8. Aerial feeders, etc | Swallows, martins, swifts, mousebirds, bee-eaters, kingfishers, rollers, hoopoes, hornbills, barbets, woodpeckers, wryneck & honeyguides. |
| 9. Cryptic & elusive insect-eaters | Larks, finchlarks, pipits, wagtails, drongos, black flycatcher, cuckooshrikes, crows, orioles, bulbuls, tits, babblers, thrushes, chats & robins. |
| 10. Regular insect-eaters | Warblers, apalises, titbabblers, eremomelas, carmoropteras, grassbird, cisticolas, prinias, flycatchers, batises, shrikes, boubous, tchagras, helmetshrikes & starlings. |
| 11. Oxpeckers & nectar feeders | Sunbirds, oxpeckers, white-eyes & queleas. |
| 12. Seedeaters | Sparrows, weavers, widow birds, bishops, finches, firefinches, waxbills, manikins, whydahs, canaries, siskins & buntings. |

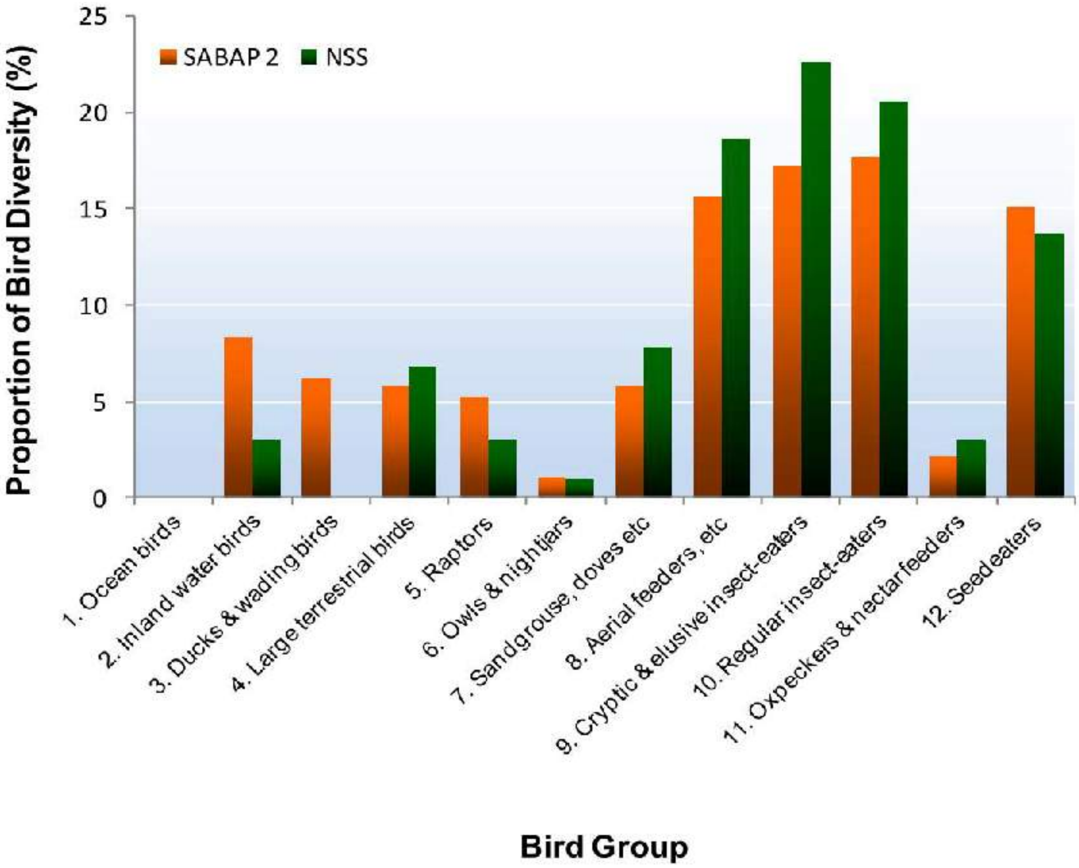



**Figure 3-4 Percentage of bird species with different feeding habits (modified from Newman, 2002), observed in the AYCP study area by DEC and NSS, or in the region during the SABAP 2.**

## 3.3. Reptiles

The complete list of 68 potentially occurring reptile species for the study area is provided in **Appendix 4**. Of the 68 species, 47 have a high LoO, 15 species have a moderate LoO, and six species are considered unlikely to occur in the study area based on their marginal distribution and/or lack of suitable habitat. Seventeen reptile species were detected on site by NSS through active searching and live-trapping. Examples of specimens are shown in **Figure 3-5**. Numbers of potentially occurring and observed species in different reptile families are summarised in **Table 3-4** using Branch's (1998) classification.

**Table 3-4 Reptile diversity in the study area**

| FAMILY & COMMON NAMES | SPECIES RICHNESS | | PROPORTION (%) |
|---|---|---|---|
| | POTENTIAL | OBSERVED | |
| TYPHLOPIDAE (Blind snakes) | 1 | 1 | 100 |
| LEPTOTYPHLOPIDAE (Thread snakes) | 1 | 1 | 100 |
| ATRACTASPIDIDAE (Burrowing snakes) | 4 | 1 | 25 |
| COLUBRIDAE (Typical snakes) | 24 | 5 | 21 |
| ELAPIDAE (Mambas, cobras & relatives) | 4 | 0 | 0 |
| VIPERIDAE (Adders & vipers) | 2 | 1 | 50 |
| AGAMIDAE (Agamas) | 3 | 1 | 33 |
| CHAMAELEONIDAE (Chameleons) | 1 | 1 | 100 |
| VARANIDAE (Monitors) | 2 | 0 | 0 |
| LACERTIDAE (Lacertids) | 3 | 0 | 0 |
| SCINCIDAE (Skinks) | 9 | 2 | 22 |
| CORDYLIDAE (Girdled lizards & grass lizards) | 2 | 1 | 50 |
| GERRHOSAURIDAE (Plated lizards) | 5 | 2 | 40 |
| GEKKONIDAE (Geckos) | 5 | 1 | 20 |
| PELOMEDUSIDAE (Terrapins) | 1 | 0 | 0 |
| TESTUDINIDAE (Tortoises) | 1 | 0 | 0 |
| **TOTAL** | **68** | **17** | **25** |

**Sources:** Branch (1998); SARCA website (2010)

The most reptile species (10 spp.) were found in Rocky Grassland, followed by Dry Grassland (5 spp.) and Savanna (4 spp.). Rocky Grasslands provided suitable habitat for rupicolous species such as Spotted Rock Snake (*Lamprophis guttatus*), Southern Rock Agama (*Agama atra*) and Transvaal Girdled Lizard (*Cordylus vittifer*), among others. Spotted Rock Snake, in particular, is highly dependent on rocky habitats where it shelters in cracks between large, exfoliating rocks (Alexander & Marais, 2009). The gentle-sloping Dry and Rocky Grasslands provided ideal habitat for the South African endemic subspecies of Cape Grass Lizard (*Chamaesaura anguina anguina*). During our summer surveys this grassland specialist was frequently observed in undisturbed rocky areas near wetlands.

Common Night Adder
(*Causus rhombeatus*)

Rhombic Egg-eater
(*Dasypeltis scabra*)

Brown House Snake
(*Lamprophis capensis*)

Spotted Rock Snake
(*Lamprophis guttatus*)

Cape Centipede-eater
(*Aparallactus capensis*)

Peter's Thread Snake
(Leptotyphlops scutifrons conjunctus)

Cape Grass Lizard
(*Chamaesaura anguina*)

Yellow-throated Plated Lizard
(*Gerrhosaurus flavigularis*)

Flap-necked Chameleon
(*Chamaeleo dilepis*)

**Figure 3-5 Examples of reptile species encountered in the study area**

Two reptile species that NSS detected in the study area have not yet been recorded in local QDSs. These included Common Night Adder (*Causus rhombeatus*), which was caught in a funnel trap in Dry Grassland, and Southern Rock Agama (*Agama atra*), which was frequently observed in rocky areas.

### 3.4. Frogs

The complete list of frog species for the study area is provided in **Appendix 5**. Of 23 potentially occurring frog species, 19 species have a high LoO, four have a moderate LoO, and six species species are unlikely to occur due to their marginal distribution ranges and/or lack of suitable habitat on site. Of the 23 potentially occurring frog species, 10 species (34%) were recorded on site by NSS. Examples of specimens are shown in **Figure 3-6**. A summary of the numbers of potentially occurring and observed species in different frog families is given in **Table 3-5**.

Raucous Toad
(*Amietophrynus rangeri*)

Common Platanna
(*Xenopus laevis*)

Common River Frog
(*Amieta angolensis*)

Natal Sand Frog
(*Tomopterna natalensis*)

Bronze Caco
(*Cacosternum nanum*)

Eastern Olive Toad
(*Amietophrynus garmani*)

**Figure 3-6 Examples of frog species encountered in the study area**

**Table 3-5 Frog diversity in the study area**

| FAMILY & COMMON NAMES | SPECIES RICHNESS | | PROPORTION (%) |
|---|---|---|---|
| | POTENTIAL | OBSERVED | |
| BREVICIPITIDAE (Rain frogs) | 2 | 0 | 0 |
| BUFONIDAE (Toads) | 6 | 3 | 50 |
| HELEOPHRYNIDAE (Ghost frogs & Cascade Frog) | 1 | 0 | 0 |
| HEMISOTIDAE (Shovel-nosed frogs) | 1 | 0 | 0 |
| HYPEROLIIDAE (Kassinas, Rattling Frog & reed frogs) | 3 | 0 | 0 |
| PHRYNOBATRACHIDAE (Puddle frogs) | 2 | 0 | 0 |
| PTYCHADENIDAE (Grass & Ornate frogs) | 2 | 1 | 50 |
| PIPIDAE (Platannas) | 1 | 1 | 100 |
| PYXICEPHALIDAE (African common frogs) | 11 | 5 | 45 |
| **TOTAL** | **29** | **10** | **34** |

**Sources:** Minter *et al.* (2004); Du Preez & Carruthers (2009)

The greatest diversity (6 spp.) of frogs was recorded in Wetlands (6 spp.) but a high diversity (5 spp.) of frogs was also recorded in surrounding Dry Grasslands. This revealed the importance of non-aquatic habitat for foraging, overwintering and dispersal between wetlands of frogs, especially those species that breed in seasonal or ephemeral water, or on land. More frog species may have been detected had surveys been performed in early summer after rain.

## 3.5. Butterflies & Other Terrestrial Macro-invertebrates

The complete list of 151 butterfly species for the study area is provided in **Appendix 6**. Of the 151 species, 89 have a high LoO and 53 have a moderate LoO. Numbers of potentially occurring and observed species per butterfly subfamily are summarised in **Table 3-6** using Migdoll's (1994) classification. Twenty-three (15%) of the 151 potentially occurring species were recorded by NSS in the AYCP study area. Examples of specimens are shown in **Figure 3-7**.

Wetlands and Dry Grasslands supported a variety of butterfly species including the conspicuous Gaudy Commodor (*Precis octavia sesamus*), which was frequently seen near streams and seeps in summer. Rocky Grassland and hilltops were characterized by species such as Wichgraf's Brown (*Stygionympha wichgrafi wichgrafi*), the Rainforest Brown (*Cassionympha cassius*), and Common Black-eye (*Leptomyrina gorgias gorgias*). In Savanna areas the Black Heart (*Uranothauma nubifer nubifer*), White Pie (*Tuxentius calice calice*), Babaults Blue (*Leptotes babulti*), Long-tailed Blue (*Lampides boeticus*), Dotted Blue (*Tarucus sybaris sybaris*) and Common Meadow Blue (*Cupidopsis cissus cissus*) were common. Several subfamilies (e.g. LYCAENIDAE, SATYRINAE, HESPERIINAE and PYRGINAE) were undersampled due, in part, to the small size, inconspicuous colouration (e.g. and) and/or the fast and/or erratic flight of species in these taxa. Baited live-trapping and sweep-netting during different times of the year and at more localities could have increased the number of butterfly species recorded on site.

**Table 3-6 Butterfly diversity in the study area**

| SUBFAMILY & COMMON NAMES | SPECIES RICHNESS | | PROPORTION (%) |
|---|---|---|---|
| | POTENTIAL | OBSERVED | |
| DANAINAE (Monarchs) | 1 | 1 | 100 |
| SATYRINAE (Browns, widows & ringlets) | 13 | 2 | 15 |
| PORITIINAE (Zulus, buffs, rocksitters) | 2 | 0 | 0 |
| HELICONIINAE (Acraeas) | 10 | 2 | 20 |
| BIBLIDINAE ( Nymphs, jokers & pipers) | 13 | 0 | 0 |
| NYMPHALINAE (Diadems, commodores, pansies & admirals) | 11 | 6 | 55 |
| MILETINAE (Woolly legs & skollys) | 2 | 0 | 0 |
| LYCAENINAE (Saphires, playboys, coppers, opals, hairtails & blues) | 62 | 8 | 13 |
| PIERINAE (Vagrants, orange tips, whites & borders) | 7 | 1 | 14 |
| COLIADINAE (Yellows & migrants) | 5 | 0 | 0 |
| PAPILIONINAE (Swallowtails & swordtails) | 4 | 1 | 25 |
| COELIADINAE (Policemen) | 2 | 0 | 0 |
| PYRGINAE (Flats, skippers, elfins & sandmen) | 10 | 2 | 20 |
| HETEROPTERINAE (Sylphs) | 3 | 0 | 0 |
| HESPERIINAE (Rangers, darts, hoppers & swifts) | 7 | 0 | 0 |
| **TOTAL** | **152** | **23** | **15** |

**Sources:** Migdoll (1994); Henning *et al.* (2009); SABCA website (2010)

Apart for butterflies there is currently limited information on the geographic ranges and conservation status of other terrestrial macro-invertebrates. Moreover, comprehensive sampling and accurate identification of insects, arachnids, crustaceans, molluscs and other terrestrial macro-invertebrates taxa would require considerable sampling effort, time, specialist expertise and funding. The AYCP faunal assessment, therefore, involved opportunistic sampling of conspicuous terrestrial macro-invertebrates. Identified taxa are listed in **Appendix 7**, and examples of specimens are shown in **Figure 3-7.**

Apart from butterflies the most frequently encountered macro-invertebrates belonged to the insect orders Orthoptera (crickets, locusts and grasshopers) and Coleoptera (beetles). In summer, fruit chafer beetles were common on fruiting trees such as the Blue Bush (*Diospyros lycioides*).

Two scorpion species, *Chelectonus jonesii* and *Uroplectes olivaceus* (**Figure 3-7**), were frequently revealed with rock-turning. The former species (which represents a monotypic genus within Southern Africa) is large, docile and not threatening (i.e. venomous) to humans. The latter species, in contrast, is quick-moving and responsible for a high number of human stings, although the venom is not considered life-threatening (Leeming, 2003).

Black Heart
(*Uranothauma nubifer nubifer*)

Babaults Blue
(*Leptotes babulti*)

Common Hottentot Skipper
(*Gegenes niso niso*)

Green Milkweed Locust
(*Phymateus viridpes*)

Zig-zag Fruit Chafer
(*Anisorrhina flavomaculata*)

Damselfly
(*Ischnura senegalensis*)

Scorpion
(*Chelectonus jonesii*)

Crab spider (*Runcinia* sp.) & Brown-veined White (*Belenois aurota aurota*)

Scorpion
(*Uroplectes olivaceus*)

**Figure 3-7 Examples of terrestrial macro-invertebrates in the study area**

# 4. Conservation Important Species

The IUCN (2012) Red List criteria and catgories, shown in **Figure 4-1,** were developed to provide a simple and effective system for rating the conservation status of species, mainly at global and regional levels. In South Africa, as in many other countries, the IUCN Red List criteria and categories have been adapted for evaluating the conservation status of species at national and provincial levels.

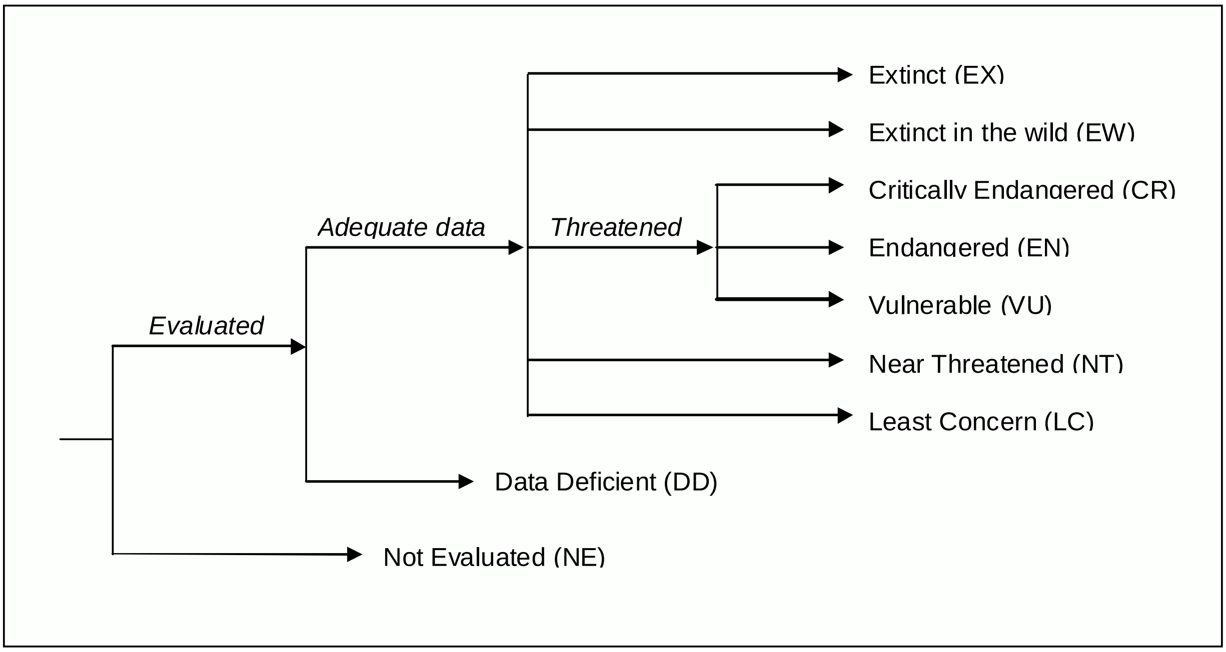



**Figure 4-1 IUCN Red List categories**

South African faunal atlases and Red Data books for mammals, birds, frogs and butterflies have been published, respectively, by Friedmann & Daly (2004), Barnes (2000), Minter *et al*. (2004) and Henning *et al.* (2009). The South African Red Data book for birds is currently being revised, and an update is expected soon. The Southern African Reptile Conservation Assessment (SARCA) is pending publication and, therefore, in this study, for reptiles the global IUCN conservation status is used.

A legally-binding national list of Threatened or Protected Species (ToPS) is provided in the NEM:BA (2007), and provincial-specific lists of Conservation Important (CI) species have been compiled in some provinces, e.g. Mpumalanga. As there is often spatio-temporal variation in human disturbances, the conservation status of some species differs between the IUCN global/regional, national and provincial Red Listings. Unless otherwise stated, the national Red Data status of a species is used by default.

The locations of detected CI faunal species in the AYCP study area are shown in **Figure 4-3**, and local farms with records of CI faunal species, which were supplied by the MTPA (pers. comm. 2013), are shown in **Figure 4-3**. Twelve CI animal species were found in, or adjacent to the proposed surface infrastructure area.

## 4.1. Mammals

A staggering 38 CI mammal species potentially occur in the study area (**Table 4-1**). Of these, 21 species have been recorded in the QDS's wherein the AYCP is situated (Friedmann & Daly, 2004; MTPA pers comm. 2013). NSS detected eight CI mammal species in the AYCP study area, including one Endangered, five Near Threatened and two Data Deficient species, discussed next. Seven of the 10 CI mammal species were recorded in, or adjacent to the proposed surface infrastructure area.

**Swinny's Horseshoe Bat (*Rhinolophus swinnyi*) – Endangered**

Calls of this species were recorded and a specimen was caught on 15 January 2013 outside an old mine adit approximately 1.24km north-east of the proposed Alfred decline, and 315-335m outside the proposed surface infrastructure layout, and 180-300m outside the proposed underground mining area. This small horseshoe bat is sparsely distributed across south-eastern Africa, and is considered near-endemic to Southern Africa (Csorba *et al*. 2003) and rare by Monadjem *et al*. (2010). Like most *Rhinolophus* bats, Swinny's Horseshoe Bat roosts in caves and other subterranean habitats such as abandoned mine adits (Friedmann & Daly, 2004). Individuals roost alone or in groups of <5 individuals. In the southern parts of its range this bat frequents temperate Afro-montane forest (Monadjem *et al*. 2001) and, therefore, may utilize Scarp Forest in the study area for foraging. The availability of suitable subterranean roost sites is considered to be more limiting to the distribution of this species than vegetation type (Monadjem *et al*. 2010). Therefore, destruction or disturbance of roosts poses the most significant threat to this species, followed by loss of foraging habitat (IUCN 2013).

**Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*) – Near Threatened**

Over 290 individuals of this species were counted during visual observations in six old mine adits within the study area. The vast majority of this population (>200 individuals.) was found to be roosting in the same large adit where Swinny's Horseshoe Bat was detected, i.e. approximately 1.24km north-east of the proposed Alfred decline. Geoffroy's Horseshoe Bat is signficantly larger than Swinny's Horseshoe Bat but also roosts in caves and old mine adits, where hundreds or thousands of individuals may congregate Monadjem *et al*. (2010). Although this species occurs in large numbers over a wide area including much of South Africa, it is potentially threatened because of its tendency to roost in very large numbers in limited sites. Destruction or disturbance of such roosts would have a considerable impact on this species.

**Natal Clinging (Long-fingered) Bat (*Miniopterus natalensis*) – Near Threatened**

Several individuals of this species were found roosting in the large adit where Swinny's Horseshoe Bat was detected. Like the afore-mentioned species, the Natal Clinging Bat is widely distributed in southern Africa (excluding the Kalahari), and is highly dependant on caves and old mine shafts, where hundreds or thousands of individuals may congregate. Adults migrate between summer maternity roosts and winter hibernacular (situated in cooler, higher altitude regions (Monadjem *et al*. 2010). Like Geoffroy's Horseshoe Bat, the Natal Clinging Bat is potentially threatened because of its tendency to roost in very large numbers in limited sites. The destruction or disturbance of summer or winter roosts has the potential to cause significant population declines in this species.

**Temminck's Hairy Bat (*Myotis tricolor*) – Near Threatened**

Temminck's Hairy Bat inhabits montainous areas in eastern sub-Saharan Africa where colonies of up to 1500 individuals may roost in suitable subterranean habitats such as caves and old mine shafts. Groups of up to 5 individuals of this species were found in two of the adits that were explored in the study area. Like the Natal Clinging Bat, Temminck's Hairy Bat migrates between summer maternity roosts and winter hibernacular (Monadjem *et al*. 2010) and, therefore, the destruction or disturbance of either of these has the potential to cause significant population declines in this species.

**Rusty Pipistrelle (*Pipistrellus rusticus*) – Near Threatened**

Calls of this species were recorded in the study area but unlike the afore-mentioned cave-dwelling bats, the Rusty Pipistrelle roosts in crevices in trees. It is, therefore, predominant in savanna, and dependent on riverine and forest patches in grassland. Very little is known about the Rusty Pipistrelle, and the closest reported record for this species is north of Swaziland, >200km away (Friedmann & Daly, 2004). For some reason(s), populations of this species have disappeared and, consequently, it is regarded as Near Threatened.

**Serval (*Leptailurus serval*) – Near Threatened**

Camera traps photographed this species at two separate locations in the study area, including a stream surrounded by grassland, and a dirt road bisecting a stand of alien Blue Gum (*Eucalyptus*) trees in the proposed surface infrastructure area. Serval typically frequent dense, grassy habitat near water but may occur in other habitats e.g. savanna. The South African population is small (<10,000 individuals) and highly fragemented due to the destruction, degradation and fragmentation of wetland and grassland habitat (Friedmann & Daly, 2004).

Both the Data Deficient Swamp Musk Shrew (*Crocidura mariquensis*) and Reddish-grey Musk Shrew (*Crocidura cyanea*) were found in the proposed surface infrastructure area in hydromorphic grassland surrounding wetland habitat.. As their conservation status implies, little is known about these small, inconspicuous insectivores. However, it is unlikely that the Reddish-grey Musk Shrew is threatened given its wide distribution across South Africa and broad habitat tolerance (Friedmann & Daly, 2004). The Swamp Musk Shrew, in contrast, has a smaller distribution and may be threatened by loss of wetland habitat.

Several other CI mammal species potentially occur in the study area but were not detected during field surveys (**Table 4-1**). Suitable habitat appears to be present in the proposed surface infrastructure and underground mining areas for most of these species including the Critically Endangered Rough-haired Golden Mole (*Chrysospalax villosus*), the Endangered White-tailed Mouse (*Mystromys albicaudatus*) and the Endangered Oribi (*Ourebia ourebi*).

**Table 4-1 Potentially occurring and observed CI mammal species in the study area**

| ORDER & SPECIES | COMMON NAME | LoO | STATUS | | | RECORDS | |
|---|---|---|---|---|---|---|---|
| | | | SA RED LIST | NEM:BA | MTPA | ATLAS: 2730 AA-AD | MTPA: 2730 AB & AD |
| **RODENTIA (Rodents)** | | | | | | | |
| *Mystromys albicaudatus* | White-tailed Mouse | 2 | EN | | | x | |
| *Lemniscomys rosalia* | Single-striped Grass Mouse | 2 | DD | | | x | |
| *Dasymys incomtus* | African Marsh Rat | 3 | NT | | | | |
| *Otomys sloggetti* | Sloggett's Vlei Rat | 2 | DD | | | x | |
| **INSECTOVORA (Insectivores)** | | | | | | | |
| *Chrysospalax villosus* | Rough-haired Golden Mole | 2 | CR | CR | | x | |
| *Amblysomus septentrionalis* | Highveld Golden Mole | 2 | NT | | | x | |
| *Amblysomus hottentotus* | Hottentot Golden Mole | 4 | DD | | | | |
| *Chlorotalpa sclateri* | Sclater's Golden Mole | 2 | DD | | | | |
| *Myosorex cafer* | Dark-footed Forest Shrew | 2 | DD | | | x | |
| *Myosorex varius* | Forest Shrew | 2 | DD | | | x | |
| *Suncus varilla* | Lesser Dwarf Shrew | 3 | DD | | | | |
| *Suncus infinitesimus* | Least Dwarf Shrew | 2 | DD | | | x | |
| ***Crocidura mariquensis*** | **Swamp Musk Shrew** | **1** | **DD** | | | **x** | |
| *Crocidura fuscomurina* | Tiny Musk Shrew | 3 | DD | | | | |
| ***Crocidura cyanea*** | **Reddish-grey Musk Shrew** | **1** | **DD** | | | | |
| *Crocidura silacea* | Lesser Grey-brown Musk Shrew | 2 | DD | | | x | |
| *Crocidura flavescens* | Greater Red Musk Shrew | 2 | DD | | | x | |

| ORDER & SPECIES | COMMON NAME | LoO | STATUS: SA RED LIST | STATUS: NEM:BA | STATUS: MTPA | RECORDS: ATLAS: 2730 AA-AD | RECORDS: MTPA: 2730 AB & AD |
|---|---|---|---|---|---|---|---|
| *Crocidura hirta* | Lesser Red Musk Shrew | 3 | DD | | | | |
| **CHIROPTERA (Bats)** | | | | | | | |
| ***Rhinolophus swinnyi*** | **Swinny's Horseshoe Bat** | **1** | **EN** | | | | |
| ***Rhinolophus clivosus*** | **Geoffroy's Horseshoe bat** | **1** | **NT** | | | **x** | |
| *Rhinolophus darlingi* | Darling's Horseshoe Bat | 3 | NT | | | | |
| *Rhinolophus landeri* | Lander's Horseshoe Bat | 3 | NT | | | | |
| *Miniopterus fraterculus* | Lesser Long-fingered Bat | 2 | NT | | | x | |
| ***Miniopterus natalensis*** | **Natal Clinging Bat** | **1** | **NT** | | | | |
| *Myotis welwitschii* | Welwitsch's Hairy Bat | 4 | NT | | | | |
| ***Pipistrellus rusticus*** | **Rusty Pipistrelle** | **1** | **NT** | | | | |
| ***Myotis tricolor*** | **Temminck's Hairy Bat** | **1** | **NT** | | | | |
| **PHOLIDOTA (Pangolin)** | | | | | | | |
| *Manis temminckii* | Ground Pangolin | 4 | VU | VU | | | |
| **CARNIVORA (Carnivores)** | | | | | | | |
| *Parahyaena brunne* | Brown Hyaena | 2 | NT | PS | | x | |
| *Panthera pardus* | Leopard | 3 | LC | VU | | x | |
| *Felis nigripes* | Black-footed Cat* | 4 | LC | PS | | | |
| ***Leptailurus serval*** | **Serval** | **1** | **NT** | **PS** | | | |
| *Vulpes chama* | Cape Fox | 2 | LC | PS | | x | |
| *Lutra maculicollis* | Spotted-necked Otter | 3 | NT | PS | | x | |
| *Mellivora capensis* | Honey Badger | 3 | NT | PS | | x | |
| *Poecilogale albinucha* | African Striped Weasel | 2 | DD | | | x | |
| **ARTIODACTYLA (Even-toed ungulates)** | | | | | | | |
| *Connochaetes gnou* | Black Wildebeest | 5 | LC | PS | | | |
| *Redunca arundinum* | Southern Reedbuck | 5 | LC | PS | | x | |
| *Ourebia ourebi* | Oribi | 3 | EN | EN | EN | | x |

**KEY**

**LoO:** 1=Present; 2=Highly likely; 3=Moderately likely; 4=Unlikely; 5=Managed population

**Status:** CR=Critically Endangered; EN=Endangered; VU=Vulnerable; PS=Protected Species; NT=Near Threatened; DD=Data Deficient; LC=Least Concern

**Sources:** Friedmann & Daly (2004); NEM:BA (2007), MTPA (pers. comm. 2013)

## 4.2. Birds

Eighteen CI bird species have been recorded in or near the AYCP study area, which are listed in **Table 4-2**. Twelve CI bird species were recorded during surveys for the SABAP 2 in the nine pentads wherein the AYCP is located. DEC and NSS observed five CI bird species during surveys for the AYCP, and DEC previously also observed the Near Threatened Half-collared Kingfisher (*Alcedo semitorquata*) on a nearby tributary of the Assegaai River. Fourteen CI bird species have been recorded by other observers on farms in the QDSs 2730AB and AD according to the MTPA (pers. comm. 2013).

**Table 4-2 CI bird species recorded in or near the study area**

| GROUP & SPECIES | COMMON NAME | LoO | STATUS | | | RECORDS | |
|---|---|---|---|---|---|---|---|
| | | | SA RED LIST | NEM:BA 2007 | MTPA | SABAP 2: PENTADS | MTPA: 2730 AB & AD |
| **Inland water birds** | | | | | | | |
| *Ciconia nigra* | Black Stork | 3 | NT | VU | NT | | x |
| *Geronticus calvus* | Southern Bald Ibis | 2 | VU | VU | VU | x | x |
| **Large terrestrial birds** | | | | | | | |
| ***Sagittarius serpentarius*** | **Secretarybird** | **1** | **NT** | | **NT** | **x** | **x** |
| *Eupodotis caerulescens* | Blue Korhaan | 2 | NT | VU | VU | x | x |
| ***Lissotis melanogaster*** | **Black-bellied Bustard** | **1** | **NT** | | | **x** | |
| *Balearica regulorum* | Grey-crowned Crane | 2 | VU | EN | | x | x |
| *Anthropoides paradiseus* | Blue Crane | 2 | VU | EN | VU | x | x |
| *Neotis denhami* | Denham's Bustard | 2 | VU | | VU | x | x |
| ***Eupodotis senegalensis*** | **White-bellied Korhaan** | **1** | **VU** | | **VU** | **x** | **x** |
| **Raptors** | | | | | | | |
| *Falco biarmicus* | Lanner Falcon | 2 | NT | VU | VU | x | x |
| *Stephanoaetus coronatus* | African Crowned Eagle | 3 | NT | | NT | x | |
| **Owls & nightjars** | | | | | | | |
| ***Tyto capensis*** | **African Grass-owl** | **1** | **VU** | **VU** | **VU** | | **x** |
| **Aerial feeders** | | | | | | | |
| ***Alcedo semitorquata*** | **Half-collared Kingfisher** | **1** | **NT** | | | | |
| **Cryptic & elusive insect-eaters** | | | | | | | |
| *Heteromirafra ruddi* | Rudd's Lark | 3 | CR | | CR | | x |
| *Bugeranus carunculatus* | Wattled Crane | 3 | CR | CR | CR | | x |
| ***Lioptilus nigricapillus*** | **Bush Blackcap** | **1** | **NT** | | **NT** | **x** | **x** |
| *Schoenicola brevirostris* | Fan-tailed Grassbird | 2 | NT | | NT | x | x |
| *Anthus chloris* | Yellow-breasted Pipit | 2 | VU | | VU | | x |
| **KEY** | | | | | | | |
| **LoO:** 1=Present; 2=Highly likely; 3=Moderately likely; 4=Unlikely | | | | | | | |
| **Status:** CR=Critically Endangered; EN=Endangered; VU=Vulnerable; NT=Near Threatened | | | | | | | |
| **Sources:** Barnes, 2000; MTPA (pers. comm. 2013); SABAP 2 website (2013) | | | | | | | |

**Southern Bald Ibis (*Geronticus calvus*) – Vulnerable & Endemic**

Estimated population in SA: ≤10,000 birds

Although there were no sightings of this species during the field surveys, Bald Ibises have been recorded from seven of the nine buffer pentads including the AYCP pentad. This species feeds in sour grassland and harvested/ ploughed crop land, and as such, is expected to occur in the study area.

**Blue Crane (*Anthropoides paradiseus*) – Vulnerable**

Estimated population in SA: 15,000 - 25,000 birds

Blue Cranes have been recorded from the pentads to the north, south, and south-east of the AYCP pentad. This species regularly frequents drier areas than the other two crane species and often forages in grassland habitats. Suitable habitat for this species is present on site.

**Grey-crowned Crane (*Balearica regulorum*) – Vulnerable**

Estimated population in SA: 2,500 - 4,300 birds

This species has only been recorded in the pentad to the south-west of the AYCP pentad. Grey-crowned Cranes forage mainly in wetland areas such as sponges, pans etc. They also visit newly ploughed or harvested cropland and may occur within the study area on occasion.

**Denham's Bustard (*Neotis denhami*) – Vulnerable**

Estimated population in SA: <1,500 birds

This species has been recorded from the AYCP pentad, and also from the pentad immediately to the south. Denham's Bustards feed in sour grassland and suitable habitat for the species was identified on site.

**White-bellied Korhaan (*Eupodotis senegalensis*) – Vulnerable**

Estimated population in SA: <5,000 birds

This species has been recorded from four of the eight pentads surrounding the site. It favours longer grass, often with scattered trees or bushes and suitable habitat for the species was identified in the project area. The species is highly cryptic in its behaviour and is best detected by call. This species was regularly heard calling in the proposed surface infrastructure area during the field survey in July 2013. Current taxonomy treats the South African population of this korhaan as an endemic race – *E. s. barrowii,* but it has been suggested that it is in fact distinct from the species found in Namibia through to East Africa. If this is confirmed, an estimated world population of <5,000 birds would mean that the threat status would be raised to a higher category.

**African Grass-owl (*Tyto capensis*) – Vulnerable**

Estimated population in SA: 1,000 - 5,000 birds

The African Grass-owl inhabits wetlands and tall grassland where adults utilize tunnels and nests on the ground. During the July 2013 field survey, a Grass-owl nest was found in the proposed surface infrastructure area. This suggests that there is a local breeding population of this species in the study area. African Grass-owls have been extirpated in south-western South Africa and Lesotho, and the combined pressure from development, fire mismanagement, land clearing for agriculture, overgrazing, afforestation and roadkill are of serious concern for the species.

**Secretarybird (*Sagittarius serpentarius*) – Near Threatened**

Estimated population in SA: ~1500 pairs

Secretarybirds feed primarily in grassland, and extensive areas of suitable foraging habitat were identified in the project area. This species was recorded almost daily during field surveys and an analysis of SABAP 2 data for the nine buffer pentad area revealed that three of the six records for the species in the atlas database are from the AYCP pentad. This suggests that the proposed surface infrastructure and underground mining areas fall within the focal foraging area of a local population. Nesting of this species occurs year-round with most (70%) of the records for north-eastern South Africa falling between July and November. Field surveys may have, therefore, missed any breeding on site.

**Lanner Falcon (*Falco biarmicus*) – Near Threatened**

Estimated population in SA: 9,000 - 18,000 pairs

This species has been recorded from the AYCP pentad and also from the pentad immediately to the north. Lanners nest between May and September and could potentially nest on the sandstone ledges in the amphitheatre on the north-western boundary of the site. However, there were no indications – (such as "white-wash" faecal sprays below suitable ledges) of this during the field surveys. The species is, however, likely to hunt over the AYCP study area.

**Blue Korhaan (*Eupodotis caerulescens*) – Near Threatened**

Estimated population in SA: >10,000 birds

This species has only been recorded from the pentad to the west of AYCP pentad. Blue Korhaans typically feed and nest in areas with shorter grass, compared to White-bellied Korhaans, and are thus slightly easier to locate. Potentially suitable habitat for this species was identified on site.

**Black-bellied Bustard (*Lissotis melanogaster*) – Near Threatened**

Estimated population in SA: <5,000 birds

This bustard has been recorded from the AYCP pentad, and also from the one immediately to the west. During the January 2013 site visit, two calling males were located in the proposed surface infrastructure area, indicating that Black-bellied Bustards are breeding on site. Female bustards visit these calling males to mate and then move off into areas of tall grass were one or two eggs are laid in a shallow scrape in the ground. Nests are well hidden and this, together with the cryptic behaviour of the nesting females, makes the location of active nests difficult. All incubation and care of young is undertaken by the female.

**Half-collared Kingfisher (*Alcedo semitorquata*) – Near Threatened**

Estimated population in SA: Unknown

Half-collared Kingfishers favour quiet, wooded stretches of clear-flowing rivers and streams and are dependent on healthy river systems. Prior to field surveys for the present assessment, DEC observed Half-collared Kingfisher on a nearby tributary of the Assegaai River. Pollution, increased silt loads, noise and other forms of disturbance negatively affect this species.

**Bush Blackcap (*Lioptilus nigricapillus*) – Near Threatened**

Estimated population in SA: <5,000 birds

A single bird was located in a patch of Scarp Forest during the March 2013 site visit. Several other areas of optimal habitat were identified in the study area, and it is likely that several pairs of this endemic species breed on site.

**Fan-tailed Grassbird (*Schoenicola brevirostris*) – Near Threatened**

Estimated population in SA: Unknown

This species has ONLY been recorded from the AYCP pentad within the complete nine pentad buffer area. The species favours areas of long, rank grassland – often in damp areas. Suitable habitat exists in the lower-lying sections of the study area and the possibility that Fan-tailed Grassbirds will be found breeding on the site cannot be ruled out. Displaying males give characteristic, metallic-sounding *"Tswink …. tswink…"* calls during November, but the delay in finalising the mine layout meant that the planned early-summer survey occurred too late to confirm the status of this species on site.

CI bird species that were not recorded in local pentads during the SABAP 2, but which were recorded on nearby farms by other observers according to the MTPA (pers. comm. 2013), include the Critically Endangered Wattled Crane (*Bugeranus carunculatus*), Critically Endangered Rudd's Lark (*Heteromirafra ruddi*), Vulnerable Yellow-breasted Pipit (*Anthus chloris*), Near Threatened African Crowned Eagle (*Stephanoaetus coronatus*) and Near Threatened Black Stork (*Ciconia nigra*). Suitable habitat for all these CI bird species was present in the AYCP study area, including the proposed underground mining and surface infrastructure areas.

## 4.3. Reptiles

Online (2010) reptile species distribution maps of the unpublished Southern African Reptile Conservation Assessment (SARCA), and CI reptile species records supplied by the MTPA (pers. comm. 2013) indicate that at least seven CI reptile species may occur in the AYCP study area (**Table 4-3**). These include one provincially Vulnerable and six globally or provincially Near Threatened species. One of these CI species was detected during fieldwork in the proposed surface infrastructure area, i.e. the provincially Near Threatened and South African endemic sub-species of the Cape Grass Lizard (*Chamaesaura anguina anguina*).

**Table 4-3 Potentially occurring and observed CI reptile species in the study area**

| FAMILY & SPECIES | COMMON NAME | LoO | STATUS | | | RECORDS | |
|---|---|---|---|---|---|---|---|
| | | | IUCN RED LIST | NEM:BA 2007 | MTPA | ATLAS: 2730 AA-AD | 2730 AB & AD |
| **ATRACTASPIDIDAE (Burrowing snakes)** | | | | | | | |
| *Homoroselaps dorsalis* | Striped Harlequin Snake | 3 | NT* | - | | | |
| **COLUBRIDAE (Typical Snakes)** | | | | | | | |
| *Lamprophis aurora* | Aurora House Snake | 3 | LC** | - | | | |
| *Lamprophis fuscus* | Yellow-bellied House Snake | 3 | NT | - | | | |
| **SCINCIDAE (Skinks)** | | | | | | | |
| *Acontias breviceps* | Short-headed Legless Skink | 2 | NT | - | VU | x | x |
| **CORDYLIDAE (Girdled lizards)** | | | | | | | |
| *Cordylus warreni warreni* | Warren's Girdled Lizard | 3 | LC | - | NT | | x |
| *Chamaesaura aenea* | Transvaal Grass Lizard | 2 | LC*** | - | NT | x | |
| ***Chamaesaura anguina anguina*** | **Cape Grass Lizard** | **1** | **-** | **-** | **NT** | **x** | **x** |
| **KEY** | | | | | | | |
| **LoO:** 1=Present; 2=Highly likely; 3=Moderately likely | | | | | | | |
| **Status:** VU=Vulnerable; NT=Near Threatened; LC=Least Concern | | | | | | | |
| * Globally NT (IUCN, 2013) | | | | | | | |
| ** Declining (IUCN, 2013) | | | | | | | |
| *** Provisionally listed as VU - SARCA (in press) | | | | | | | |
| **Sources:** NEM:BA (2007); SARCA website (2010), IUCN (2013); MTPA (pers. comm., 2013) | | | | | | | |

### Cape Grass Lizard (*Chamaesaura anguina anguina*) – Near Threatened

Like most grass lizards, Cape Grass Lizards are extreme grassland specialists. They possess significantly reduced limbs and long slender bodies, enabling them to move swiftly through their habitat. During field surveys several individuals were caught at various locations throughout the study area (including the proposed surface infrastructure area), and always in rocky hill-slopes with dense grass cover. As with the Transvaal Grassl Lizard (*Chamaesaura aenea*), this species is likely threatened by loss of grassland habitat.

Transvaal Grass Lizard (*Chamaesaura aenea*) have a marginal distribution in the study area and if present, will likely be restricted to natural grassland areas in proximity to rocks, which provide important shelter for these lizards during veld fires. These endemic grassland specialists are provisionally listed as Vulnerable by the SARCA (Alexander, 2009). They are patchily distributed, and threatened by loss and fragmentation of their grassland habitat.

Striped Harlequin Snakes (*Homoroselaps dorsalis*) are endemic to South Africa and are listed as globally Near Threatened (IUCN, 2013). The species is illusive and very sparsely distributed, particularly outside Gauteng. They feed exclusively on Thread Snakes (*Leptotyphlops* spp.) and are highly threatened by transformation of their Highveld grassland habitat due to agriculture and other forms of land-use (Branch, 1998; Alexander, 2009).

Although listed as Least Concern, the Aurora House Snake (*Lamprophis aurora*) is reportedly experiencing rapid local population declines (Patterson, 1987; IUCN, 2013). Although widely distributed, Aurora House Snakes are uncommon throughout their range (Branch, 1998). Threats to this species include habitat loss, harvesting for the pet trade, and their associated mortality caused by road traffic (IUCN, 2013).

The Near Threatened Yellow-bellied House Snake (*Lamprophis fuscus*) is a rare snake that is usually found in old termite nests in grassland and fynbos. This species is threatened by loss of its grassland and fynbos habitats, and the destruction of old termite mounds by people who use them, for example, like ovens to cook food.

## 4.4. Frogs

Five CI frog species may occur in the AYCP study area (**Table 4-4**) based on the published frog species distribution maps in Minter *et al*. (2004). None of these CI frog species were detected possibly because no survey work was performed in early summer after heavy rain. Two of the species have, however, been recorded by other observers on nearby farms according to the MTPA (pers. comm. 2013). These include the Karoo Toad (*Vandijkophrynus gariepensis*) and Natal Cascade Frog (*Hadromophryne natalensis*).

The Natal Cascade Frog, although listed nationally as Least Concern, is threatened by introduced trout and destruction of its clear, fast-flowing, montane stream habitat (Du Preez & Curruthers, 2009) and, therefore, is recognised as a Vulnerable in Mpumalanga. Suitable habitat for this species is present on site.

The Karoo Toad, which is listed as provincially Vulnerable, is highly likely to occur on site particularly in the higher altitude moist grasslands.

The AYCP study area falls within the distribution range of the nationally Near Threatened Plain Stream Frog (*Strongylopus wageri*) and suitable habitat for this species (fast-flowing montane streams in Scarp Forest) exists on site.

The Spotted Shovel-nosed Frog (*Hemisus guttatus*) is listed as nationally Vulnerable due to its small extent of occurrence. It occupies a variety of habitats (Du Preez & Curruthers, 2009), in close proximity to wetlands or emphemeral pools where the surrounding substrate is conducive to its burrowing lifestyle. Habitat in the AYCP study area is considered suitable for this species.

The Near Threatened Giant Bullfrog (*Pyxicephalus adsperus*) is listed as nationally Near Threatened and provincially Vulnerable in Mpumalanga, where very few breeding populations of this species are known. Giant Bullfrogs use shallow, still-standing seasonal water with emergent grassy vegetation for breeding, and spend most of their lives buried underground in grassland surrounding their breeding sites. Based on ecological niche modelling by Yetman *et al.* (2012), this species may occur in the AYCP area.

**Table 4-4 Potentially occurring CI frog species in the study area**

| SPECIES | COMMON NAME | LoO | STATUS | | | RECORDS | |
|---|---|---|---|---|---|---|---|
| | | | SA RED LIST | NEM:BA 2007 | MTPA | ATLAS: 2730 AA-AD | MTPA: 2730 AB & AD |
| **BUFONIDAE (Toads)** | | | | | | | |
| *Vandijkophrynus gariepensis* | Karoo Toad | 2 | LC | | VU | x | x |
| **HELEOPHRYNIDAE (Ghost Frogs and Cascade Frog)** | | | | | | | |
| *Hadromophryne natalensis* | Natal Cascade Frog | 3 | LC | | VU | x | x |
| **HEMISOTIDAE (Shovel-nosed Frogs)** | | | | | | | |
| *Hemisus guttatus* | Spotted Shovel-nosed Frog | 2 | VU* | | | | |
| **PYXICEPHALIDAE (African Common Frogs)** | | | | | | | |
| *Strongylopus wager* | Plain Stream Frog | 2 | NT | | | x | |
| *Pyxicephalus adspersus* | Giant Bullfrog | 3 | NT | | VU | | |
| **KEY** | | | | | | | |
| **LoO:** 2=Highly likely; 3=Moderately likely; 4=Unlikely | | | | | | | |
| **Status:** VU=Vulnerable, NT=Near Threatened, LC=Least Concern | | | | | | | |
| * Listed as globally VU (IUCN 2013) | | | | | | | |
| **Sources:** Minter *et al.* (2004); NEM:BA (2007); Du Preez & Carruthers (2009); IUCN (2013); MTPA (pers. comm. 2013) | | | | | | | |

## 4.5. Terrestrial Macro-invertebrates

Although no CI terrestrial macro-invertebrate species were found (**Table 4-5**), there is suitable habitat for several of these species within the AYCP study area, including the Vulnerable Marsh Sylph (*Metisella meninx*) and five nationally Protected Species of scorpion and baboon spider.

The small, cryptic, Marsh Sylph butterfly occurs exclusively at altitudes of 1400-1700m a.s.l. in marshy wetlands that support its larval food plant called Rice Grass (*Leersia hexandra*). Like most of the afore-mentioned CI faunal species, the Marsh Sylph is threatened by loss of its wetland and grassland habitat due to agriculture, mining, afforestation and urbanisation.

**Table 4-5 Potentially occurring CI terrestrial macro-invertebrate taxa in the study area**

| TAXA | COMMON NAME | LoO | STATUS | |
|---|---|---|---|---|
| | | | SA RED LIST | NEM:BA 2007 |
| **Insects** | | | | |
| *Metisella meninx* | Marsh Sylph | 2 | VU | PS |
| *Manticora* spp. | Monster Tiger Beetles | 2 | - | PS |
| **Arachnids** | | | | |
| *Opisthacanthus* spp. | Creeping Scorpions | 2 | - | PS |
| *Opistophthalmus* spp. | Burrowing Scorpions | 2 | - | PS |
| *Ceratogyrus* sp. | Horned Baboon Spiders | 3 | - | PS |
| *Harpactira* sp. | Common Baboon Spiders | 2 | - | PS |
| *Pterinochilus* sp. | Golden Brown Baboon Spiders | 3 | - | PS |
| **Key:** | | | | |
| **LoO:** =Highly likely; 3=Moderately likely | | | | |
| **Source:** Henning *et al*. (2004); NEM:BA (2007) | | | | |

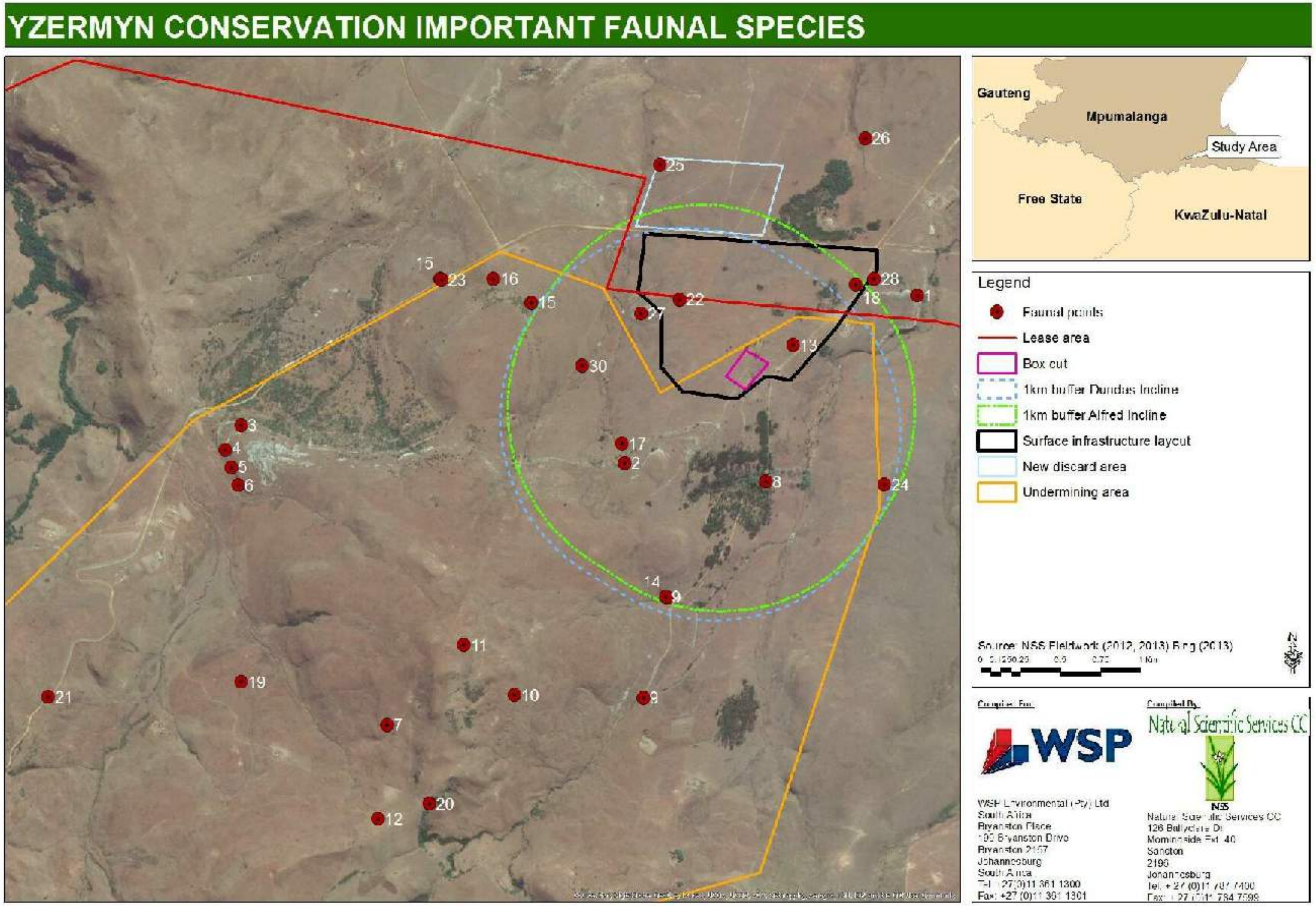



**Figure 4-2** **Locations of Conservation Important faunal species detected by NSS and DEC in the study area (legend in Table 4-6)**

**Table 4-6 Legend for Figure 4-2**

| LOCALITY | COMMON NAME | SPECIES | STATUS | CO-ORDINATES | PENTAD | QDS |
|---|---|---|---|---|---|---|
| **1** | Swinny's Horseshoe Bat | *Rhinolophus swinnyi* | EN | S27.21464 E30.32268 | 2710_3015 | 2730AB |
| **1** | Geoffroy's Horseshoe Bat | *Rhinolophus clivosus* | NT | | | |
| **1** | Temminck's Hairy Bat | *Myotis tricolor* | NT | | | |
| **1** | Natal Clinging Bat | *Miniopterus natalensis* | NT | | | |
| **2** | Geoffroy's Horseshoe Bat | *Rhinolophus clivosus* | NT | S27.22301 E30.30625 | 2710_3015 | 2730AB |
| **3** | Geoffroy's Horseshoe Bat | *Rhinolophus clivosus* | NT | S27.22111 E30.28468 | 2710_3015 | 2730AB |
| **4** | Geoffroy's Horseshoe Bat | *Rhinolophus clivosus* | NT | S27.22236 E30.28379 | 2710_3015 | 2730AB |
| **5** | Geoffroy's Horseshoe Bat | *Rhinolophus clivosus* | NT | S27.22322 E30.28414 | 2710_3015 | 2730AB |
| **6** | Geoffroy's Horseshoe Bat | *Rhinolophus clivosus* | NT | S27.22411 E30.28452 | 2710_3015 | 2730AB |
| **6** | Temminck's Hairy Bat | *Myotis tricolor* | NT | | | |
| **7** | Secretarybird | *Sagittarius serpentarius* | NT | S27.23610 E30.29290 | 2710_3015 | 2730AB |
| **8** | Serval | *Leptailurus serval* | NT | S27.22393 E30.31418 | 2710_3015 | 2730AB |
| **9** | Cape Grass Lizard | *Chamaesaura anguina* | NT | S27.22969 E30.30854 | 2710_3015 | 2730AB |
| **10** | Cape Grass Lizard | *Chamaesaura anguina* | NT | S27.23461 E30.30003 | 2710_3015 | 2730AB |
| **11** | Cape Grass Lizard | *Chamaesaura anguina* | NT | S27.23211 E30.29720 | 2710_3015 | 2730AB |
| **12** | Cape Grass Lizard | *Chamaesaura anguina* | NT | S27.24079 E30.29236 | 2710_3015 | 2730AB |
| **13** | Reddish-grey Musk Shrew | *Crocidura cyanea* | DD | S27.21711 E30.31569 | 2710_3015 | 2730AB |
| **14** | Swamp Musk Shrew | *Crocidura mariquensis* | DD | S27.22976 E30.30867 | 2710_3015 | 2730AB |
| **15** | Secretarybird | *Sagittarius serpentarius* | NT | S27.21381 E30.29588 | 2710_3015 | 2730AB |
| **15** | Secretarybird | *Sagittarius serpentarius* | NT | S27.21498 E30.30097 | 2710_3015 | 2730AB |
| **16** | Secretarybird | *Sagittarius serpentarius* | NT | S27.21381 E30.29886 | 2710_3015 | 2730AB |
| **17** | Black-bellied Bustard | *Lissotis melanogaster* | NT | S27.22203 E30.30606 | 2710_3015 | 2730AB |
| **18** | Secretarybird | *Sagittarius serpentarius* | NT | S27.21408 E30.31922 | 2710_3015 | 2730AB |
| **19** | Secretarybird | *Sagittarius serpentarius* | NT | S27.23394 E30.28467 | 2710_3015 | 2730AB |
| **20** | Bush Blackcap | *Lioptilus nigricapillus* | NT | S27.24003 E30.29525 | 2710_3015 | 2730AB |
| **21** | Secretarybird | *Sagittarius serpentarius* | NT | S27.23469 E30.27383 | 2710_3015 | 2730AB |
| **22** | Secretarybird | *Sagittarius serpentarius* | NT | S27.21483 E30.30933 | 2710_3015 | 2730AB |
| **23** | Secretarybird | *Sagittarius serpentarius* | NT | S27.21385 E30.29593 | 2710_3015 | 2730AB |
| **24** | Black-bellied Bustard | *Lissotis melanogaster* | NT | S27.22408 E30.32083 | 2710_3015 | 2730AB |
| **25** | White-bellied Korhaan | *Eupodotis senegalensis* | VU | S27.20815 E30.30820 | 2710_3015 | 2730AB |
| **26** | White-bellied Korhaan | *Eupodotis senegalensis* | VU | S27.20682 E30.31977 | 2710_3015 | 2730AB |
| **27** | White-bellied Korhaan | *Eupodotis senegalensis* | VU | S27.21554 E30.30714 | 2710_3015 | 2730AB |
| **28** | Secretarybird | *Sagittarius serpentarius* | NT | S27.21381 E30.32026 | 2710_3015 | 2730AB |
| **29** | Serval | *Leptailurus serval* | NT | S27.23475 E30.30728 | 2710_3015 | 2730AB |
| **30** | African Grass-owl | *Tyto capensis* | VU | S27.21816 E30.30386 | 2710_3015 | 2730AB |

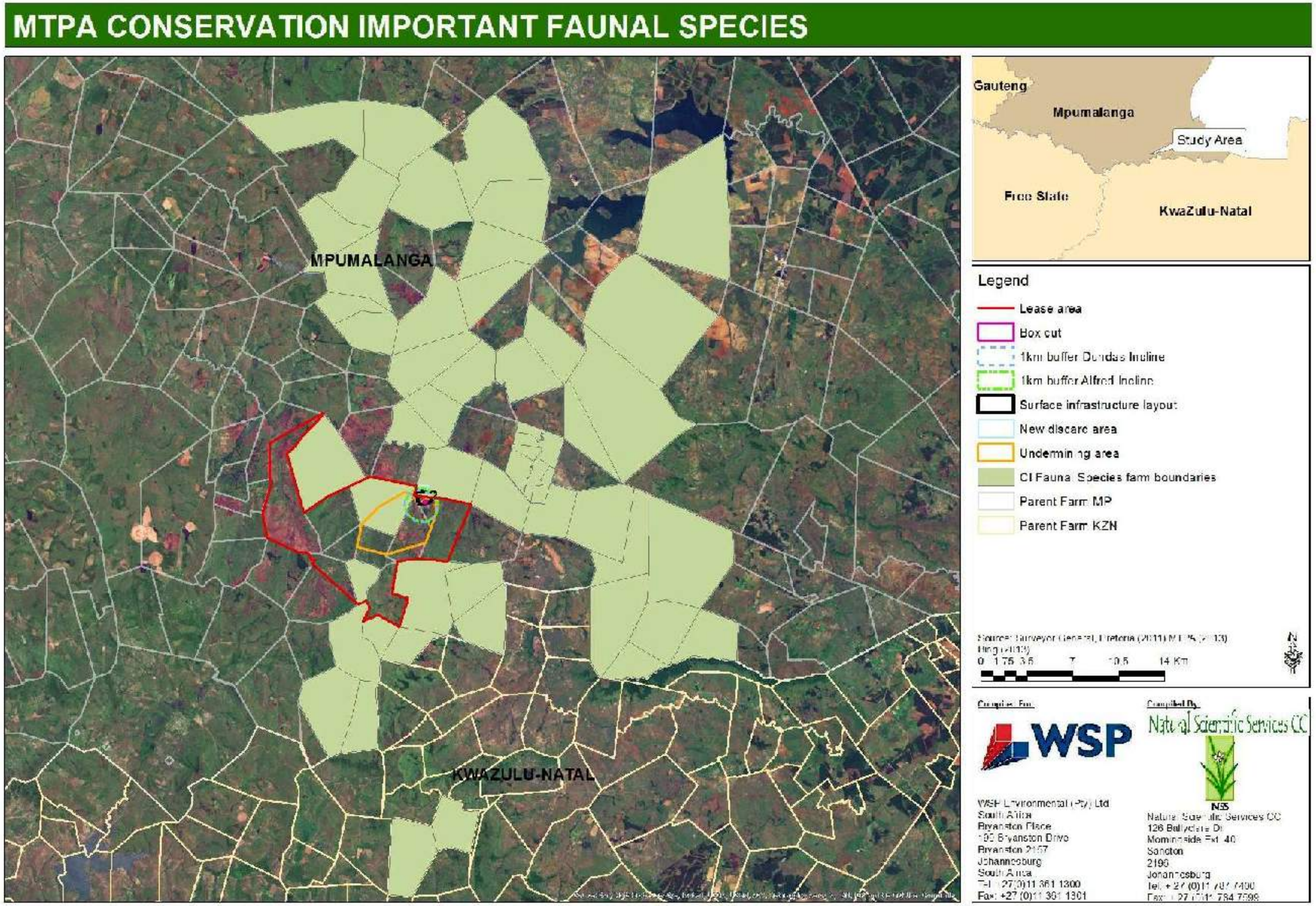



**Figure 4-3** **Farms in the study area with records of Conservation Important faunal species supplied by the MTPA (pers. comm. 2013)**

# 5. Appendices

## 5.1. Appendix 1 Mammal list for the study area

| ORDER &SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| **MACROSCELIDEA (Elephant-shrews)** | | | | | | | | | | | | | | |
| *Elephantulus myurus* | Eastern Rock Elephant-shrew | LC | 2 | | | | | | | | | | | |
| **TUBILIDENTATA (Aardvark)** | | | | | | | | | | | | | | |
| *Orycteropus afer* | Aardvark | LC | 1 | | | | | | x | x | | | | |
| **HYRACOIDEA (Dassies)** | | | | | | | | | | | | | | |
| *Procavia capensis* | Rock Dassie | LC | 1 | | | | x | x | | | | | | |
| **LAGOMORPHA (Hares & rabbits)** | | | | | | | | | | | | | | |
| *Lepus capensis* | Cape Hare | LC | 3 | | | | | | | | | | | |
| *Lepus saxatilis* | Scrub Hare | LC | 1 | | | x | x | | x | x | | | x | |
| *Pronolagus saundersiae* | Hewitt's Red Rock Rabbit | LC | 2 | | | | | | | | | | | |
| *Pronolagus crassicaudatus* | Natal Red Rock Rabbit | LC | 2 | | | | | | | | | | | |
| **RODENTIA (Rodents)** | | | | | | | | | | | | | | |
| *Cryptomys hottentotus* | African Mole-rat | LC | 1 | | | x | | | x | x | | | | |
| *Georychus capensis* | Ape Mole-rat | LC | 2 | | | x | x | | | | | | | |
| *Hystrix africaeaustralis* | Porcupine | LC | 1 | | x | | x | | x | x | | x | | |
| *Pedetes capensis* | Springhare | LC | 4 | | | | | | | | | | | |
| *Thryonomus swinderianus* | Greater Canerat | LC | 3 | | | | | | | | | | | |
| *Graphiurus murinus* | Woodland Dormouse | LC | 2 | x | | | | | | | | | | |
| *Mystromys albicaudatus* | White-tailed Mouse | EN | 2 | | | | x | | | | | | | |
| *Lemniscomys rosalia* | Single-striped Grass Mouse | DD | 2 | | | x | | | | | | | | |
| *Rhabdomys pumilio* | Four-striped Grass Mouse | LC | 1 | x | | x | x | | | | | | | |
| *Dasymys incomtus* | African Marsh Rat | NT | 3 | | | | | | | | | | | |

| ORDER &SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Mus minutoides* | Pygmy Mouse | LC | 1 | | | | | | | | | x | | |
| *Mastomys natalensis* | Natal Multimammate Mouse | LC | 2 | x | | x | x | | | | | | | |
| *Thallomys paedulcus* | Acacia Rat | LC | 2 | | | | | | | | | | | |
| *Aethomys namaquensis* | Namaqua Rock Mouse | LC | 2 | | | x | x | | | | | | | |
| *Aethomys ineptus* | Tete Veld Rat | LC | 2 | | | x | | | | | | | | |
| *Otomys angoniensis* | Angoni Vlei Rat | LC | 3 | | | | | | | | | | | |
| *Otomys irroratus* | Vlei Rat | LC | 2 | x | | x | x | | | | | | | |
| *Otomys sloggetti* | Sloggett's Vlei Rat | DD | 2 | | | x | | | | | | | | |
| *Tatera brantsii* | Highveld Gerbil | LC | 2 | x | | x | | | | | | | | |
| *Saccostomus campestris* | Pouched Mouse | LC | 2 | x | | | | | | | | | | |
| *Dendromus melanotis* | Grey Climbing Mouse | LC | 2 | | | | | | | | | | | |
| *Dendromus mesomelas* | Brants' Climbing Mouse | LC | 3 | | | | | | | | | | | |
| *Dendromus mystacalis* | Chestnut Climbing Mouse | LC | 3 | | | | | | | | | | | |
| *Steatomys krebsii**ac* | Krebs's Fat Mouse | LC | 2 | | | x | | | | | | | | |
| **PRIMATES (Bushbabies, monkeys & baboon)** | | | | | | | | | | | | | | |
| *Otolemur crassicaudatus* | Greater Galago | LC | 3 | | | x | x | | | | | | | |
| *Papio hamadryas* | Chacma Baboon | LC | 2 | x | | | x | | | | | | | |
| *Cercopithecus pygerythrus* | Vervet Monkey | LC | 3 | | | | | | | | | | | |
| **INSECTOVORA (Insectivores)** | | | | | | | | | | | | | | |
| *Chrysospalax villosus* | Rough-haired Golden Mole | CR | 2 | | | x | | | | | | | | |
| *Amblysomus septentrionalis* | Highveld Golden Mole | NT | 2 | | | x | x | | | | | | | |
| *Amblysomus hottentotus* | Hottentot Golden Mole | DD | 4 | | | | | | | | | | | |
| *Chlorotalpa sclateri* | Sclater's Golden Mole | DD | 2 | | | | | | | | | | | |
| *Myosorex cafer* | Dark-footed Forest Shrew | DD | 2 | | | x | x | | | | | | | |
| *Myosorex varius* | Forest Shrew | DD | 2 | x | | x | x | | | | | | | |
| *Suncus varilla* | Lesser Dwarf Shrew | DD | 3 | | | | | | | | | | | |
| *Suncus infinitesimus* | Least Dwarf Shrew | DD | 2 | x | | | | | | | | | | |
| *Crocidura mariquensis* | Swamp Musk Shrew | DD | 1 | x | | x | x | | | | | x | | |

| ORDER &SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Crocidura fuscomurina* | Tiny Musk Shrew | DD | 3 | | | | | | | | | | | |
| *Crocidura cyanea* | Reddish-grey Musk Shrew | DD | 1 | | | | | | | | | x | | |
| *Crocidura silacea* | Lesser Grey-brown Musk Shrew | DD | 2 | | | x | | | | | | | | |
| *Crocidura flavescens* | Greater Red Musk Shrew | DD | 2 | | | x | x | | | | | | | |
| *Crocidura hirta* | Lesser Red Musk Shrew | DD | 3 | | | | | | | | | | | |
| **CHIROPTERA (Bats)** | | | | | | | | | | | | | | |
| *Epomophorus wahlbergi* | Wahlberg's Epauletted Fruit Bat | LC | 2 | | | x | | | | | | | | |
| *Rhinolophus clivosus* | Geoffroy's Horseshoe Bat | NT | 1 | | | | x | | | | | | | x |
| *Rhinolophus darlingi* | Darling's Horseshoe Bat | NT | 3 | | | | | | | | | | | |
| *Rhinolophus landeri* | Lander's Horseshoe Bat | NT | 3 | | | | | | | | | | | |
| *Rhinolophus swinnyi* | Swinny's Horseshoe Bat | EN | 1 | | | | | | | | | | | x |
| *Chaerephon pumilus* | Little Free-tailed Bat | LC | 4 | | | | | | | | | | | |
| *Cistugo leseuri* | Leseur's Hairy Bat | NT | 3 | | | | | | | | | | | |
| *Tadarida aegyptiaca* | Egyptian Free-tailed Bat | LC | 1 | | | | | | | | | | | x |
| *Miniopterus fraterculus* | Lesser Long-fingered Bat | NT | 2 | | | x | | | | | | | | |
| *Miniopterus natalensis* | Natal Clinging Bat | NT | 1 | | | | | | | | | | | x |
| *Pipistrellus hesperidus* | African Pipistrelle | LC | 3 | | | | | | | | | | | |
| *Pipistrellus rusticus* | Rusty Pipistrelle | NT | 1 | | | | | | | | | | | x |
| *Neoromicia capensis* | Cape Serotine Bat | LC | 1 | | | x | | | | | | | | x |
| *Myotis welwitschii* | Welwitsch's Hairy Bat | NT | 4 | | | | | | | | | | | |
| *Myotis tricolor* | Temminck's Hairy Bat | NT | 1 | | | | | | | | | | | x |
| *Scotophilus dinganii* | African Yellow Bat | LC | 2 | | | x | | | | | | | | |
| *Nycteris thebaica* | Egyptian Slit-faced Bat | LC | 2 | | | x | | | | | | | | |
| **PHOLIDOTA (Pangolin)** | | | | | | | | | | | | | | |
| *Manis temminckii* | Ground Pangolin | VU | 4 | | | | | | | | | | | |
| **CARNIVORA (Carnivores)** | | | | | | | | | | | | | | |
| *Proteles cristatus* | Aardwolf | LC | 2 | x | | x | | | | | | | | |
| *Parahyaena brunne* | Brown Hyaena | NT | 2 | | | x | | | | | | | | |
| *Panthera pardus* | Leopard | LC | 3 | | | x | x | | | | | | | |
| *Caracal caracal* | Caracal | LC | 2 | | | x | x | | | | | | | |

| ORDER &SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Felis silvestris* | African Wild Cat | LC | 2 | | | x | x | | | | | | | |
| *Felis nigripes* | Black-footed Cat | LC | 4 | | | | | | | | | | | |
| *Leptailurus Serval* | Serval | NT | 1 | | | | | | | | | x | x | |
| *Genetta genetta* | Small-spotted Genet | LC | 2 | | | x | x | | | | | | | |
| *Genetta tigrina* | South African Large-spotted Genet | LC | 1 | x | | | x | | x | | | | | |
| *Suricata suricatta* | Meerkat | LC | 2 | x | | | | | | | | | | |
| *Cynictis penicillata* | Yellow Mongoose | LC | 1 | | | | | | | | | | x | |
| *Galerella sanguinea* | Slender Mongoose | LC | 1 | x | | | | | | x | | | | |
| *Galerella pulverulenta* | Cape Grey Mongoose | LC | 3 | | | | x | | | | | | | |
| *Ichneumia albicauda* | White-tailed Mongoose | LC | 2 | x | | | x | | | | | | | |
| *Atilax paludinosus* | Marsh Mongoose | LC | 1 | | | | | | | | | x | | |
| *Mungos mungo* | Banded Mongoose | LC | 3 | | | | | | | | | | | |
| *Helogale parvula* | Dwarf Mongoose | LC | 4 | | | | | | | | | | | |
| *Vulpes chama* | Cape Fox | LC | 2 | x | | | x | | | | | | | |
| *Canis mesomelas* | Black-backed Jackal | LC | 2 | x | | x | x | | | | | | | |
| *Aonyx capensis* | African Clawless Otter | LC | 1 | x | | | x | | | | | x | | |
| *Lutra maculicollis* | Spotted-necked Otter | NT | 3 | | | | x | | | | | | | |
| *Mellivora capensis* | Honey Badger | NT | 3 | x | | | | | | | | | | |
| *Poecilogale albinucha* | African Striped Weasel | DD | 2 | | | x | | | | | | | | |
| *Ictonyx striatus* | Striped Polecat | LC | 2 | x | | x | x | | | | | | | |
| **PERISSODACTYLA (Odd-toed ungulates)** | | | | | | | | | | | | | | |
| *Equus quagga* | Plains Zebra | LC | 5 | | | | | | | | | | | |
| **ARTIODACTYLA (Even-toed ungulates)** | | | | | | | | | | | | | | |
| *Potamochoerus larvatus* | Bushpig | LC | 1 | | | | | x | | | | | | |
| *Phacochoerus africanus* | Common Warthog | LC | 3 | | | | | | | | | | | |
| *Tragelaphus scriptus* | Bushbuck | LC | 2 | | | | x | | | | | | | |
| *Tragelaphus oryx* | Eland | LC | 5 | | | | | | | | | | | |
| *Connochaetes gnou* | Black Wildebeest | LC | 5 | | | | | | | | | | | |
| *Connochaetes taurinus* | Blue Wildebeest | LC | 5 | | | | | | | | | | | |
| *Alcelaphus buselaphus* | Red Hartebeest | LC | 5 | | | | | | | | | | | |

| ORDER &SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Damaliscus pygargus phillipsi* | Blesbok | LC | 5 | | | x | x | | | | | | | |
| *Sylvicapra grimmia* | Common Duiker | LC | 1 | x | | x | x | | x | x | | | x | |
| *Redunca arundinum* | Southern Reedbuck | LC | 5 | | | x | x | | | | | | | |
| *Redunca fulvorufula* | Mountain Reedbuck | LC | 1 | x | | x | x | | | | x | | | |
| *Pelea capreolus* | Grey Rhebok | LC | 5 | x | | x | x | | | | | | | |
| *Antidorcas marsupialis* | Springbok | LC | 5 | | | | | | | | | | | |
| *Ourebia ourebi* | Oribi | EN | 3 | | | | | | | | | | | |
| *Raphicerus campestris* | Steenbok | LC | 1 | x | | | x | | | x | | | | |
| *Aepyceros melampus* | Impala | LC | 5 | | | | | | | | | | | |
| *Oreotragus oreotragus* | Klipspringer | LC | 2 | | | x | | | | | | | | |

**KEY**

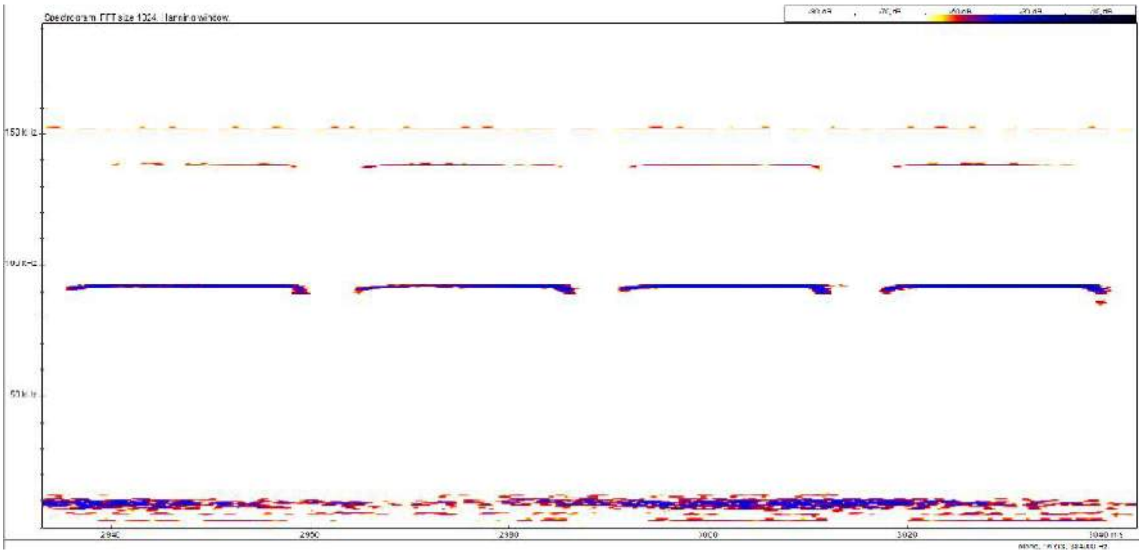
**LoO:** 1=Present, 2=Highly likely, 3=Moderately likely, 4=Unlikely, 5=Managed populations

**Status (SA Red List):** EN=Endangered; VU=Vulnerable; NT=Near Threatened; LC=Least Concern; DD=Data Deficient

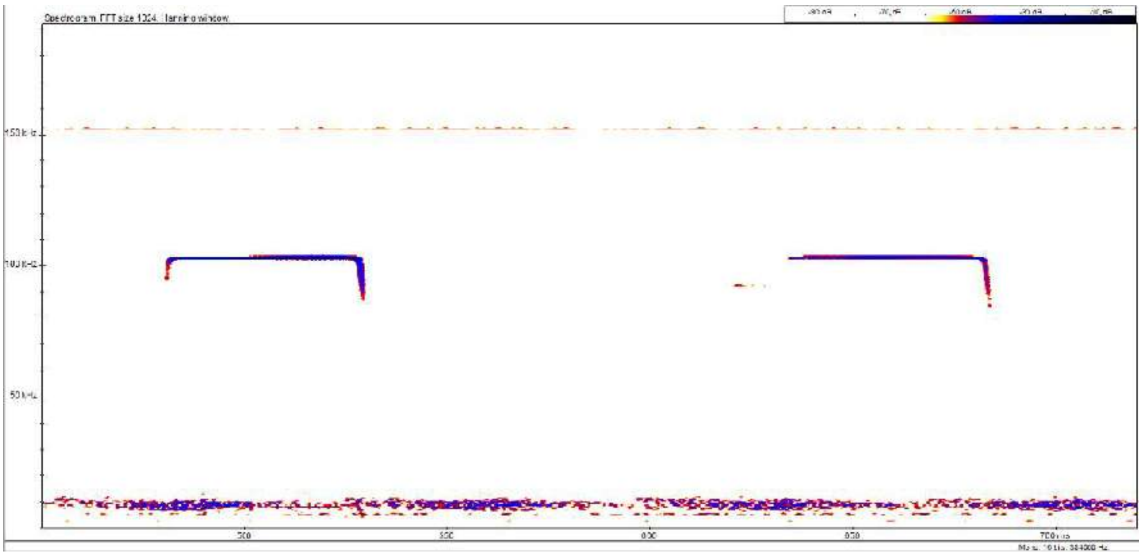
**Habitat:** AD=Adit; AL=Alien Bushclump; DG=Dry Grassland; SF=Scarp Forest; SV=Savanna; RG=Rocky Grassland; WT=Wetland

**Sources:** Friedmann & Daly (2004); NEM:BA (2007); Monadjem *et al.* (2010); MTPA pers. comm. (2013)

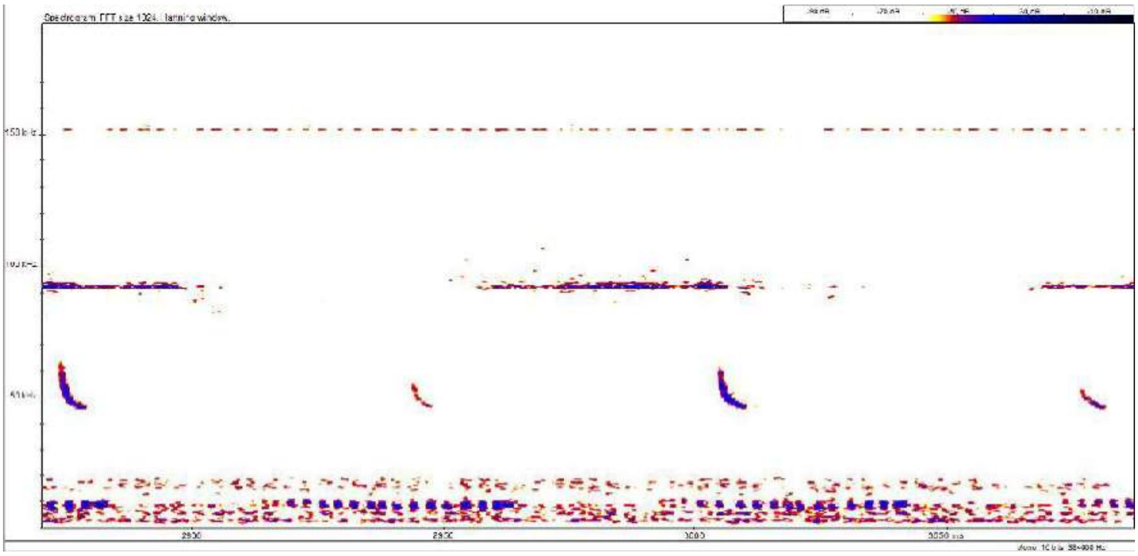
## 5.2. Appendix 2 Examples of recorded bat calls displayed in BatSound Pro.



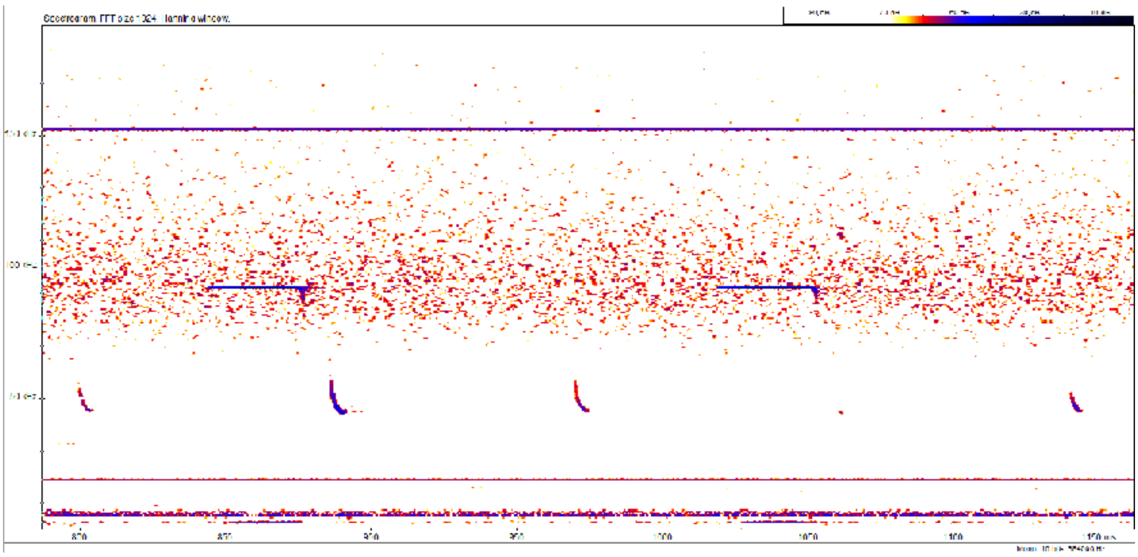
Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*)



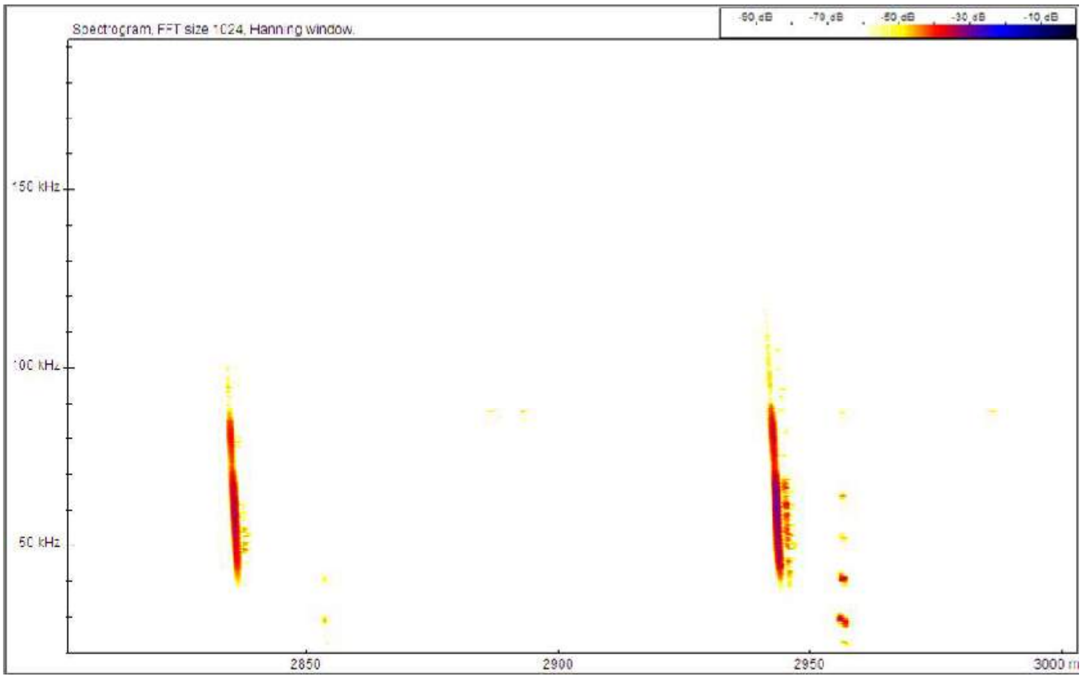
Swinny's Horseshoe Bat (*Rhinolophus swinnyi*)



Natal Clinging Bat (*Miniopterus natalensis*)



Rusty Pipistrelle (*Pipistrellus rusticus*)




Temminck's Hairy Bat (*Myotis tricolor*)

## 5.3. Appendix 3 Bird list for the study area

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 1 Atlas card | | | Pentad 2705_3015 3 Atlas cards | | | Pentad 2705_3020 1 Atlas card | | | Pentad 2710_3010 2 Atlas cards | | | Pentad 2710_3015 6 Atlas cards | | | Pentad 2710_3020 2 Atlas cards | | | Pentad 2715_3010 7 Atlas cards | | | Pentad 2715_3015 5 Atlas cards | | | Pentad 2715_3020 4 Atlas cards | | | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | |
| **2. Inland water birds** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 50 | *Phalacrocorax africanus* | Reed Cormorant | LC | | | 1 | | | | | | | | | | | | | | | | 2 | 29 | 1 | | | | | | | |
| 54 | *Ardea cinerea* | Grey Heron | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | | | | | |
| 55 | *Ardea melanocephala* | Black-headed Heron | LC | | | 2 | 1 | 33 | 1 | | | | | | | | | | 1 | 50 | 1 | 5 | 71 | | 3 | 60 | 1 | 1 | 25 | | |
| 56 | *Ardea goliath* | Goliath Heron | LC | | | | | | | | | | | | | | | | 1 | 50 | | | | | | | | | | | |
| 57 | *Ardea purpurea* | Purple Heron | LC | | | | | | | | | | | | | | | | 1 | 50 | | | | | | | | | | | |
| 58 | *Egretta alba* | Great Egret | LC | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| 59 | *Egretta garzetta* | Little Egret | LC | | | | | | | | | | | | | | | | | | | 1 | 14 | | | | | | | | |
| 60 | *Egretta intermedia* | Yellow-billed Egret | LC | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 61 | *Bubulcus ibis* | Cattle Egret | LC | 1 | 100 | | 1 | 33 | | | | | | | | | | | 1 | 50 | 1 | 3 | 43 | | | | | | | | |
| 72 | *Scopus umbretta* | Hamerkop | LC | 1 | 50 | | 1 | 33 | | | | | | | | | | | | | | 3 | 43 | | | | | | | | x |
| 80 | *Ciconia ciconia* | White Stork | LC | | | | 1 | 33 | | | | | | | | 1 | 17 | | | | | 1 | 14 | | 1 | 20 | 1 | 1 | 25 | | x |
| 81 | *Threskiornis aethiopicus* | African Sacred Ibis | LC | 1 | 100 | | | | | | | | | | | | | | 1 | 50 | | | | | | | | | | | |
| 82 | *Geronticus calvus* | Southern Bald Ibis | VU | 1 | 100 | 1 | 2 | 67 | 2 | | | | 1 | 50 | | 1 | 17 | | 1 | 50 | 1 | 3 | 43 | 2 | 3 | 60 | 1 | | | | |
| 84 | *Bostrychia hagedash* | Hadeda Ibis | LC | 1 | 100 | | 2 | 67 | 1 | 1 | 100 | 1 | 1 | 50 | 1 | 4 | 67 | 1 | 2 | 100 | 1 | 6 | 86 | 1 | 5 | 100 | 1 | 2 | 50 | | x |
| 85 | *Platalea alba* | African Spoonbill | LC | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 305 | *Chlidonias hybrida* | Whiskered Tern | LC | | | 1 | | | | | | | | | | | | | | | | 1 | 14 | | | | | | | | |
| **3. Ducks & wading birds** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | *Tachybaptus ruficollis* | Little Grebe | LC | | | 1 | | | | | | | | | | | | | | | | 3 | 43 | 1 | 1 | 20 | 3 | | | | |
| 88 | *Plectropterus gambensis* | Spur-winged Goose | LC | 1 | 100 | 1 | 1 | 33 | 1 | | | | 1 | 50 | | 2 | 33 | | 1 | 50 | 2 | 1 | 14 | 1 | 2 | 40 | | | | | |
| 89 | *Alopochen aegyptiacus* | Egyptian Goose | LC | 1 | 100 | 2 | 2 | 67 | 1 | 1 | 100 | 1 | | | | 1 | 17 | 1 | 2 | 100 | | 5 | 71 | 2 | 1 | 20 | 1 | | | | |
| 95 | *Anas sparsa* | African Black Duck | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | 1 | 20 | | | | | |
| 96 | *Anas undulata* | Yellow-billed Duck | LC | | | 1 | 1 | 33 | | 1 | 100 | | | | | 1 | 17 | | 1 | 50 | | 3 | 43 | 1 | 1 | 20 | | | | | |
| 97 | *Anas erythrorhyncha* | Red-billed Teal | LC | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 210 | *Gallinula chloropus* | Common Moorhen | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | | | | | |
| 212 | *Fulica cristata* | Red-knobbed Coot | LC | | | | 1 | 33 | | | | | | | | | | | 1 | 50 | | 4 | 57 | | 3 | 60 | | | | | |

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 1 Atlas card | | | Pentad 2705_3015 3 Atlas cards | | | Pentad 2705_3020 1 Atlas card | | | Pentad 2710_3010 2 Atlas cards | | | Pentad 2710_3015 6 Atlas cards | | | Pentad 2710_3020 2 Atlas cards | | | Pentad 2715_3010 7 Atlas cards | | | Pentad 2715_3015 5 Atlas cards | | | Pentad 2715_3020 4 Atlas cards | | | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | |
| 242 | *Vanellus coronatus* | Crowned Lapwing | LC | | | 1 | | | | | | | | | | 1 | 17 | | | | | 1 | 14 | | | | | | | | |
| 245 | *Vanellus armatus* | Blacksmith Lapwing | LC | 1 | 100 | | | | | | | 1 | 1 | 50 | 1 | | | | | | | 3 | 43 | 1 | | | | | | | |
| 247 | *Vanellus senegallus* | African Wattled Lapwing | LC | | | 1 | | | | | | | 1 | 50 | | 1 | 17 | | | | | 3 | 43 | | 1 | 20 | | | | | |
| 270 | *Himantopus himantopus* | Black-winged Stilt | LC | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| **4. Large terrestrial birds** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 105 | *Sagittarius serpentarius* | Secretarybird | NT | | | | | | | | | | | | | 3 | 50 | | | | | 1 | 14 | | | | | 2 | 50 | | x |
| 178 | *Scleroptila levaillantii* | Red-winged Francolin | LC | | | | | | | | | 1 | | | | 2 | 33 | | 1 | 50 | | | | | 1 | 20 | 1 | 1 | 25 | | x |
| 185 | *Pternistis swainsonii* | Swainson's Spurfowl | LC | 1 | 100 | | 1 | 33 | | | | | 1 | 50 | | 3 | 50 | | 1 | 50 | | 3 | 43 | | | | | | | | x |
| 189 | *Coturnix coturnix* | Common Quail | LC | | | | | | | | | | | | | 1 | 17 | | 1 | 50 | | 2 | 29 | | 1 | 20 | | | | | x |
| 192 | *Numida meleagris* | Helmeted Guineafowl | LC | 1 | 100 | | 1 | 33 | | 1 | 100 | 1 | 2 | 100 | 2 | 4 | 67 | | | | | 3 | 43 | 3 | 1 | 20 | 1 | 2 | 50 | | x |
| 214 | *Balearica regulorum* | Grey Crowned Crane | VU | | | | | | | | | | | | | | | | | | | 2 | 29 | | | | | | | | |
| 216 | *Anthropoides paradiseus* | Blue Crane | VU | | | | | | 1 | | | | | | | | | | | | | | | | 1 | 20 | 1 | 1 | 25 | | |
| 219 | *Neotis denhami* | Denham's Bustard | VU | | | | | | | | | | | | | 2 | 33 | | | | | | | | 1 | 20 | | | | | |
| 222 | *Eupodotis senegalensis* | White-bellied Korhaan | VU | | | | 1 | 33 | | 1 | 100 | | 1 | 50 | | | | | | | | | | | | | | 1 | 25 | | x |
| 223 | *Eupodotis caerulescens* | Blue Korhaan | NT | | | | | | | | | | 1 | 50 | | | | | | | | | | | | | | | | | |
| 227 | *Lissotis melanogaster* | Black-bellied Bustard | NT | | | | | | | | | | 1 | 50 | | 2 | 33 | 1 | | | | | | | | | | | | | x |
| 114 | *Falco biarmicus* | Lanner Falcon | NT | | | | 1 | 33 | | | | | | | | 1 | 17 | | | | | 1 | 14 | | | | | | | | |
| **5. Raptors** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 119 | *Falco amurensis* | Amur Falcon | LC | | | | 1 | 33 | | | | | | | | 3 | 50 | | 1 | 50 | | 1 | 14 | 1 | 1 | 20 | | | | | x |
| 123 | *Falco rupicolus* | Rock Kestrel | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |
| 129 | *Milvus aegyptius* | Yellow-billed Kite | LC | | | | | | | | | | 1 | 50 | | | | | | | | | | | | | 1 | | | | |
| 130 | *Elanus caeruleus* | Black-shouldered Kite | LC | 1 | 100 | | | | | | 0 | 1 | 1 | 50 | 1 | 1 | 17 | | | | 1 | 2 | 29 | 2 | 2 | 40 | 1 | | | | |
| 143 | *Stephanoaetus coronatus* | African Crowned Eagle | NT | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| 145 | *Circaetus cinereus* | Brown Snake-Eagle | LC | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| 149 | African Fish-eagle | *Haliaeetus vocifer* | LC | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| 152 | *Buteo rufofuscus* | Jackal Buzzard | LC | | | | 1 | 33 | | 1 | 100 | | 2 | 100 | | 4 | 67 | 1 | 1 | 50 | 1 | 6 | 86 | | 4 | 80 | 1 | 4 | 10 0 | | x |
| 154 | *Buteo vulpinus* | Steppe Buzzard | LC | | | 2 | | | 1 | 1 | 100 | | 2 | 100 | 1 | 2 | 33 | | | | 1 | 3 | 43 | 1 | 3 | 60 | 1 | | | 1 | x |

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 1 Atlas card | | | Pentad 2705_3015 3 Atlas cards | | | Pentad 2705_3020 1 Atlas card | | | Pentad 2710_3010 2 Atlas cards | | | Pentad 2710_3015 6 Atlas cards | | | Pentad 2710_3020 2 Atlas cards | | | Pentad 2715_3010 7 Atlas cards | | | Pentad 2715_3015 5 Atlas cards | | | Pentad 2715_3020 4 Atlas cards | | | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | |
| 171 | *Polyboroides typus* | African Harrier-Hawk | LC | | | | 1 | 33 | 1 | | | | | | | | | | | | | 1 | 14 | | | | | | | | |
| **6. Owls & nightjars** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 360 | *Tyto capensis* | African Grass-owl | VU | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| 368 | *Bubo africanus* | Spotted Eagle-owl | LC | | | | | | | | | | 1 | 50 | | | | | | | | | | | | | | | | | |
| 373 | *Caprimulgus pectoralis* | Fiery-necked Nightjar | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | x |
| **7. Sandgrouse, doves etc** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 311 | *Columba guinea* | Speckled Pigeon | LC | | | | | | | | | | 1 | 50 | 1 | 2 | 33 | 1 | | | | 3 | 43 | | | | | 1 | 25 | | x |
| 312 | *Columba arquatrix* | African Olive Pigeon | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | x |
| 314 | *Streptopelia semitorquata* | Red-eyed Dove | LC | | | | 1 | 33 | | | | 1 | | | | 2 | 33 | | | | | 5 | 71 | 1 | 1 | 20 | | 2 | 50 | | x |
| 316 | *Streptopelia capicola* | Cape Turtle Dove | LC | 1 | 100 | | 2 | 67 | | 1 | 100 | 1 | 1 | 50 | 2 | 5 | 83 | 1 | 2 | 100 | | 5 | 71 | | 4 | 80 | 1 | 3 | 75 | | x |
| 317 | *Streptopelia senegalensis* | Laughing Dove | LC | 1 | 100 | | 1 | 33 | | | | 1 | | | | 1 | 17 | | 1 | 50 | | 3 | 43 | | | | | 1 | 25 | | x |
| 318 | *Oena capensis* | Namaqua Dove | LC | | | | 1 | 33 | | | | | | | | | | | | | | | | | | | | | | | |
| 322 | *Aplopelia larvata* | Lemon Dove | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |
| 343 | *Cuculus solitarius* | Red-chested Cuckoo | LC | | | | 1 | 33 | 2 | | | | 1 | 50 | | 2 | 33 | 1 | | | | 3 | 43 | | 4 | 80 | 1 | 2 | 50 | | x |
| 344 | *Cuculus clamosus* | Black Cuckoo | LC | | | | | | 2 | | | | 1 | 50 | 1 | 2 | 33 | 2 | | | | | | | 2 | 40 | 1 | 2 | 50 | | x |
| 351 | *Chrysococcyx klaas* | Klaas's Cuckoo | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | | | | | |
| 352 | *Chrysococcyx caprius* | Diderick Cuckoo | LC | | | | | | 1 | | | | 1 | 50 | | 4 | 67 | 3 | 1 | 50 | | 1 | 14 | | 1 | 20 | 1 | 2 | 50 | 1 | x |
| **8. Aerial feeders, etc** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 380 | *Apus barbatus* | African Black Swift | LC | | | | 1 | 33 | | | | | 1 | 50 | | 2 | 33 | | | | | | | | 1 | 20 | | | | 1 | x |
| 383 | *Apus caffer* | White-rumped Swift | LC | | | | | | | | | | 1 | 50 | | 3 | 50 | | 1 | 50 | | 2 | 29 | | 3 | 60 | | 3 | 75 | 1 | x |
| 384 | *Apus horus* | Horus Swift | LC | 1 | 100 | | | | | | | | | | | 2 | 33 | | | | | | | | | | | | | | |
| 385 | *Apus affinis* | Little Swift | LC | | | | | | | 1 | 100 | | | | | 1 | 17 | | 1 | 50 | | | | | | | | | | | |
| 386 | *Tachymarptis melba* | Alpine Swift | LC | | | | | | | | | | 1 | 50 | | | | | | | | | | | | | | 1 | 25 | | |
| 387 | *Cypsiurus parvus* | African Palm-Swift | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | |
| 390 | *Colius striatus* | Speckled Mousebird | LC | | | | | | | | | | 1 | 50 | | 3 | 50 | 1 | | | | | | | 2 | 40 | 1 | | | | x |
| 395 | *Megaceryle maximus* | Giant Kingfisher | LC | | | | | | | | | | | | | 2 | 33 | | | | | | | | | | | | | | x |
| 397 | *Alcedo cristata* | Malachite Kingfisher | LC | | | | | | | | | 1 | | | | 2 | 33 | | | | | | | | | | | | | | x |
| 402 | *Halcyon albiventris* | Brown-hooded Kingfisher | LC | | | | | | | 1 | 100 | | 1 | 50 | | 1 | 17 | | | | | | | | | | | | | | x |

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 1 Atlas card | | | Pentad 2705_3015 3 Atlas cards | | | Pentad 2705_3020 1 Atlas card | | | Pentad 2710_3010 2 Atlas cards | | | Pentad 2710_3015 6 Atlas cards | | | Pentad 2710_3020 2 Atlas cards | | | Pentad 2715_3010 7 Atlas cards | | | Pentad 2715_3015 5 Atlas cards | | | Pentad 2715_3020 4 Atlas cards | | | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | |
| 418 | *Upupa africana* | African Hoopoe | LC | | | | | | | | | | | | | | | 1 | | | | | | | 1 | 20 | 2 | | | | |
| 419 | *Phoeniculus purpureus* | Green Wood-hoopoe | LC | | | | | | | | | | | | | 2 | 33 | | | | | | | | | | | | | | |
| 431 | *Lybius torquatus* | Black-collared Barbet | LC | | | | 1 | 33 | | | | | | | | 3 | 50 | 1 | 1 | 50 | | | | | 1 | 20 | 1 | 2 | 50 | | x |
| 440 | *Indicator indicator* | Greater Honeyguide | LC | | | | | | | | | | | | | 1 | 17 | 1 | | | | | | | | | | | | | x |
| 442 | *Indicator minor* | Lesser Honeyguide | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | x |
| 443 | *Prodotiscus regulus* | Brown-backed Honeybird | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | 2 | | | | |
| 445 | *Geocolaptes olivaceus* | Ground Woodpecker | LC | | | | | | | | | | 1 | 50 | | 2 | 33 | | | | | | | | | | | 1 | 25 | | x |
| 447 | *Campethera abingoni* | Golden-tailed Woodpecker | LC | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| 452 | *Dendropicos griseocephalus* | Olive Woodpecker | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | 1 | 25 | | x |
| 453 | *Jynx ruficollis* | Red-throated Wryneck | LC | | | | | | | | | | | | | 1 | 17 | 1 | 1 | 50 | | | | | 1 | 20 | 1 | | | | x |
| 493 | *Hirundo rustica* | Barn Swallow | LC | 1 | 100 | 2 | 3 | 100 | 1 | 1 | 100 | | 2 | 100 | 2 | 5 | 83 | 3 | 2 | 100 | | 4 | 57 | | 3 | 60 | 3 | 2 | 50 | | x |
| 495 | *Hirundo albigularis* | White-throated Swallow | LC | 1 | 100 | | 1 | 33 | | | | | 2 | 100 | 1 | 3 | 50 | 1 | 2 | 100 | | 4 | 57 | 1 | 3 | 60 | | 2 | 50 | | x |
| 502 | *Hirundo cucullata* | Greater Striped Swallow | LC | 1 | 100 | 1 | 3 | 100 | 2 | | | | 2 | 100 | 1 | 4 | 67 | 2 | 2 | 100 | 1 | 3 | 43 | | 3 | 60 | 4 | 4 | 100 | | x |
| 503 | *Hirundo abyssinica* | Lesser Striped Swallow | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |
| 504 | *Hirundo spilodera* | South African Cliff-swallow | LC | | | | 2 | 67 | | 1 | 100 | | 1 | 50 | | 1 | 17 | 2 | 1 | 50 | | | | | 1 | 20 | | | | | |
| 506 | *Hirundo fuligula* | Rock Martin | LC | | | | | | | | | | | | | 2 | 33 | | 1 | 50 | | | | | | | | 2 | 50 | | x |
| 507 | *Delichon urbicum* | Common House Martin | LC | | | | 3 | 100 | | | | | | | | 2 | 33 | | | | | | | | | | | | | | x |
| 509 | *Riparia paludicola* | Brown-throated Martin | LC | | | 1 | 1 | 33 | | | 0 | 1 | | | | | | | | | | | | | | | | | | | |
| 510 | *Riparia cincta* | Banded Martin | LC | 1 | 100 | 1 | 2 | 67 | 1 | 1 | 100 | 1 | 2 | 100 | 2 | 6 | 100 | 2 | 2 | 100 | | 2 | 29 | | 3 | 60 | 3 | 2 | 50 | | x |
| 511 | *Psalidoprocne holomelaena* | Black Saw-wing | LC | | | | | | | | | | | | | 2 | 33 | 1 | | | | 1 | 14 | | 1 | 20 | | 1 | 25 | | x |
| **9. Cryptic & elusive insect-eaters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 458 | *Mirafra africana* | Rufous-naped Lark | LC | 1 | 100 | | | | | 1 | 100 | | 1 | 50 | | 4 | 67 | 1 | 1 | 50 | | | | | | | 1 | | | | x |
| 474 | *Chersomanes albofasciata* | Spike-heeled Lark | LC | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| 488 | *Calandrella cinerea* | Red-capped Lark | LC | | | | 1 | 33 | | | | | | | | | | | 1 | 50 | | | | | 2 | 40 | | | | | |
| 542 | *Lioptilus nigricapillus* | Bush Blackcap | NT | | | | | | | | | | 1 | 50 | | 1 | 17 | | | | | | | | 2 | 40 | 2 | 1 | 25 | | x |
| 545 | *Pycnonotus tricolor* | Dark-capped Bulbul | LC | | | | 3 | 100 | 1 | | | 1 | 2 | 100 | 1 | 6 | 100 | 1 | 1 | 50 | | 6 | 86 | 1 | 4 | 80 | 3 | 4 | 100 | | x |
| 546 | *Phyllastrephus terrestris* | Terrestrial Brownbul | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 1 Atlas card | | | Pentad 2705_3015 3 Atlas cards | | | Pentad 2705_3020 1 Atlas card | | | Pentad 2710_3010 2 Atlas cards | | | Pentad 2710_3015 6 Atlas cards | | | Pentad 2710_3020 2 Atlas cards | | | Pentad 2715_3010 7 Atlas cards | | | Pentad 2715_3015 5 Atlas cards | | | Pentad 2715_3020 4 Atlas cards | | | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | |
| 551 | *Andropadus importunus* | Sombre Greenbul | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | | 1 | 25 | | |
| 599 | *Phylloscopus trochilus* | Willow Warbler | LC | | | | 1 | 33 | | | | | 2 | 100 | | 1 | 17 | | | | | | | | 1 | 20 | | | | | x |
| 609 | *Bradypterus baboecala* | Little Rush-warbler | LC | | | | | | | | | | | | | | | | | | | 2 | 29 | | | | | | | | |
| 610 | *Bradypterus barratti* | Barratt's Warbler | LC | | | | | | | | | | 1 | 50 | | | | | | | | 2 | 29 | | 3 | 60 | 1 | 1 | 25 | | |
| 616 | *Schoenicola brevirostris* | Fan-tailed Grassbird | NT | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | |
| 618 | *Sphenoeacus afer* | Cape Grassbird | LC | | | | 2 | 67 | 1 | 1 | 100 | | 1 | 50 | | 4 | 67 | | | | | 3 | 43 | 1 | 2 | 40 | 2 | 1 | 25 | | x |
| 622 | *Apalis thoracica* | Bar-throated Apalis | LC | | | | 1 | 33 | | | | | | | | 3 | 50 | | | | | 2 | 29 | | 2 | 40 | 4 | 1 | 25 | | x |
| 629 | *Cisticola juncidis* | Zitting Cisticola | LC | | | | 2 | 67 | | 1 | 100 | | 2 | 100 | | 4 | 67 | | 2 | 100 | 1 | 6 | 86 | 1 | 3 | 60 | | 3 | 75 | | x |
| 631 | *Cisticola textrix* | Cloud Cisticola | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | 2 | 40 | | 1 | 25 | | |
| 634 | *Cisticola ayresii* | Wing-snapping Cisticola | LC | | | | 1 | 33 | | 1 | 100 | | 1 | 50 | | 4 | 67 | 1 | 2 | 100 | | | | | 3 | 60 | | 1 | 25 | | x |
| 635 | *Cisticola cinnamomeus* | Pale-crowned Cisticola | LC | | | | | | | | | | | | | 2 | 33 | 1 | | | | 1 | 14 | | 1 | 20 | | | | | x |
| 637 | *Cisticola fulvicapilla* | Neddicky | LC | | | | | | | | | | 2 | 100 | | 3 | 50 | | 1 | 50 | | | | | | | | 1 | 25 | | x |
| 639 | *Cisticola lais* | Wailing Cisticola | LC | | | | 1 | 33 | | | | | | | | 4 | 67 | | | | | 2 | 29 | | 2 | 40 | | 1 | 25 | | x |
| 646 | *Cisticola tinniens* | Levaillant's Cisticola | LC | 1 | 100 | 2 | 3 | 100 | 1 | 1 | 100 | | 1 | 50 | 1 | 5 | 83 | 2 | 1 | 50 | | 5 | 71 | | 2 | 40 | | 2 | 50 | | x |
| 648 | *Cisticola aberrans* | Lazy Cisticola | LC | | | | 1 | 33 | | | | | | | | 2 | 33 | | | | | 1 | 14 | | | | 1 | 1 | 25 | | x |
| 649 | *Prinia subflava* | Tawny-flanked Prinia | LC | | | 1 | | 0 | 1 | | | | | | | | | | | | | 1 | 14 | | | | | | | | |
| 650 | *Prinia flavicans* | Black-chested Prinia | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | x |
| 666 | *Chloropeta natalensis* | Dark-capped Yellow Warbler | LC | | | | 1 | 33 | | | | | 1 | 50 | | 4 | 67 | 1 | | | | 2 | 29 | | 1 | 20 | 1 | | | | x |
| 671 | *Phylloscopus ruficapilla* | Yellow-throated Woodland Warbler | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |
| 686 | *Motacilla capensis* | Cape Wagtail | LC | | | 1 | 2 | 67 | 1 | 1 | 100 | 1 | 1 | 50 | 1 | 4 | 67 | 2 | 1 | 50 | | 3 | 43 | 1 | 2 | 40 | 2 | | | | x |
| 692 | *Anthus cinnamomeus* | African Pipit | LC | 1 | 100 | | 1 | 33 | | 1 | 100 | 1 | 1 | 50 | 2 | 5 | 83 | 2 | 2 | 100 | | 4 | 57 | 1 | 2 | 40 | 1 | 2 | 50 | | x |
| 693 | *Anthus similis* | Long-billed Pipit | LC | | | | 2 | 67 | | | | | | | | 5 | 83 | | | | | | | | 2 | 40 | | 2 | 50 | | x |
| 694 | *Anthus leucophrys* | Plain-backed Pipit | LC | | | | 1 | 33 | | 1 | 100 | | 1 | 50 | | | | | | | | | | | 1 | 20 | | | | | |
| 695 | *Anthus vaalensis* | Buffy Pipit | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | x |
| 696 | *Anthus lineiventris* | Striped Pipit | LC | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| 703 | *Macronyx capensis* | Cape Longclaw | LC | | | 1 | 2 | 67 | 1 | 1 | 100 | 1 | | | | 5 | 83 | 1 | 2 | 100 | | 3 | 43 | | 5 | 100 | 2 | 1 | 25 | | x |
| 1049 | *Prinia hypoxantha* | Drakensberg Prinia | LC | | | | 1 | 33 | | | | | 2 | 100 | | 3 | 50 | | | | | 3 | 43 | | 2 | 40 | | 1 | 25 | | x |

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 | | | Pentad 2705_3015 | | | Pentad 2705_3020 | | | Pentad 2710_3010 | | | Pentad 2710_3015 | | | Pentad 2710_3020 | | | Pentad 2715_3010 | | | Pentad 2715_3015 | | | Pentad 2715_3020 | | | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 Atlas card | | | 3 Atlas cards | | | 1 Atlas card | | | 2 Atlas cards | | | 6 Atlas cards | | | 2 Atlas cards | | | 7 Atlas cards | | | 5 Atlas cards | | | 4 Atlas cards | | | |
| | | | | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | |
| 1183 | *Mirafra fasciolata* | Eastern Clapper Lark | LC | | | | | | | | | 1 | | | | 1 | 17 | | | | | | | | | | | | | | |
| 4126 | *Certhilauda semitorquata* | Eastern Long-billed Lark | LC | | | | 1 | 33 | | | | | | | | | | | 1 | 50 | | | | | | | | | | | |
| **10. Regular insect-eaters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 513 | *Campephaga flava* | Black Cuckooshrike | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | 1 | 25 | | |
| 517 | *Dicrurus adsimilis* | Fork-tailed Drongo | LC | | | | | | | | | | 1 | 50 | | 5 | 83 | | | | | 2 | 29 | | 1 | 20 | | 1 | 25 | | x |
| 521 | *Oriolus larvatus* | Black-headed Oriole | LC | | | | | | | | | | 1 | 50 | | 4 | 67 | 2 | | | | | | | 2 | 40 | | 1 | 25 | | x |
| 523 | *Corvus capensis* | Cape Crow | LC | | | | 3 | 100 | 1 | 1 | 100 | | | | | 2 | 33 | | 1 | 50 | | 5 | 71 | 5 | 4 | 80 | 2 | | | | x |
| 527 | *Parus niger* | Southern Black Tit | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | |
| 552 | *Turdus libonyanus* | Kurrichane Thrush | LC | | | | | | | | | | | | | 2 | 33 | | | | | | | | | | | | | | x |
| 557 | *Psophocichla litsipsirupa* | Groundscraper Thrush | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |
| 559 | *Monticola rupestris* | Cape Rock-Thrush | LC | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 50 | 1 | |
| 560 | *Monticola explorator* | Sentinel Rock-Thrush | LC | | | | | | | | | | | | | | | | 1 | 50 | | 1 | 14 | | | | 1 | | | | |
| 564 | *Oenanthe monticola* | Mountain Wheatear | LC | | | | | | | | | | | | | 2 | 33 | | | | | 1 | 14 | | | | | | | | x |
| 569 | *Oenanthe bifasciata* | Buff-streaked Chat | LC | | | 1 | 1 | 33 | | | | 1 | | | | 5 | 83 | 1 | 1 | 50 | | 4 | 57 | 1 | | | | 1 | 25 | | x |
| 570 | *Cercomela familiaris* | Familiar Chat | LC | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
| 573 | *Thamnolaea cinnamomeiventris* | Mocking Cliff-Chat | LC | | | | | | | | | | | | | 5 | 83 | | | | | | | | | | | | | | x |
| 575 | *Myrmecocichla formicivora* | Anteating Chat | LC | 1 | 100 | 2 | 3 | 100 | 1 | 1 | 100 | | 2 | 100 | 2 | 6 | 100 | 3 | 1 | 50 | 1 | 2 | 29 | 1 | 3 | 60 | 2 | 3 | 75 | | x |
| 576 | *Saxicola torquatus* | African Stonechat | LC | | | | 3 | 100 | 1 | 1 | 100 | 1 | 2 | 100 | 3 | 6 | 100 | 2 | 2 | 100 | | 7 | 100 | 2 | 4 | 80 | 3 | 3 | 75 | | x |
| 578 | *Cossypha dichroa* | Chorister Robin-chat | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | 1 | 25 | | x |
| 581 | *Cossypha caffra* | Cape Robin-chat | LC | | | | 2 | 67 | 1 | | 0 | 1 | 2 | 100 | | 4 | 67 | 1 | | | | 5 | 71 | 1 | 5 | 100 | 4 | 2 | 50 | | x |
| 589 | *Pogonocichla stellata* | White-starred Robin | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |
| 655 | *Muscicapa adusta* | African Dusky Flycatcher | LC | | | | | | | | | | | | | 2 | 33 | | | | | | | | | | | | | | x |
| 665 | *Sigelus silens* | Fiscal Flycatcher | LC | | | | | | | | | | 1 | 50 | | 3 | 50 | | | | | | | | 1 | 20 | | | | | x |
| 672 | *Batis capensis* | Cape Batis | LC | | | | | | | | | | | | | 2 | 33 | | | | | | | | 4 | 80 | 1 | 1 | 25 | | x |
| 682 | *Terpsiphone viridis* | African Paradise-flycatcher | LC | | | | 1 | 33 | 2 | | | | 2 | 100 | | 4 | 67 | 2 | 1 | 50 | | 1 | 14 | | 3 | 60 | 1 | 1 | 25 | | x |
| 707 | *Lanius collaris* | Common Fiscal | LC | 1 | 100 | 2 | 2 | 67 | 1 | | | 1 | 2 | 100 | 2 | 6 | 100 | 2 | 1 | 50 | 1 | 6 | 86 | 2 | 5 | 100 | 1 | 3 | 75 | | x |
| 709 | *Laniarius ferrugineus* | Southern Boubou | LC | | | | 1 | 33 | | | | | 1 | 50 | | 3 | 50 | 1 | | | | 2 | 29 | | 3 | 60 | 1 | 2 | 50 | | x |

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 (1 Atlas card) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2705_3015 (3 Atlas cards) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2705_3020 (1 Atlas card) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2710_3010 (2 Atlas cards) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2710_3015 (6 Atlas cards) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2710_3020 (2 Atlas cards) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2715_3010 (7 Atlas cards) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2715_3015 (5 Atlas cards) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Pentad 2715_3020 (4 Atlas cards) Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 712 | *Dryoscopus cubla* | Black-backed Puffback | LC | | | | | | | | | | | | | 3 | 50 | | | | | | | | | | | | | | x |
| 715 | *Tchagra senegalus* | Black-crowned Tchagra | LC | | | | | | | | | | | | | 2 | 33 | | | | | | | | | | | | | | x |
| 717 | *Telophorus olivaceus* | Olive Bush-Shrike | LC | | | | | | | | | | | | | | | | | | | | | | 3 | 60 | 2 | 1 | 25 | | |
| 722 | *Telophorus zeylonus* | Bokmakierie | LC | 1 | 100 | | 1 | 33 | | | | 1 | 2 | 100 | 2 | 4 | 67 | | 1 | 50 | | 7 | 100 | | 5 | 100 | 2 | 1 | 25 | | x |
| 731 | *Nilaus afer* | Brubru | LC | | | | | | | | | | | | | 1 | 17 | 1 | | | | | | | | | | | | | |
| 736 | *Cinnyricinclus leucogaster* | Violet-backed Starling | LC | | | | | | | | | | 1 | 50 | | 1 | 17 | | | | | | | | | | | | | | |
| 745 | *Onychognathus morio* | Red-winged Starling | LC | | | | | | 1 | | | | 1 | 50 | | 1 | 17 | 2 | 1 | 50 | | 2 | 29 | | 4 | 80 | | 4 | 100 | | |
| 746 | *Spreo bicolor* | Pied Starling | LC | | | | 3 | 100 | 1 | | | 1 | 1 | 50 | | 3 | 50 | 1 | 2 | 100 | 1 | 6 | 86 | 1 | 2 | 40 | 1 | 2 | 50 | 1 | x |
| 1104 | *Turdus smithi* | Karoo Thrush | LC | | | | | | | | | | | | | | | | | | | | | | 2 | 40 | | | | | |
| 1105 | *Turdus olivaceus* | Olive Thrush | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | 1 | | | | |
| **11. Oxpeckers & nectar feeders** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 751 | *Nectarinia famosa* | Malachite Sunbird | LC | | | | 1 | 33 | | | | | | | | 3 | 50 | | | | | | | | 4 | 80 | 3 | 1 | 25 | | x |
| 758 | *Cinnyris afer* | Greater Double-collared Sunbird | LC | | | | | | | | | | | | | 2 | 33 | | | | | 1 | 14 | | 2 | 40 | 1 | | | | x |
| 772 | *Chalcomitra amethystina* | Amethyst Sunbird | LC | | | | 1 | 33 | | | | | | | | | | | | | | | | | 1 | 20 | | | | | |
| 1172 | *Zosterops virens* | Cape White-eye | LC | | | | 1 | 33 | | | | | 1 | 50 | | 3 | 50 | 2 | | | | 2 | 29 | | 4 | 80 | | 2 | 50 | | x |
| **12. Seed-eaters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 784 | *Passer domesticus* | House Sparrow | AL | | | | | | | | | | | | | | | | 1 | 50 | | | | | | | | | | | |
| 786 | *Passer melanurus* | Cape Sparrow | LC | | | | 1 | 33 | | 1 | 100 | | | | 1 | 1 | 17 | | 2 | 100 | 3 | 1 | 14 | | | | | | | | |
| 797 | *Ploceus cucullatus* | Village Weaver | LC | | | | | | | | | | | | | 1 | 17 | | | | | | | | | | | | | | |
| 799 | *Ploceus capensis* | Cape Weaver | LC | 1 | 100 | | 2 | 67 | | | | | | | | 5 | 83 | | 1 | 50 | | 4 | 57 | | 1 | 20 | | | | | x |
| 803 | *Ploceus velatus* | Southern Masked Weaver | LC | 1 | 100 | 1 | 2 | 67 | 1 | 1 | 100 | 1 | 1 | 50 | 2 | 2 | 33 | | 1 | 50 | | 3 | 43 | | 1 | 20 | 2 | 2 | 50 | 1 | x |
| 805 | *Quelea quelea* | Red-billed Quelea | LC | | | 1 | | | | | | | | | | 1 | 17 | | 1 | 50 | | 3 | 43 | | | | | | | | |
| 808 | *Euplectes orix* | Southern Red Bishop | LC | 1 | 100 | 2 | 3 | 100 | 1 | 1 | 100 | | 2 | 100 | 3 | 3 | 50 | 1 | 2 | 100 | 2 | 7 | 100 | 2 | 3 | 60 | 1 | 1 | 25 | | x |
| 810 | *Euplectes capensis* | Yellow Bishop | LC | | | | 1 | 33 | | | | | | | | | | | | | | | | | | | 1 | | | | |
| 812 | *Euplectes afer* | Yellow-crowned Bishop | LC | 1 | 100 | 1 | 1 | 33 | 1 | 1 | 100 | | 1 | 50 | | 1 | 17 | 1 | 1 | 50 | | 5 | 71 | | 1 | 20 | | | | | x |
| 813 | *Euplectes ardens* | Red-collared Widowbird | LC | | | | 3 | 100 | 1 | | | 1 | 2 | 100 | | 4 | 67 | 2 | 1 | 50 | | 2 | 29 | | 2 | 40 | 2 | 1 | 25 | | x |
| 816 | *Euplectes axillaris* | Fan-tailed Widowbird | LC | | | 2 | 2 | 67 | 1 | 1 | 100 | | 1 | 50 | 1 | 4 | 67 | 1 | | | 1 | 4 | 57 | 1 | | | 1 | | | | x |

| GROUP & No. | SPECIES | COMMON NAME | STATUS | Pentad 2705_3010 1 Atlas card | | | Pentad 2705_3015 3 Atlas cards | | | Pentad 2705_3020 1 Atlas card | | | Pentad 2710_3010 2 Atlas cards | | | Pentad 2710_3015 6 Atlas cards | | | Pentad 2710_3020 2 Atlas cards | | | Pentad 2715_3010 7 Atlas cards | | | Pentad 2715_3015 5 Atlas cards | | | Pentad 2715_3020 4 Atlas cards | | | SITE (DEC & NSS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | Full protocol records | Reporting rate (%) | Ad hoc/ incidental records | |
| 818 | *Euplectes progne* | Long-tailed Widowbird | LC | 1 | 100 | 2 | 3 | 100 | 1 | 1 | 100 | | 1 | 50 | 2 | | | | 2 | 100 | 1 | 7 | 100 | 2 | 4 | 80 | 1 | 2 | 50 | | x |
| 825 | *Coccopygia melanotis* | Swee Waxbill | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | | | | | |
| 833 | *Lagonosticta rubricata* | African Firefinch | LC | | | | | | | | | | 1 | 50 | | | | | | | | | | | | | | 1 | 25 | | |
| 838 | *Amandava subflava* | Orange-breasted Waxbill | LC | | | | 1 | 33 | | | | | | | | | | | | | | | | | | | | | | | |
| 839 | *Uraeginthus angolensis* | Blue Waxbill | LC | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 25 | | |
| 843 | *Estrilda astrild* | Common Waxbill | LC | 1 | 100 | | 3 | 100 | | 1 | 100 | | 2 | 100 | | 5 | 83 | | | | | 1 | 14 | | 1 | 20 | 2 | 1 | 25 | | x |
| 844 | *Ortygospiza atricollis* | African Quailfinch | LC | | | | 1 | 33 | | | 0 | | 1 | 50 | | 2 | 33 | | | | | | | | | | | | | | x |
| 846 | *Vidua macroura* | Pin-tailed Whydah | LC | 1 | 100 | | 2 | 67 | | 1 | 100 | | 2 | 100 | 2 | 6 | 100 | 2 | 1 | 50 | | 3 | 43 | | 2 | 40 | 2 | 2 | 50 | | x |
| 849 | *Vidua funerea* | Dusky Indigobird | LC | | | | | | | | | | 1 | 50 | | | | | | | | | | | | | | | | | |
| 857 | *Serinus canicollis* | Cape Canary | LC | 1 | 100 | | 2 | 67 | | | | | 2 | 100 | 2 | 4 | 67 | | | | | 6 | 86 | 1 | 5 | 100 | 2 | 2 | 50 | | x |
| 858 | *Crithagra scotops* | Forest Canary | LC | | | | | | | | | | | | | | | | | | | | | | 1 | 20 | | | | | |
| 859 | *Crithagra mozambicus* | Yellow-fronted Canary | LC | | | | 1 | 33 | | | | | 1 | 50 | | 2 | 33 | | | | | | | | 1 | 20 | | 1 | 25 | | x |
| 860 | *Crithagra atrogularis* | Black-throated Canary | LC | 1 | 100 | | 1 | 33 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| 867 | *Crithagra gularis* | Streaky-headed Seedeater | LC | | | | | | | | | | 1 | 50 | | 1 | 17 | | | | | 1 | 14 | | | | 1 | | | | x |
| 872 | *Emberiza tahapisi* | Cinnamon-breasted Bunting | LC | | | | 1 | 33 | | | | | | | | 1 | 17 | | | | | | | | | | | | | | |
| 873 | *Emberiza capensis* | Cape Bunting | LC | | | | | | | | | 1 | | | | 2 | 33 | | | | | 1 | 14 | | | | | | | | |
| 874 | *Emberiza flaviventris* | Golden-breasted Bunting | LC | | | | | | | | | | 1 | 50 | 1 | | | | | | | | | | | | | | | | |
| 4142 | *Passer diffusus* | Southern Grey-headed Sparrow | LC | 1 | 100 | | 1 | 33 | | 1 | 100 | | 2 | 100 | 3 | 5 | 83 | 1 | 1 | 50 | | 1 | 14 | | 3 | 60 | 1 | 1 | 25 | | x |

**Key:**

**Status (SA Red List):** VU=Vulnerable; NT=Near Threatened; LC=Least Concern

**Sources:** NEM:BA (2007); MTPA pers. comm.. (2013); SABAP 2 website (2013)

## 5.4. Appendix 4 Reptile list for the study area

| | | | | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FAMILY & SPECIES** | **COMMON NAME** | **STATUS** | **LoO** | **2730AA** | **2730AB** | **2730AC** | **2730AD** | **SF** | **SV** | **DG** | **RG** | **WT** | **AL** | **AD** |
| **TYPHLOPIDAE (Blind snakes)** | | | | | | | | | | | | | | |
| *Afrotyphlops bibronii* | Bibron's Blind Snake | | 1 | | | x | x | | | | x | | | |
| **LEPTOTYPHLOPIDAE (Thread Snakes)** | | | | | | | | | | | | | | |
| *Leptotyphlops scutifrons conjunctus* | Peter's Thread Snake | - | 1 | x | | x | x | | | | x | | | |
| **ATRACTASPIDIDAE (Burrowing snakes)** | | | | | | | | | | | | | | |
| *Atractaspis bibronii* | Bibron's Burrowing Asp | - | 2 | | | | x | | | | | | | |
| *Aparallactus capensis* | Cape Centipede-eater | LC | 1 | x | | | x | | | x | | | | |
| *Homoroselaps dorsalis* | Striped Harlequin Snake | NT | 3 | | | | | | | | | | | |
| *Homoroselaps lacteus* | Spotted Harlequin Snake | - | 3 | x | | | x | | | | | | | |
| **COLUBRIDAE (Typical snakes)** | | | | | | | | | | | | | | |
| *Lycodonomorphus laevissimus* | Dusky-bellied Water Snake | - | 2 | | | | x | | | | | | | |
| *Lycodonomorphus rufulus* | Common Water Snake | - | 1 | | | x | x | | | | | x | | |
| *Lamprophis aurora* | Aurora House Snake | LC* | 3 | | | | | | | | | | | |
| *Lamprophis capensis* | Brown House Snake | - | 1 | | | | x | | x | | | x | | |
| *Lamprophis fuscus* | Yellow-bellied House Snake | NT | 3 | | | | | | | | | | | |
| *Lamprophis guttatus* | Spotted Rock Snake | - | 1 | | | x | x | | | | x | | | |
| *Lamprophis inornatus* | Olive House Snake | - | 3 | | | x | | | | | | | | |
| *Lycophidion capense* | Common Wolf Snake | - | 2 | | x | | x | | | | | | | |
| *Duberria lutrix* | Common Slug-eater | LC | 2 | | | | | | | | | | | |
| *Pseudaspis cana* | Mole Snake | - | 2 | | | x | x | | | | | | | |
| *Amplorhinus multimaculatus* | Many-Spotted Snake | - | 2 | | | x | | | | | | | | |
| *Prosymna bivittata* | Two-striped Shovel-snout | - | 3 | | | | x | | | | | | | |
| *Psammophylax rhombeatus* | Spotted Skaapsteker | - | 1 | x | x | x | x | | | x | x | | | |
| *Psammophylax tritaeniatus* | Striped Skaapsteker | LC | 3 | | | x | | | | | | | | |
| *Psammophis mossambicus* | Olive Grass Snake | - | 2 | | x | | x | | | | | | | |
| *Psammophis brevirostris* | Short-snouted Grass Snake | - | 2 | | x | | x | | | | | | | |
| *Psammophis crucifer* | Cross-marked Grass Snake | - | 2 | | | x | x | | | | | | | |
| *Philothamnus hoplogaster* | Green Water Snake | - | 2 | | | | | | | | | | | |
| *Philothamnus natalensis occidentalis* | Eastern Green Snake | - | 2 | | | | | | | | | | | |

| FAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Philothamnus semivariegatus* | Spotted Bush Snake | - | 2 | x | | | x | | | | | | | |
| *Dasypeltis inornata* | Southern Brown Egg-eater | - | 2 | | | | | | | | | | | |
| *Dasypeltis scabra* | Rhombic Egg-eater | LC | 1 | | | x | x | | | | x | | | |
| *Crotaphopeltis hotamboeia* | Red-lipped Herald Snake | - | 2 | | x | x | | | | | | | | |
| *Dispholidus typus* | Boomslang | - | 2 | | | | | | | | | | | |
| **ELAPIDAE (Mambas, cobras & relatives)** | | | | | | | | | | | | | | |
| *Elapsoidea sundevallii sundevalli* | Sundevall's Garter Snake | - | 3 | | | | | | | | | | | |
| *Naja annulifera* | Snouted Cobra | - | 3 | | | | | | | | | | | |
| *Naja mossambica* | Mozambique Spitting Cobra | - | 2 | | | | x | | | | | | | |
| *Hemachatus haemachatus* | Rinkhals | LC | 2 | | | | | | | | | | | |
| **VIPERIDAE (Adders & vipers)** | | | | | | | | | | | | | | |
| *Causus rhombeatus* | Common Night Adder | - | 1 | | | | | | | x | | | | |
| *Bitis arietans* | Puff Adder | - | 2 | | | | x | | | | | | | |
| **AGAMIDAE (Agamas)** | | | | | | | | | | | | | | |
| *Acanthocercus atricollis* | Tree Agama | - | 2 | | | x | x | | | | | | | |
| *Agama aculeata distanti* | Ground Agama | - | 2 | | x | | x | | | | | | | |
| *Agama atra* | Southern Rock Agama | - | 1 | | | | | | | | x | | | |
| **CHAMAELEONIDAE (Chameleons)** | | | | | | | | | | | | | | |
| *Chamaeleo dilepis* | Flap-necked Chameleon | LC | 1 | | | x | x | | x | x | | | | |
| **VARANIDAE (Monitors)** | | | | | | | | | | | | | | |
| *Varanus albigularis* | Rock Leguaan | - | 2 | | | | x | | | | | | | |
| *Varanus niloticus* | Water Leguaan / Nile Monitor Lizard | - | 2 | | | | | | | | | | | |
| **LACERTIDAE (Lacertids)** | | | | | | | | | | | | | | |
| *Nucras lalandii* | Delalande's Sandveld Lizard | - | 2 | x | | x | x | | | | | | | |
| *Nucras ornate* | Ornate Sandveld Lizard | - | 3 | | | | x | | | | | | | |
| *Pedioplanis burchelli* | Burchell'S Sand Lizard | - | 2 | x | x | | | | | | | | | |
| **SCINCIDAE (Skinks)** | | | | | | | | | | | | | | |
| *Acontias breviceps* | Short-headed Legless Skink | - | 2 | | x | x | x | | | | | | | |
| *Acontias gracilicauda gracilicauda* | Thin-tailed Legless Skink | - | 2 | | | | x | | | | | | | |
| *Acontias plumbeus* | Giant Legless Skink | - | 4 | | | | | | | | | | | |

| | | | | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FAMILY & SPECIES** | **COMMON NAME** | **STATUS** | **LoO** | **2730AA** | **2730AB** | **2730AC** | **2730AD** | **SF** | **SV** | **DG** | **RG** | **WT** | **AL** | **AD** |
| *Panaspis walbergii* | Wahlberg's Snake-eyed Skink | - | 3 | | | | | | | | | | | |
| *Scelotes mirus* | Montane Dwarf Burrowing Skink | - | 3 | | | | x | | | | | | | |
| *Trachylepis capensis* | Cape Skink | - | 1 | x | x | x | x | | x | | | | | |
| *Trachylepis margaritifera* | Rainbow Skink | - | 3 | | | | x | | | | | | | |
| *Trachylepis punctatissima* | Montane Speckled Skink | LC | 2 | x | x | x | x | | | | | | | |
| *Trachylepis varia* | Variable Skink | - | 1 | x | x | | x | | | | x | | | |
| **GERRHOSAURIDAE (Plated lizards)** | | | | | | | | | | | | | | |
| *Gerrhosaurus flavigularis* | Yellow-throated Plated Lizard | - | 1 | x | | | x | | x | | | | | |
| **CORDYLIDAE (Girdled lizards & grass lizards)** | | | | | | | | | | | | | | |
| *Cordylus vittifer* | Transvaal Girdled Lizard | - | 1 | x | x | x | x | | | | x | | | |
| *Cordylus warreni warreni* | Warren's Girdled Lizard | LC | 3 | | | | | | | | | | | |
| *Pseudocordylus melanotis* | Drakensberg Crag Lizard | - | 2 | x | x | x | x | | | | | | | |
| *Pseudocordylus microlepidotus* | Cape Crag Lizard | - | 4 | | | x | | | | | | | | |
| *Chamaesaura aenea* | Transvaal Grass Lizard | - | 2 | | | x | | | | | | | | |
| *Chamaesaura anguina* | Cape Grass Lizard | - | 1 | | x | | | | | x | x | | | |
| **GEKKONIDAE (Geckos)** | | | | | | | | | | | | | | |
| *Hemidactylus mabouia* | Moreau's Tropical House Gecko | - | 3 | | | | x | | | | | | | |
| *Lygodactylus capensis* | Cape Dwarf Gecko | - | 3 | | | | x | | | | | | | |
| *Lygodactylus ocellatus* | Spotted Dwarf Gecko | - | 1 | | x | | x | | | | x | | | |
| *Pachydactylus vansoni* | Van Son's Gecko | - | 2 | x | x | x | x | | | | | | | |
| *Pachydactylus maculates* | Spotted Thick-toed Gecko | - | 2 | | | | x | | | | | | | |
| **PELOMEDUSIDAE (Terrapins)** | | | | | | | | | | | | | | |
| *Pelomedusa subrufa* | Marsh Terrapin | - | 3 | | | | x | | | | | | | |
| **TESTUDINIDAE (Tortoises)** | | | | | | | | | | | | | | |
| *Kinixys spekii* | Speke's Hinged Tortoise | - | 3 | | | x | | | | | | | | |
| **KEY** | | | | | | | | | | | | | | |
| **LoO:** 1=Present; 2=Highly likely; 3=Moderately likely; 4=Unlikely | | | | | | | | | | | | | | |
| **Status (SA Red List):** NT=Near-threatened; LC=Least Concern; *Provisional listing, pending on the publication of the Southern African Reptile Conservation Assessment (SARCA) | | | | | | | | | | | | | | |
| **Habitat:** AD=Adit; AL=Alien Bushclump; DG=Dry Grassland; SF=Scarp Forest; SV=Savanna; RG=Rocky Grassland; WT=Wetland | | | | | | | | | | | | | | |
| **Sources:** NEM:BA (2007); SARCA website (2010); MTPA pers. comm. (2013) | | | | | | | | | | | | | | |

## 5.5. Appendix 5 Frog list for the study area

| FAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| **BREVICIPITIDAE (Rain frogs)** | | | | | | | | | | | | | | |
| *Breviceps adspersus adspersus* | Bushveld Rain Frog | LC | 3 | | | | | | | | | | | |
| *Breviceps mossambicus* | Mozambique Rain Frog | LC | 2 | x | | x | x | | | | | | | |
| **BUFONIDAE (Toads)** | | | | | | | | | | | | | | |
| *Amietophrynus garmani* | Eastern Olive Toad | LC | 1 | | | | | | | | | | | x |
| *Amietophrynus gutturalis* | Guttural Toad | LC | 1 | x | x | x | x | x | | x | | | | |
| *Amietophrynus maculatus* | Flat-backed Toad | LC | 4 | | | | | | | | | | | |
| *Amietophrynus rangeri* | Raucous Toad | LC | 1 | x | x | x | | x | | x | x | | | |
| *Vandijkophrynus gariepensis* | Karoo Toad | LC | 2 | | | x | x | | | | | | | |
| *Schismaderma carens* | Red Toad | LC | 2 | | | | | | | | | | | |
| **HELEOPHRYNIDAE (Ghost frogs & Cascade Frog)** | | | | | | | | | | | | | | |
| *Hadromophryne natalensis* | Natal Cascade Frog | LC | 3 | | | | x | | | | | | | |
| *Hemisus guttatus* | Spotted Shovel-nosed Frog | VU | 4 | | | | | | | | | | | |
| **HYPEROLIIDAE (Kassinas, Rattling Frog & reed frogs)** | | | | | | | | | | | | | | |
| *Hyperolius marmoratus taeniatus* | Painted Reed Frog | LC | 3 | | x | | x | | | | | | | |
| *Kassina senegalensis* | Bubbling Kassina | LC | 2 | x | x | x | x | | | | | | | |
| *Semnodactylus wealii* | Rattling Frog | LC | 2 | x | | x | x | | | | | | | |
| **PHRYNOBATRACHIDAE (Puddle frogs)** | | | | | | | | | | | | | | |
| *Phrynobatrachus mababiensis* | Dwarf Puddle Frog | LC | 4 | | | | | | | | | | | |
| *Phrynobatrachus natalensis* | Snoring Puddle Frog | LC | 3 | | | | | | | | | | | |
| **PTYCHADENIDAE (Grass & Ornate Frogs)** | | | | | | | | | | | | | | |
| *Ptychadena oxyrhynchus* | Sharp-nosed Grass Frog | LC | 4 | | | | | | | | | | | |
| *Ptychadena porosissima* | Striped Grass Frog | LC | 1 | x | x | x | | | | x | | | | |
| **PIPIDAE (Platannas)** | | | | | | | | | | | | | | |
| *Xenopus laevis* | Common Platanna | LC | 1 | x | | | | | | | | x | | |
| **PYXICEPHALIDAE (African common frogs)** | | | | | | | | | | | | | | |
| *Cacosternum boettgeri* | Boettger's Caco | | 1 | x | x | x | x | | | x | | x | | |

| FAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Cacosternum nanum* | Bronze Caco | | 1 | x | | x | x | | | x | | x | | |
| *Amieta angolensis* | Common River Frog | | 1 | x | x | x | x | | x | | | x | | |
| *Amietia fuscigula* | Cape River Frog | | 2 | x | x | x | x | | | | | | | |
| *Strongylopus fasciatus* | Striped Stream Frog | | 1 | | x | x | x | | | | | x | | |
| *Strongylopus grayii* | Clicking Stream Frog | | 2 | x | x | x | x | | | | | | | |
| *Strongylopus wager* | Plain Stream Frog | NT | 2 | | | x | | | | | | | | |
| *Tomopterna cryptotis* | Tremolo Sand Frog | | 2 | | | | | | | | | | | |
| *Tomopterna natalensis* | Natal Sand Frog | | 1 | x | x | x | x | | | | | x | | |
| *Tomopterna tandyi* | Tandy's Sand Frog | | 4 | | | | | | | | | | | |
| *Pyxicephalus adspersus* | Giant Bullfrog | NT | 4 | | | | | | | | | | | |

**KEY**

**LoO:** 1=Present; 2=Highly likely; 3=Moderately likely; 4=Unlikely

**Status (SA Red List):** NT=Near-threatened; LC=Least Concern

**Habitat:** AD=Adit; AL=Alien Bushclump; DG=Dry Grassland; SF=Scarp Forest; SV=Savanna; RG=Rocky Grassland; WT=Wetland

**Sources:** Minter *et al.* (2004); NEM:BA (2007); Du Preez & Carruthers (2009); MTPA pers. comm. (2013)

## 5.6. Appendix 6 Butterfly list for the study area

| SUBFAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| **DANAINAE (Monarchs)** | | | | | | | | | | | | | | |
| *Danaus chrysippus orientis* | African Monarch | LC | 1 | | | x | | | x | x | | x | | |
| **SATYRINAE (Browns, widows & ringlets)** | | | | | | | | | | | | | | |
| *Bicyclus safitza safitza* | Common Bush Brown | LC | 2 | | | x | | | | | | | | |
| *Aeropetes tulbaghia* | Table Mountain Beauty (Mountain Pride) | LC | 3 | | | | | | | | | | | |
| *Dingana alticola* | Red-banded Widow | LC | 2 | | | x | | | | | | | | |
| *Coenyra hebe* | Zulu Shadefly | LC | 3 | | | | x | | | | | | | |
| *Coenyra aurantiaca* | Pondo Shadefly | LC | 3 | | | | x | | | | | | | |
| *Physcaeneura panda* | Dark-webbed Ringlet | LC | 2 | | | | | | | | | | | |
| *Cassionympha cassius* | Rainforest Brown | LC | 1 | | | x | x | | | | x | | | |
| *Pseudonympha poetula* | Drakensberg brown | LC | 3 | | | | | | | | | | | |
| *Pseudonympha magoides* | False Silver-bottom Brown | LC | 2 | | | x | x | | | | | | | |
| *Stygionympha scotina scotina* | Eastern Hillside Brown | LC | 3 | | | | x | | | | | | | |
| *Stygionympha wichgrafi wichgrafi* | Wichgraf's Brown | LC | 1 | | | x | x | | | | x | | | |
| *Stygionympha wichgrafi williami* | William's Brown | LC | 2 | | | | x | | | | | | | |
| *Ypthima asterope hereroica* | African Ringlet | LC | 4 | | | | | | | | | | | |
| **HELICONIINAE (Acraeas)** | | | | | | | | | | | | | | |
| *Acraea horta* | Garden Acraea | LC | 1 | | | x | x | | x | | | | | |
| *Acraea neobule neobule* | Wandering Donkey Acraea | LC | 2 | | | | x | | | | | | | |
| *Acraea algaonice* | Clear-spotted Acraea | LC | 3 | | | | x | | | | | | | |
| *Acraea violarum* | Speckled Red Acraea | LC | 2 | | | | x | | | | | | | |
| *Telchinia rahira rahira* | Marsh Acraea | LC | 2 | | | | | | | | | | | |
| *Telchinia Anacreon* | Orange Acraea | LC | 1 | | | x | x | | x | x | | | | |
| *Telchinia alalonga* | Long-winged Orange Acraea | LC | 3 | | | x | | | | | | | | |
| *Telchinia esebria esebria* | Dusky Acraea | LC | 4 | | | | | | | | | | | |
| *Telchinia encedon encedon* | White-barred Acraea | LC | 4 | | | | | | | | | | | |
| *Telchinia serena* | Dancing (Small Orange) Acraea | LC | 3 | | | | | | | | | | | |
| **BIBLIDINAE ( Nymphs, jokers & pipers)** | | | | | | | | | | | | | | |
| *Pardopsis punctatissima* | Polka Dot | LC | 4 | | | | | | | | | | | |

| SUBFAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Phalanta phalantha aethiopica* | African (Common) Leopard | LC | 2 | | | | | | | | | | | |
| *Charaxes varanes varanes* | Pearl Emperor | LC | 2 | | | x | | | | | | | | |
| *Charaxes jasius saturnus* | Foxy Emperor | LC | 2 | | | | | | | | | | | |
| *Charaxes brutus natalensis* | White-barred Emperor | LC | 4 | | | | | | | | | | | |
| *Charaxes druceanus moerens* | Marieps Silver-barred Emperor | LC | 3 | | | | | | | | | | | |
| *Charaxes xiphares penningtoni* | Pennington's Forest King Emperor | LC | 4 | | | | | | | | | | | |
| *Cymothoe alcimeda trimeni* | Trimen's Glider | LC | 2 | | | | x | | | | | | | |
| *Neptis laeta* | Common Sailor | LC | 3 | | | | | | | | | | | |
| *Byblia anvatara acheloia* | Common Joker | LC | 3 | | | | | | | | | | | |
| *Byblia ilithyia* | Spotted Joker | LC | 2 | | | | | | | | | | | |
| *Eurytela hiarbas angustata* | Pied Piper | LC | 2 | | | | | | | | | | | |
| *Eurytela dryope angulata* | Golden Piper | LC | 3 | | | | | | | | | | | |
| **NYMPHALINAE (Diadems, commodores, pansies & admirals)** | | | | | | | | | | | | | | |
| *Hypolimnas misippus* | Common Diadem | LC | 1 | | | | | | | x | | | | |
| *Hypolimnas anthedon wahlbergi* | Variable Diadem | LC | 3 | | | | | | | | | | | |
| *Catacroptera cloanthe cloanthe* | Pirate | LC | 1 | | | | | | x | x | | x | | |
| *Precis octavia sesamus* | Gaudy Commodore | LC | 1 | | | x | x | x | | | x | x | | |
| *Precis ceryne ceryne* | Marsh Commodore | LC | 2 | | | | | | | | | | | |
| *Precis archesia archesia* | Garden Inspector (Commodore) | LC | 2 | | | | x | | | | | | | |
| *Junonia natalica natalica* | Brown Pansy | LC | 3 | | | | | | | | | | | |
| *Junonia hierta cebrene* | Yellow Pansy | LC | 1 | x | | x | x | | x | x | x | x | | |
| *Junonia oenone oenone* | Blue Pansy | LC | 2 | | | | | | | | | | | |
| *Junonia orithya madagascariensis* | Eyed Pansy | LC | 1 | | | x | | | x | x | x | x | | |
| *Vanessa cardui* | Painted Lady | LC | 1 | | | x | x | | x | x | | | | |
| **PORITIINAE (Zulus, buffs, rocksitters)** | | | | | | | | | | | | | | |
| *Alaena amazoula amazoula* | Southern Yellow Zulu | LC | 3 | | | | | | | | | | | |
| *Durbania amakosa ayres* | Northern Rocksitter | LC | 3 | | | | x | | | | | | | |
| **MILETINAE (Woolly legs & skollys)** | | | | | | | | | | | | | | |
| *Lachnocnema bibulus* | Common Woolly Legs | LC | 2 | | | | | | | | | | | |
| *Thestor basutus* | Basuto Skolly (Magpie) | LC | 2 | | | | | | | | | | | |
| **LYCAENINAE (Saphires, playboys, coppers, opals, hairtails & blues)** | | | | | | | | | | | | | | |

| SUBFAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Stugeta bowkeri tearei* | Teare's Sapphire | LC | 3 | | | | | | | | | | | |
| *Leptomyrina henningi* | Henning's Black-eye | LC | 2 | | | x | | | | | | | | |
| *Leptomyrina gorgias gorgias* | Common Black-eye | LC | 1 | | | | x | | | | x | | | |
| *Capys alphaeus extentus* | Eastern Orange-banded Protea-butterfly | LC | 2 | | | | x | | | | | | | |
| *Deodorix antalus* | Brown Playboy | LC | 3 | | | | | | | | | | | |
| *Myrina silenus ficendula* | Common Fig-tree Blue | LC | 3 | | | | | | | | | | | |
| *Cigaritis natalensis* | Natal Bar | LC | 2 | | | | | | | | | | | |
| *Cigaritis mozambica* | Mozambique Bar | LC | 3 | | | | | | | | | | | |
| *Cigaritis phanes* | Silvery Bar | LC | 4 | | | | | | | | | | | |
| *Cigaritis ella* | Ella's Bar | LC | 3 | | | | | | | | | | | |
| *Axiocerses tjoane tjoane* | Common Scarlet | LC | 3 | | | | | | | | | | | |
| *Axiocerses amanga amanga* | Bush Scarlet | LC | 3 | | | | | | | | | | | |
| *Aloeides merces* | Wakkerstroom Copper | LC | 2 | | x | | x | | | | | | | |
| *Aloeides pallida pallida* | Giant Copper | LC | 2 | | | x | x | | | | | | | |
| *Aloeides tite* | Tite's Copper | LC | 2 | | | x | x | | | | | | | |
| *Aloeides aranda* | Aranda Copper | LC | 2 | | | | | | | | | | | |
| *Aloeides henningi* | Henning's Copper | LC | 3 | | | | | | | | | | | |
| *Aloeides swanepoeli* | Swanepoel's Copper | LC | 2 | | | x | | | | | | | | |
| *Aloeides trimeni trimeni* | Trimen's Copper | LC | 3 | | | | | | | | | | | |
| *Aloeides taikosama* | Dusky Copper | LC | 3 | | | | | | | | | | | |
| *Chrysoritis aethon* | Lydenburg Opal | LC | 2 | | | x | x | | | | | | | |
| *Chrysoritis lycegenes* | Mooi River Opal | LC | 2 | | | | | | | | | | | |
| *Chrysoritis aureus* | Heidelberg Copper (Golden Opal) | VU | 3 | | | x | | | | | | | | |
| *Chrysoritis pan pan* | Pan Opal | LC | 3 | | | | | | | | | | | |
| *Chrysoritis swanepoeli swanepoeli* | Swanepoel's Opal | LC | 3 | | | | | | | | | | | |
| *Chrysoritis beaufortius tearei* | Teare's Opal | LC | 3 | | | | | | | | | | | |
| *Crudaria leroma* | Silver-spotted Grey | LC | 3 | | | | | | | | | | | |
| *Lycaena clarki* | Eastern Sorrel Copper | LC | 2 | | | x | x | | | | | | | |
| *Anthene amarah amarah* | Black-striped Hairtail | LC | 3 | | | | | | | | | | | |
| *Anthene butleri livida* | Pale Hairtail | LC | 3 | | | | | | | | | | | |

| SUBFAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Uranothauma nubifer nubifer* | Black Heart | LC | 1 | | | | | | x | | | | | |
| *Cacyreus marshalli* | Geranium Bronze | LC | 2 | | | | x | | | | | | | |
| *Cacyreus fracta fracta* | - | - | 2 | | | | x | | | | | | | |
| *Zintha hintza hintza* | Hintza Blue | LC | 2 | | | x | | | | | | | | |
| *Tuxentius calice calice* | White Pie | LC | 1 | | | | | | x | | | | | |
| *Tuxentius melaena melaena* | Black Pie | LC | 3 | | | | | | | | | | | |
| *Leptotes pirithous pirithous* | Common Blue | LC | 2 | | | | | | | | | | | |
| *Leptotes babulti* | Babaults Blue | LC | 1 | | | | | | x | | | | | |
| *Lampides boeticus* | Long-tailed Blue | LC | 1 | | | | | | x | | | | | |
| *Tarucus sybaris sybaris* | Dotted Blue | LC | 1 | | | | | | x | | | | | |
| *Harpendyreus noquasa* | Marsh Blue | LC | 2 | | | x | x | | | | | | | |
| *Lepidochrysops variabilis* | Variable Blue | LC | 3 | | | | x | | | | | | | |
| *Lepidochrysops ketsi ketsi* | Ketsi Blue | LC | 3 | | | x | | | | | | | | |
| *Lepidochrysops ignota* | Zulu Blue | LC | 3 | | | | | | | | | | | |
| *Lepidochrysops plebeia plebeia* | Twin-spot Blue | LC | 3 | | | | | | | | | | | |
| *Lepidochrysops patricia* | Patrician Blue | LC | 2 | | | | | | | | | | | |
| *Orachrysops subravus* | Grizzled Blue | LC | 4 | | | x | | | | | | | | |
| *Euchrysops malathana* | Common Smokey Blue | LC | 3 | | | | | | | | | | | |
| *Euchrysops dolorosa* | Sabi Smokey Blue | LC | 4 | | | | | | | | | | | |
| *Eicochrysops messapus mahallakoanea* | Northern Cupreous Blue | LC | 3 | | | | | | | | | | | |
| *Cupidopsis cissus cissus* | Common Meadow Blue | LC | 1 | | | | | | x | | | | | |
| *Cupidopsis jobates jobates* | Tailed Meadow Blue | LC | 3 | | | | | | | | | | | |
| *Actizera lucida* | Rayed Blue | LC | 2 | | | x | | | | | | | | |
| *Zizeeria knysna* | Sooty Blue | LC | 2 | | | | | | | | | | | |
| *Zizina otis antanossa* | Clover Blue | LC | 2 | | | | x | | | | | | | |
| *Azanus ubaldus* | Velvet-spotted Blue | LC | 2 | | | | x | | | | | | | |
| *Azanus jesous jesous* | Topaz-spotted Blue | LC | 2 | | | | x | | | | | | | |
| *Azanus natalensis* | Natal Spotted Blue | LC | 1 | | | | | | x | x | | | | |
| *Azanus moriqua* | Thorn-tree Blue | LC | 2 | | | | | | | | | | | |
| *Chilades trochylus* | Grass Jewel Blue | LC | 3 | | | | | | | | | | | |

| SUBFAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS | | | | HABITAT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2730AA | 2730AB | 2730AC | 2730AD | SF | SV | DG | RG | WT | AL | AD |
| *Zizula hylax* | Gaika Blue | LC | 2 | | | | x | | | | | | | |
| **PIERINAE (Vagrants, orange tips, whites & borders)** | | | | | | | | | | | | | | |
| *Colotis vesta argillaceus* | Veined Orange (Tip) | LC | 4 | | | | | | | | | | | |
| *Colotis euippe omphale* | Smokey Orange Tip | LC | 3 | | | | | | | | | | | |
| *Belenois aurota aurota* | Brown-veined White | LC | 1 | | | x | x | | x | x | | | | |
| *Belenois creona severina* | African Common White | LC | 2 | | | x | x | | | | | | | |
| *Pontia helice helice* | Meadow White | LC | 2 | | | x | x | | | | | | | |
| *Leptosia alcesta inalcesta* | African Wood White | LC | 2 | | | | x | | | | | | | |
| *Mylothris agathina agathina* | Common Dotted Border | LC | 3 | | | | | | | | | | | |
| **COLIADINAE (Yellows & migrants)** | | | | | | | | | | | | | | |
| *Colias electo electo* | African Clouded Yellow (Lucerne Butterfly) | LC | 2 | | | x | x | | | | | | | |
| *Catopsilia florella* | African Migrant (Common Vagrant) | LC | 2 | | | | x | | | | | | | |
| *Eurema hecabe solifera* | Common Grass Yellow | LC | 2 | | | | | | | | | | | |
| *Eurema brigitta brigitta* | Broad-bordered Grass Yellow | LC | 2 | | | | x | | | | | | | |
| *Eurema desjardinsii marshalli* | Angled Grass Yellow | LC | 2 | | | | | | | | | | | |
| **PAPILIONINAE (Swallowtails & swordtails)** | | | | | | | | | | | | | | |
| *Papilio demodocus demodocus* | Citrus Swallowtail | LC | 1 | | | x | | | x | x | | | | |
| *Papilio euphranor* | Bush Kite (Forest Swallowtail) | LC | 3 | | | | x | | | | | | | |
| *Papilio nireus lyaeus* | Green-banded Swallowtail | LC | 2 | | | | x | | | | | | | |
| *Papilio ophidicephalus ayresi* | Mariep's Emperor Swallowtail | LC | 2 | | | | x | | | | | | | |
| **COELIADINAE (Policemen)** | | | | | | | | | | | | | | |
| *Coeliades forestan forestan* | Striped Policeman | LC | 3 | | | | | | | | | | | |
| *Coeliades pisistratus* | Two-tip Policeman | LC | 2 | | | | | | | | | | | |
| **PYRGINAE (Flats, skippers, elfins & sandmen)** | | | | | | | | | | | | | | |
| *Celaenorrhinus mokeezi mokeezi* | Western Large Flat | LC | 3 | | | | | | | | | | | |
| *Eretis djaelaelae* | Marbled Efl | LC | 2 | | | x | | | | | | | | |
| *Eretis umbra umbra* | Small Marbled Elf | LC | 2 | | | | | | | | | | | |
| *Spialia asterodia* | Star Sandman | LC | 2 | | | | x | | | | | | | |
| *Spialia mafa mafa* | Mafa Sandman | LC | 2 | | | | | | | | | | | |
| *Spialia dromus* | Forest Sandman (Large Grizzled | LC | 3 | | | | | | | | | | | |

| SUBFAMILY & SPECIES | COMMON NAME | STATUS | LoO | QDS 2730AA | QDS 2730AB | QDS 2730AC | QDS 2730AD | HABITAT SF | HABITAT SV | HABITAT DG | HABITAT RG | HABITAT WT | HABITAT AL | HABITAT AD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Skipper) | | | | | | | | | | | | | |
| *Spialia diomus ferax* | Common Sandman | LC | 1 | | | x | x | | | | | x | | |
| *Spialia spio* | Mountain Sandman | LC | 2 | | | | | | | | | | | |
| *Gromalia elma elma* | Green-marbled Sandman | LC | 2 | | | | | | | | | | | |
| **HETEROPTERINAE (Sylphs)** | | | | | | | | | | | | | | |
| *Metisella malgacha malgacha* | Grassveld Sylph | LC | 2 | | | | x | | | | | | | |
| *Metisella meninx* | Marsh Sylph | VU | 2 | | | | | | | | | | | |
| *Tsitana tsita* | Dismal Sylph | LC | 2 | | | | | | | | | | | |
| **HESPERIINAE (Rangers, darts, hoppers & swifts)** | | | | | | | | | | | | | | |
| *Kedestes mohozutza* | Fulvous Ranger (Harlequin Skipper) | LC | 2 | | | x | | | | | | | | |
| *Kedestes barberae barberae* | Barber's Ranger | LC | 3 | | | | | | | | | | | |
| *Platylesches ayresii* | Peppered Hopper | LC | 3 | | | | | | | | | | | |
| *Platylesches moritili* | Honey Hopper | LC | 3 | | | | | | | | | | | |
| *Zenonia zeno* | Orange-spotted Hopper (Skipper) | LC | 3 | | | | | | | | | | | |
| *Pelopidas mathias* | Black-banded Swift | LC | 2 | | | | | | | | | | | |
| *Pelopidas thrax inconspicua* | White-banded Swift | LC | 2 | | | | | | | | | | | |
| **PYRGINAE (Flats, skippers, elfins & sandmen)** | | | | | | | | | | | | | | |
| *Gegenes niso niso* | Common Hottentot Skipper | LC | 1 | | | | | | | | | x | | |

**KEY**

**LoO:** 1=Present; 2=Highly likely; 3=Moderately likely; 4=Unlikely

**Status (SA Red List):** EN=Endangered; VU=Vulnerable; LC=Least Concern

**Habitat:** AD=Adit; AL=Alien Bushclump; DG=Dry Grassland; SF=Scarp Forest; SV=Savanna; RG=Rocky Grassland; WT=Wetland

**Source:** Migdoll (1994); NEM:BA (2007); Henning *et al*. (2009); SABCA website (2010); MTPA pers. comm. (2013)

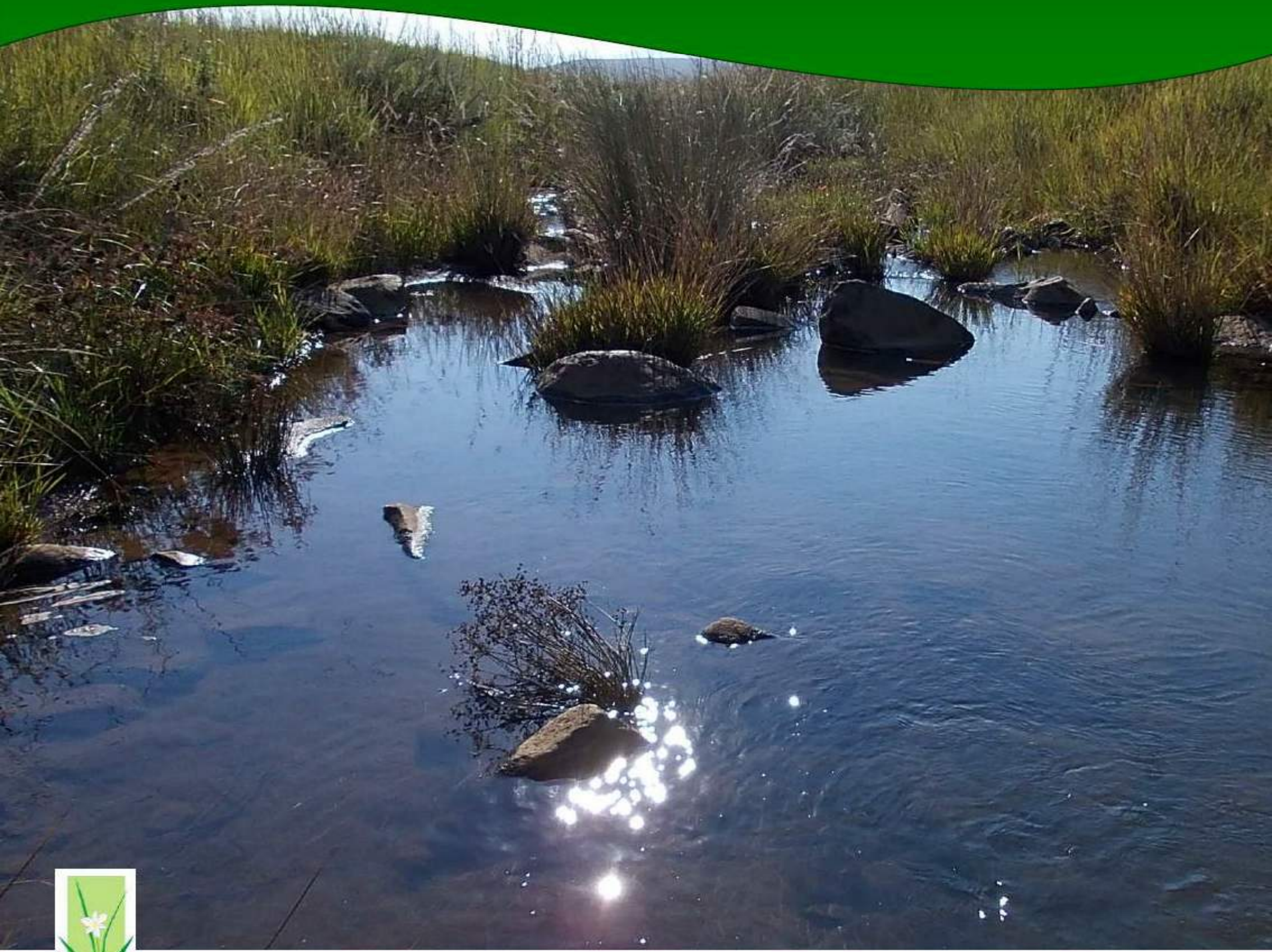
## 5.7. Appendix 7 Macro-invertebrates found opportunisitically on site

| HIGHER TAXON & FAMILY | SPECIES | COMMON NAME |
|---|---|---|
| **ODONATA (Dragonflies & damselflies)** | | |
| COENAGRIONIDAE | *Ischnura senegalensis* | |
| **ISOPTERA (Termites)** | | |
| TERMITIDAE | *Macrotermes natalensis* | |
| **ORTHOPTERA (Crickets & grasshoppers)** | | |
| ACRIDIDAE | | |
| PYRGOMORPHIDAE | *Zonocerus elegans* | Elegant Grasshopper |
| PYRGOMORPHIDAE | *Phymateus viridpes* | Green Milkweed Locust |
| GRYLLIDAE | | Cricket |
| TETTIGONIIDAE | *Conocephalus caudalis* | Meadow Katydid |
| **HEMIPTERA (Bugs)** | | |
| CICADIDAE | | Cicada |
| **NEUROPTERA (Antlions)** | | |
| MYRMELIONTIDAE | *Palpares sobtinus* | Dotted Veld Antlion |
| **COLEOPTERA (Beetles)** | | |
| LYCIDAE | | Net-Winged Beetle |
| MELOIDAE | *Mylabris oculata* | CMR Bean Beetle |
| MELOIDAE | | Blister Beetle |
| MELOIDAE | *Decaptoma lunata* | Lunate Blister Beetle |
| SCARABAEIDAE | *Anisorrhina flavomaculata* | Zig-zag Fruit Chafer |
| SCARABAEIDAE | *Porphyronota hebreae* | Marbled Fruit Chafer |
| SCARABAEIDAE | *Pachnoda sinuata* | Garden Fruit Chafer |
| CARABIDAE | | Carabid beetles |
| CURCULIONIDAE | | Weevils |
| **LEPIDOPTERA (Moths only)** | | |
| NOCTUIDAE | *Cyligramma latona* | Cream-striped Owl |
| NOCTUNIDAE | *Sphingomorpha chlorea* | Subdowner Moth |
| **HYMENOPTERA (Ants, Bees and Wasps)** | | |
| FORMICIDAE | | Ants |
| **MANTODEA (Mantids)** | | |
| THESPIDAE | *Haplocoryphela grandis* | |
| SCARABAEIDAE | *Plaesiorhnella plana* | |
| COCCINELLIDAE | *Cheilomenes lunata* | |
| **ARANEAE (Spiders)** | | |
| THOMISIDAE | *Runcinia sp.* | Crab Spider |
| CLUBIONIDAE | | Sac Spider |
| AGELENIDAE | *(Olorunia)* | Grass Funnel-web Spider |
| **SCORPIONES (Scorpions)** | | |
| ISCHNURIDAE | *Chelectonus jonesii* | |
| BUTHIDAE | *Uroplectes olivaceus* | Stinger Scorpion |
| **DECAPODA (Crabs)** | | |
| POTAMONAUTIDAE | | Freshwater Crab |
| **IXODIDA** | | |
| IXODIDAE | | Ticks |
| **DIPLOPODA (Millipedes)** | | |
| | | Giant Millipede |

| HIGHER TAXON & FAMILY | SPECIES | COMMON NAME |
|---|---|---|
| **HAPLOTAXIDA (Earth worms)** | | |
| LUMBRICIDAE | | Earth worms |
| **Sources:** Filmer (1991); Picker *et al.* (2002); Leeming (2003) | | |

## 5.8. Appendix 8 Specialist avifaunal assessment by DEC (next page)

# Section D: Aquatic Assessment



NATURAL SCIENTIFIC SERVICES

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# SECTION D: AQUATIC ASSESSMENT

## 1. Introduction

Natural Scientific Services CC (NSS) was contracted by WSP Environmental (Pty) Ltd (WSP) to perform Biodiversity Scoping, Baseline and Impact Assessments for selected aspects of the proposed ATHA Yzermyn Coal Project (AYCP). This report **Section D** details the Baseline Aquatic Assessment, which involved the assessment of ecological conditions at four aquatic sampling sites near the proposed mine surface infrastructure area. Potential impacts on aquatic ecosystems of the AYCP and recommended measures to mitigate these impacts are discussed in **Section G**.

## 2. Methodology

There are numerous streams and rivers that drain from the AYCP lease and underground mining areas. Many of these are small headwater and mountain streams, which flow into larger streams that ultimately drain into the Assegaai River. The selected sampling sites for this aquatic assessment represented the diversity of aquatic habitat near the original (old) proposed surface infrastructure area. As explained in **Section A**, no detailed information on the AYCP was available until recently, and the boundaries of the lease, underground mining and surface infrastructure areas changed during the course of this Assessment. Fortuitously, the selected aquatic sampling sites were located also in close proximity to the current (new) proposed surface infrastructure area.

Five aquatic sampling sites (referred to as YZ1-YZ5) were selected based on the following broad criteria:

- Habitat that was representative of local aquatic ecosystems.
- Accessibility and safety.
- Proximity to anthropogenic activities in the catchment.
- Proximity to river confluences.

The locations of the selected sampling sites are mapped in **Figure 2-1.** Photographs of the sampling sites are shown in **Table 2-1**, and the locations of the sampling sites in local catchments are described in **Table 2-2.** High and low flow aquatic surveys were, respectively, performed during 27-28 March and 4-5 September 2012, and involved assessment of the Present Ecological State (PES) of the sampled aquatic sites.

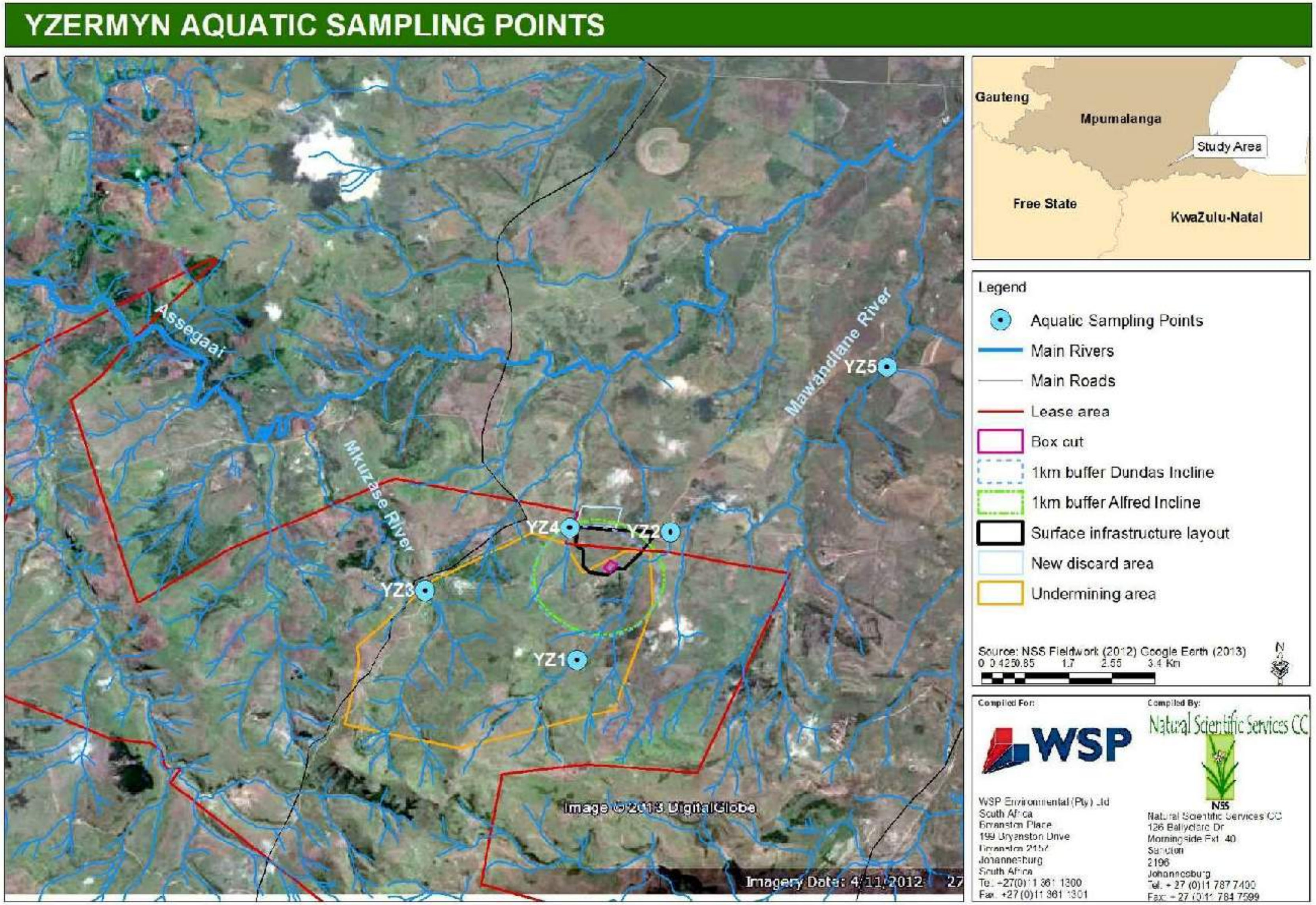



**Figure 2-1 Locations of the aquatic sampling sites**

**Table 2-1 Photographs of the aquatic sampling sites**

| | High flow: March 2012 | | Low flow: September 2012 | |
|---|---|---|---|---|
| | *Upstream* | *Downstream* | *Upstream* | *Downstream* |
| **YZ1 Mawandlane River** |  |  |  |  |
| **YZ2 Mawandlane River** |  |  |  |  |
| **YZ3 Mkusaze River** |  |  |  |  |

| | High flow: March 2012 | | Low flow: September 2012 | |
|---|---|---|---|---|
| | *Upstream* | *Downstream* | *Upstream* | *Downstream* |
| **YZ4 Tributary of the Assegaai River** |  |  |  |  |
| **YZ5 Mawandlane River** |  |  |  |  |

**Table 2-2 Catchment locations of the aquatic sampling sites**

| SITE | RIVER | POSITION RELATIVE TO PROPOSED SURFACE INFRASTRUCTURE | CO-ORDINATES | |
|---|---|---|---|---|
| YZ1 | Mawandlane River | Upstream of infrastructure | S27.23479° | E30.30729° |
| YZ2 | Mawandlane River | Downstream of infrastructure | S27.21234° | E30.32375° |
| YZ3 | Mkusaze River | Upstream of infrastructure | S27.22263° | E30.28059° |
| YZ4 | Non-perennial tributary of the Assegaai River | Downstream of infrastructure | S27.21161° | E30.30601° |
| YZ5 | Mawandlane River | Downstream of infrastructure | S27.18332° | E30.36187° |

## 2.1. Ecological Integrity / Present Ecological State (PES)

The PES of the Mkusaze and Mawandlane tributaries of the Assegaai River was evaluated in terms of water quality, habitat integrity, aquatic macro-invertebrate, and fish community ecological integrity.

Ecological Categories (EC) were used to assist in the interpretation of this data because they define the ecological condition of a river in terms of the deviation of biophysical components from the natural Reference condition (Kleynhans & Louw 2008). These categories range over a continuum of impacts from natural (Category A) to critically modified (Category F), and are represented by characteristic colours defined by Kleynhans & Louw (2008) in **Table 2-3**.

For the present assessment the ECs were assigned to the results obtained from the index scores of the Index of Habitat Integrity (IHI) measuring habitat and the Fish Response Assessment Index (FRAI; Kleynhans 2008) scores measuring fish integrity. The South African Scoring System (SASS5) for monitoring aquatic macro-invertebrates (Dickens & Graham 2002) and the Average Score per Taxon (ASPT) were assigned ECs based on the Eastern Escarpment Mountains – upper zone defined by Dallas (2007) and is discussed further on.

In some cases, there is an uncertainty as to which category a particular entity belongs. This situation falls within the concept of a "fuzzy" boundary, where a particular entity may potentially have membership of both classes. For practical purposes these situations are referred to as boundary categories and are denoted as for example B/C as depicted in **Figure 2-2**.

**Table 2-3 Present Ecological State categories and descriptions with standardised colour-coding (adapted from Kleynhans & Louw, 2008)**

| CATEGORY | MIRAI, FRAI & IHI (%) | SASS5 | ASPT | DESCRIPTION |
|---|---|---|---|---|
| A | 90 – 100 | >/=187 | >/=7.0 | **Natural** – Unmodified state with no impacts; conditions natural |
| B | 80 – 89 | >/=141<187 | >/=6.2<7.0 | **Largely natural** – Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged |
| C | 60 – 79 | >/=109<141 | >/=5.6<6.2 | **Moderately modified** –Loss and change of natural habitat and biota have occurred, but basic ecosystem functions are still predominantly unchanged |
| D | 40 – 59 | >/=86<109 | >=4.9<5.6 | **Largely modified –** A large loss of natural habitat, biota and basic ecosystem functions has occurred |
| E | 20 – 39 | <86 | <4.9 | **Seriously modified** – The loss of natural habitat, biota and basic ecosystem functions is extensive |
| F | < 20 | <86 | <4.9 | **Critically/Extremely modified** – Modifications have reached a critical level, with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible |


**Figure 2-2 The continuum of Ecological Categories as presented by Kleynhans & Louw (2008)**

## 2.2. Water Quality

Water quality is used to describe the aesthetic, biological, chemical and physical properties of water, which determine its condition for a variety of uses and for the protection of the health and integrity of aquatic ecosystems. These dissolved or suspended constituents, in the water, could influence or control the water quality properties. For example, in some cases anthropogenic activities can cause the physico-chemical constituents that occur naturally in the water to become toxic under certain conditions. Each aquatic ecosystem possesses natural limits or thresholds to the extent and frequency of change it can tolerate without being permanently modified (DWAF, 1996). If these aquatic ecosystems cross these thresholds, it will be difficult to recover or regain their functional capacity without mitigation. It must also be taken into consideration that determining the effects of changes in water quality on aquatic ecosystems is considered complex, as water fluctuates with time and space. Therefore, interpretation of WQ constituents should be done in combination with additional indicators such as biological indices.

***Physical & Chemical Water Quality Parameters***

Five physical water quality parameters were measured in-situ in the aquatic water resources assessed: temperature, pH, dissolved oxygen (DO) concentration and saturation (%), total dissolved solids (TDS) and electrical conductivity (EC). The variables were measured in the field by using a HI 9828 Multi-parameter with pH/ORP/EC/TDS/DO multi-sensor probe (Hanna Instruments[*]). A minimum of three readings were taken for each site and the average of the readings is represented in the results.

Water samples were also collected in 500ml polyethylene bottles to determine the additional chemical constituents (nutrients, trace metals, ions, organic enrichment and turbidity). The analysis of the water samples was done by Aquatico (Pty) Ltd[1] (a SANAS-accredited laboratory). The following variables were assessed: chloride (Cl), sulphate ($SO_4$), nitrate ($NO_3$), nitrite ($NO_2$), ammonium ($NH_4$), chemical oxygen demand (COD), suspended solids (SS), turbidity (NTU), total alkalinity, and metals including aluminium (Al), cadmium (Cd), calcium (Ca), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), nickel (Ni), potassium (K), sodium (Na), total chromium (Cr) and zinc (Zn). In addition, low flow samples were analysed for fluoride (F), orthophosphate ($PO_4$) and total hardness.

Field measurements and chemical constituents were compared against the Target Water Quality Range (TWQR). The TWQR is a management objective for aquatic ecosystems that was developed by DWAF (1996), and is used to specify the desired or ideal concentration range and/or water quality requirements of a particular constituent. Regular measuring of these constituents is required for long-term impact monitoring.

## 2.3. Habitat Integrity

Habitat availability and diversity are major determinants in the overall community structure of aquatic macro-invertebrates and fish, therefore, it is of the utmost importance to evaluate habitat quality when applying bio-monitoring methodologies and assessing river health. The Index of Habitat Integrity (IHI) assessment protocol designed by Kleynhans (1996), was used to assess impacts on aquatic and surrounding habitat at each sampling site. Instream and riparian habitats (IH and RH) were analysed based on a set of 12 weighted disturbances in the index. These disturbances represent some of the important and easily quantifiable anthropogenically induced impacts, including bank erosion, bed-, channel- and flow modification; alien aquatic fauna, macrophytes sand vegetation encroachment; indigenous vegetation removal; inundation; solid waste disposal, and water abstraction. The respective impacts for IH and RH were calculated, and each disturbance was assigned an impact rating (**Table 2-4**) and a confidence score. These values were used to calculate an impact score using the formula: (impact rating/25) x (the weight of that

[*]Previously known as Cleanstream Scientific Services (Pty) Ltd

impact defined in **Table 2-5**). The estimated impacts of all criteria were summed, expressed as a percentage, and subtracted from 100 to obtain a habitat integrity value for IH and RH. The final IHI was calculated and characterised into one of six categories defined by Kleynhans & Louw (2008), and shown in **Table 2-4**.

**Table 2-4 The IHI scoring of each criterion to describe the extent of each impact (from Kleynhans, 1996)**

| IMPACT CLASS | DESCRIPTION | SCORE |
|---|---|---|
| None | No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability | 0 |
| Small | The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is limited. | 1-5 |
| Moderate | The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are fairly limited. | 6-10 |
| Large | The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not affected | 11-15 |
| Serious | The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced. | 16-20 |
| Critical | The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally. | 21-25 |

**Table 2-5 Criteria and weightings used to assess Instream Habitat and Riparian Habitat Integrity (Kleynhans, 1996)**

| INSTREAM CRITERIA | WEIGHT |
|---|---|
| Water abstraction | 14 |
| Water quality | 13 |
| Flow modification | 13 |
| Bed modification | 13 |
| Channel modification | 14 |
| Inundation | 10 |
| Alien macrophytes | 9 |
| Alien fauna | 8 |
| Rubbish dumping | 6 |

| RIPARIAN CRITERIA | WEIGHT |
|---|---|
| Vegetation removal | 13 |
| Alien vegetation | 12 |
| Bank erosion | 14 |
| Channel modification | 12 |
| Water abstraction | 13 |
| Inundation | 11 |
| Flow modification | 12 |
| Water quality | 13 |

## 2.4. Macro-invertebrates

***Macro-invertebrate Habitat Availability***

Macro-invertebrate communities, like most aquatic fauna, are largely influenced by the habitat diversity within an aquatic ecosystem. Therefore, different biotope diversities were evaluated i.e. stones in current (bedrock, cascade, chute, boulder rapid, riffle and run), stones out of current (bedrock, backwater, slackwater and pool), instream vegetation, marginal vegetation and GSM (gravel, sand and mud). Each of these biotopes was rated on a scale from 0 to 5 according to the presence of biotopes, namely absent (0), rare (1), sparse (2), common (3), abundant (4) or entire (5) (Dallas, 2005). The Invertebrate Habitat Assessment System (IHAS) index was not incorporated into the present study as it still requires validation according to Dallas (2005). However, some of the categories from the IHAS were identified, including algal presence, biotopes and dominant vegetation types.

***SASS5***

The assessment of macro-invertebrate communities in a river system is a recognised means of determining river "health" (Dickens & Graham, 2002). Macro-invertebrates are good indicators because they are visible, easy to identify and have rapid life cycles. Macro-invertebrate communities were assessed using the SASS5 (South African Scoring System, version 5) sampling method described by Dickens & Graham (2002). SASS5 is a rapid assessment method of macro-invertebrate status of a flowing in-stream system. SASS5 is an accredited protocol that has been tested and widely used in South Africa as a biological index of water quality. The index is based on the presence of aquatic macro-invertebrate families and the perceived sensitivity to water quality changes of these families. Highly tolerant families include e.g. the Muscidae and Psychodidae, whereas highly sensitive families include e.g.the Oligoneuridae.

Macro-invertebrates were collected using a standard SASS net in stones (in and out of current), vegetation and gravel, sand and mud (GSM) within specified time frames. Fifteen minutes were taken to identify the presence and approximate abundances of macro-invertebrate families in each of the habitats. The SASS5 score was calculated by the sum of the sensitivity scores of the present families. The Average Score Per Taxon (ASPT) was calculated by dividing the total SASS score by the total number of taxa. The results were interpreted using the SASS5 interpretation guidelines of Dallas (2007) and the Ecological Categories derived for the Eastern Escarpment Mountains – upper zone Eco-region, shown in **Figure 2-3**.

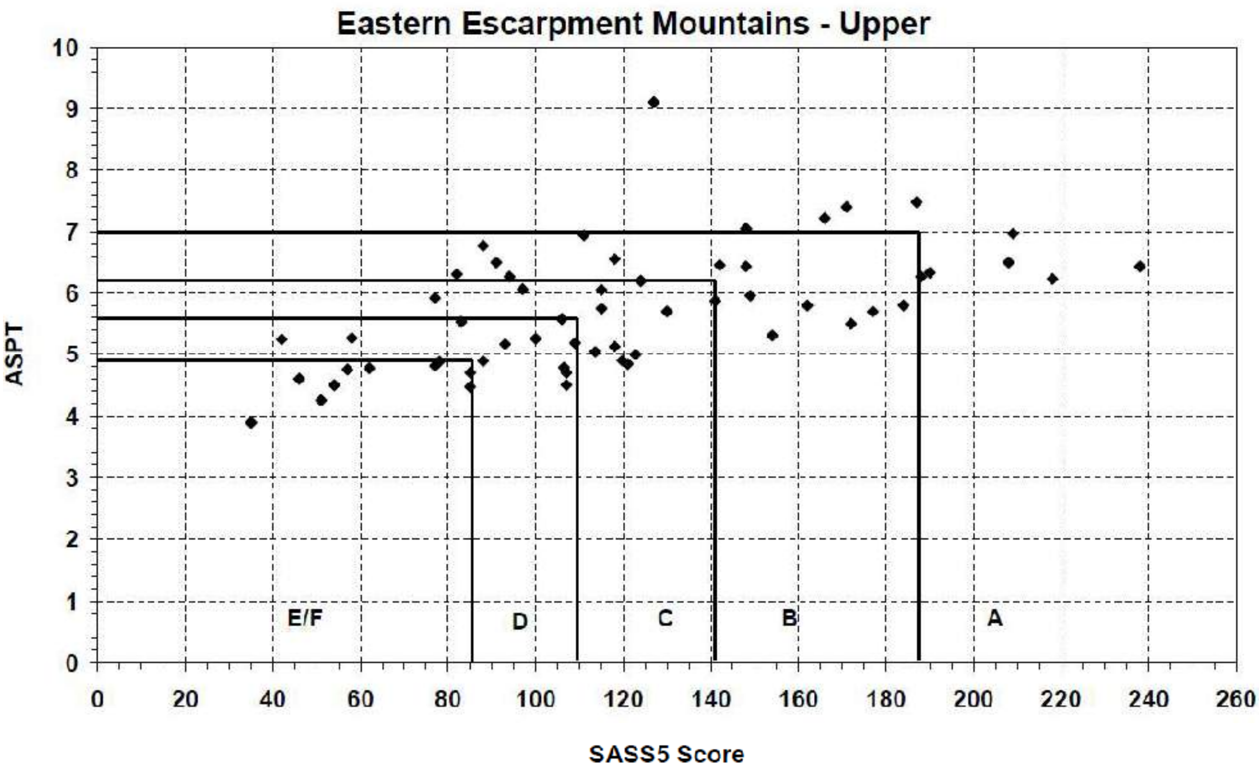



**Figure 2-3 Ecological Categories for the Eastern Escarpment Mountains – upper zone, calculated using percentiles (Dallas, 2007)**

***MIRAI***

MIRAI, the Macro-Invertebrate Response Assessment Index of Thirion (2008), was incorporated in this study as an alternative of the SASS5, for determining the PES of the macro-invertebrate community assemblage. The MIRAI integrates the ecological requirements of the invertebrate taxa in a community or assemblage, and their response to modified habitat conditions, whilst comparing the present assemblage with a Reference list (Thirion, 2007). The Reference list for this study was derived by NSS using numerous literature sources including historical data from the Rivers Database (2007), and past experience within this quaternary catchment. In addition, the functional feeding groups and river continuum were considered.

The MIRAI model makes a comparison between the expected macro-invertebrate families with the present assemblages obtained using SASS5 sampling protocol (Thirion, 2007). The habitat preferences for each of the macro-invertebrates were incorporated in terms of flow, habitat and water quality. Each component was rated within a metric in terms of how much the macro-invertebrate presence and abundances diverged from the Reference, and were done for each of the metrics. After all of the metrics were scored, the model generated a MIRAI score for each site and was characterised into an Ecological Category as shown in **Table 2-3.**

## 2.5. Ichthyofauna

The use of fish communities has been widely used to determine the overall condition of aquatic ecosystems. Fish communities have several advantages when used as indicators of ecosystem integrity (Kotze, 2001):

- Fish are present in most aquatic ecosystems except when the system is highly degraded.
- Fish can be easily identified and then returned to the aquatic ecosystem.
- Most fish species have background information available in terms of life-history and environmental response information.
- Fish are mobile and can integrate contaminant exposure or habitat degradation over a river reach.
- Fish are generally long-lived and as such, can provide long-term information regarding environmental stress.
- Fish communities are composed of various trophic levels and can indicate stressor responses at many trophic levels.
- Fishes often exhibit physiological, morphological, or behavioural responses to stresses, which have been grouped into chemical stressors, physical stressors, and perceived stressors.
- Due to the importance relating to the safe consumption of fish, and recreational, subsistence and commercial fishing activities, the Public is more likely to relate to information concerning fish communities than other biotic communities.

It is important to consider some disadvantages relating to the use of fish as bio-indicators. Some disadvantages include (Kotze, 2001):

- The select nature of sampling techniques and equipment for certain species, sizes and habitats of fishes.
- Sampling bias due to the seasonal migration and/or movement of fishes.
- A large sampling effort is often required to adequately characterise fish assemblages.
- Some fish species may be influenced by the sampling techniques.
- Being mobile, fish can avoid local disturbances and not be exposed to environmental impacts.
- Due to fishes often representing higher trophic levels, lower level organisms may provide an earlier indication of water quality pollution.

***Fish Habitat Availability***

A fish habitat assessment was done to provide a measure of the fish refuge potential associated with each of the sampling sites. This assessment characterises the fish habitats into four velocity-depth classes (including slow-deep, slow-shallow, fast-deep and fast-shallow habitat classes, where fast is greater than 0.3m/s, slow is less than 0.3m/s, deep is greater than 0.3m and shallow is less than 0.3m) and associated cover present at each of the habitats (Dallas, 2005). All of these were quantified on a scale from 0 to 5, being absent (0), rare (1), sparse (2), common (3), abundant (4) or entire (5) (Dallas, 2005). Measuring these various habitat types are an essential component in the interpretation of the fish integrity because it can influence (by creating or restricting) the fish populations and communities present within each sampling site.

***Fish Integrity***

The RHP (Mangold, 2001) and FRAI (Kleynhans, 2008) sampling methodologies were used to assess the fish populations in Mkusaze and Mawandlane Rivers. These are both tributaries of the Assegaai River, and could potentially be impacted upon by the AYCP. The technique used to sample was electro-shocking (Meador *et al.* 1993; Barbour *et al.* 1999) together with fyke nets. Samus battery-operated electro-shocking equipment was used to sample fish in the available habitat at each site. The electro-shocking technique was implemented for a minimum of one hour, depending on the site and habitat availability. Fyke nets were left overnight in deeper pools.

Sampled fish were identified to species level using Skelton (2001), and documented into the separate segments and habitat types before being safely returned to their habitat. This raw data was then utilised to calculate the Fish Frequency of Occurrence (FROC) value for use within the FRAI model, as described by Kleynhans (2008). The FRAI model makes a comparison between the expected fish species list obtained from the FROC report by Kleynhans (2007) and the FROC of sampled fish species. It incorporates the habitat preferences in terms of velocity-depth, substrate, water quality, alteration in physical-chemical composition of the water, as well as migration requirements of each fish species.

The intolerances and preferences are divided into metric groups that relate to the requirements and preferences of individual species. This allows cause-effect relationships to be understood between drivers and responses of the fish assemblage to these drivers of change. Having compared the expected list to the actual sampled list, the model generates a FRAI score for each site, which can be characterised into an EC as defined in **Table 2-3**.

## 2.6. Study Limitations

- Survey work was limited to four aquatic sampling sites in the vicinity of the proposed mine surface infrastructure area, and was not performed in remaining parts of the AYCP lease area.
- NO survey work was performed for roads, pipelines, power lines, conveyer systems or any other infrastructure or listed activity (e.g. water extraction) beyond the boundaries of the current proposed underground mining area.
- The techniques used for assessing aquatic habitat integrity were subjective.
- Insufficient habitat types were available to fully represent the aquatic resource.

- Flow, along parts of the rivers, was very low during the low flow sampling regime.
- Some aquatic species, which are uncommon, migratory, secretive, inconspicuous or otherwise difficult to detect may not have been detected even though they were potentially present on site.
- Aquatic sampling site YZ4 was located on an unnamed tributary of the Assegaai River, and represented a non-perennial stream. Consequently, apart from water quality analysis, other bio-monitoring methods could not be applied to YZ4.
- A tributary of the Assegaai River that was situated to the west of YZ4 would have been a good representative sampling site. Unfortunately this system was dry during both the high and low flow sampling runs.

# 3. Results

## 3.1. General Information for the Sampled Sites

The results for the high flow (March 2012) and low flow (September 2012) sampling runs are presented in **Table 3-1** to **Table 3-5**, along with general descriptions of each sampling site. These tables are followed by the water quality, habitat, macro-invertebrate and fish integrity results.

## 3.2. Water Quality

It is important to analyse WQ variables because they are indicative of impacts in an ecosystem that may contribute toward changes in biotic integrity. The results of the WQ analyses are presented in **Table 3-6**. The TWQR for aquatic ecosystems is provided for comparison. **Table 3-7** highlights the constituents above TWQR, together with their plausible origin and impact source.

Most of the measured *in situ* variables at the five sampling sites were within the TWQR for aquatic ecosystems as specified by DWAF (1996). Only during low flow were the DO concentrations at YZ2 and YZ4 lower than the TWQR. At both these sites this was likely due to a natural seasonal drop in water levels and flow rates. Most of the metal concentrations at the five sampling sites were also within the TWQR of these variables, where this information was available.

Exceptions to this were the elevated levels of Al, Fe and total hardness during the high flow 2012.

**Table 3-1 General results and associated information for YZ1**

| YZ1 | |
|---|---|
| High Flow 2012 | |
| *UPSTREAM*  | *DOWNSTREAM*  |
| Low Flow 2012 | |
|  |  |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **River** | Mawandlane | | | | | | |
| **Site Description** | The Mawandlane River situated within the proposed AYCP lease area. Mountain stream with numerous riffle / rapids sections present that are interspersed by pools. Two small waterfalls are present upstream that prevent fish migration. Some sedimentation evident below the track through the river. Marginal vegetation limited due to low flows. Marginal vegetation mostly grasses and shrubs. Long stretches of fast shallow riffles are located upstream at the site (approx. 400m). | | | | | | |
| **GPS co-ordinates** | S27.23479° E30.30729° | | | | | | |
| **Altitude (m.a.s.l)** | 1549m | | | | | | |
| **Quaternary Catchment** | W51A | | | | | | |
| **WMA (Midgley *et al*. 1994)** | WMA 6 Usutho to Mhlatuze | | | | | | |
| **Ecoregion** | 15.05 | | | | | | |
| **Ecoregion Name** | Eastern Escarpment Mountains | | | | | | |
| **River Conservation Status (NFEPA, 2011)** | **Tributary of National Freshwater Ecosystem Priority Area (NFEPA) River** | | | | | | |
| **Riparian Vegetation** | Grasslands; trees; shrubs | | | | | | |
| **Geomorphological Zonation (Rowntree & Wadeson, 2000)** | Mountain stream | | | | | | |
| | **High Flow (March 2012)** | | | **Low Flow (September 2012)** | | | |
| **Water Surface Dimensions** | Width: 5 m; Depth: 0.5m | | | Width: 6 m; Depth: 0.6m | | | |
| **Water Turbidity (Dallas, 2005)** | Clear | | | Clear | | | |
| **Dominant Velocity-depth Classes** | Fast shallow | | | Fast shallow | | | |
| **Water Quality Parameters** **HF** | T (°C) = 21.8; pH = 6.6; EC (mS/m) = 10.5; DO (mg/l) = 7.2; DO (%) = 99; TDS (mg/l) = 52.5 | | | | | | |
| **Water Quality Parameters** **LF** | T (°C) = 11.5; pH = 8.5; EC (mS/m) = 16.7; DO (mg/l) = 7.5; DO (%) = 83; TDS (mg/l) = 83.2 | | | | | | |
| **Algae Presence** | Isolated | | | Isolated | | | |
| **Dominant Biotope Diversity** | Riffles and pools | | | Riffles and pools | | | |
| **Other Biota** | Frogs | | | Tadpoles | | | |
| **Highly Sensitive Taxa** (Score 11-15) | Baetidae > 2sp | | | Baetidae > 2sp | | | |
| **DATE** / **SAMPLER** | **SASS5** | **ASPT** | **No of Taxa** | **MIRAI** | **IHI** | **FRAI** | |
| 27/03/2012 / W. Malherbe | **142 (B)** | **5.5** | **26** | **80 (B)** | **95 (A)** | **79.5 (B/C)** | |
| 05/09/2012 / W. Malherbe / A. Austin | **105 (C/D)** | **5.5** | **19** | **72 (C)** | **92 (A)** | **77 (C)** | |
| **Existing Threats** | Sedimentation; overgrazing | | | | | | |

**Table 3-2 General results and associated information for YZ2**

<table>
<tr><th colspan="9">YZ2</th></tr>
<tr><th colspan="9">High Flow 2012</th></tr>
<tr><th colspan="4">*UPSTREAM*</th><th colspan="5">*DOWNSTREAM*</th></tr>
<tr><td colspan="4"></td><td colspan="5"></td></tr>
<tr><th colspan="9">Low Flow 2012</th></tr>
<tr><td colspan="4"></td><td colspan="5"></td></tr>
<tr><td colspan="2">**River**</td><td colspan="7">Mawandlane</td></tr>
<tr><td colspan="2">**Site Description**</td><td colspan="7">Situated at a bridge over the Mawandlane River just outside of downstream boundary of the mine lease area. Significant sedimentation present at the bridge crossing. Upstream system is impacted upon by an *Acacia mearnsii* forest that increases woody debris. An old discard dump is present within the immediate catchment approximately 400m upstream – signs of hydrated Iron (III) oxide (drainage channel contains red precipitated water) are present. Riffle and rapid sections are interspersed with deeper pools</td></tr>
<tr><td colspan="2">**GPS co-ordinates**</td><td colspan="7">S27.21234° E30.32375°</td></tr>
<tr><td colspan="2">**Altitude (m.a.s.l)**</td><td colspan="7">1430m</td></tr>
<tr><td colspan="2">**Quaternary Catchment**</td><td colspan="7">W51A</td></tr>
<tr><td colspan="2">**WMA (Midgley *et al*. 1994)**</td><td colspan="7">WMA 6 Usutho to Mhlatuze</td></tr>
<tr><td colspan="2">**Ecoregion**</td><td colspan="7">15.05</td></tr>
<tr><td colspan="2">**Ecoregion Name**</td><td colspan="7">Eastern Escarpment Mountains</td></tr>
<tr><td colspan="2">**River conservation Status (NFEPA, 2011)**</td><td colspan="7">**Tributary of NFEPA River**</td></tr>
<tr><td colspan="2">**Riparian Vegetation**</td><td colspan="7">Grassland; Black wattle; Trees; Reeds</td></tr>
<tr><td colspan="2">**Geomorphological Zonation (Rowntree & Wadeson, 2000)**</td><td colspan="7">Upper foothill</td></tr>
<tr><td colspan="2"></td><td colspan="3">**High Flow (March 2012)**</td><td colspan="4">**Low Flow (September 2012)**</td></tr>
<tr><td colspan="2">**Water Surface Dimensions**</td><td colspan="3">Width: 5-10 m; Depth: 1m</td><td colspan="4">Width: 2-5 m; Depth: <1m</td></tr>
<tr><td colspan="2">**Water Turbidity (Dallas, 2005)**</td><td colspan="3">Silty</td><td colspan="4">Silty</td></tr>
<tr><td colspan="2">**Dominant Velocity-depth Classes**</td><td colspan="3">Fast shallow</td><td colspan="4">Slow shallow</td></tr>
<tr><td rowspan="2">**Water Quality Parameters**</td><td>**HF**</td><td colspan="7">T (°C) = 21.6; pH = 6.9; EC (mS/m) = 9.8; DO (mg/l) = 7.6; DO (%) = 102; TDS (mg/l) = 49</td></tr>
<tr><td>**LF**</td><td colspan="7">T (°C) = 11.7; pH = 8.0; EC (mS/m) = 14.6; DO (mg/l) = 6.7; DO (%) = 74; TDS (mg/l) = 73</td></tr>
<tr><td colspan="2">**Algae Presence**</td><td colspan="3">Algal bed</td><td colspan="4">Algal bed</td></tr>
<tr><td colspan="2">**Dominant Biotope Diversity**</td><td colspan="3">Riffles and pools</td><td colspan="4">Pools</td></tr>
<tr><td colspan="2">**Other Biota**</td><td colspan="3">Frogs</td><td colspan="4">Tadpoles</td></tr>
<tr><td colspan="2">**Highly Sensitive Taxa** (Score 11-15)</td><td colspan="3">None</td><td colspan="4">None</td></tr>
<tr><th>DATE</th><th>SAMPLERS</th><th>SASS5</th><th>ASPT</th><th>No of Taxa</th><th>MIRAI</th><th>IHI</th><th colspan="2">FRAI</th></tr>
<tr><td>27/03/2012</td><td>W. Malherbe</td><td>**119 (C)**</td><td>**5.4**</td><td>**22**</td><td>**73 (C)**</td><td>**87 (B)**</td><td colspan="2">**79.5 (B/C)**</td></tr>
<tr><td>05/09/2012</td><td>W. Malherbe / A. Austin</td><td>**61 (E)**</td><td>**4.6**</td><td>**13**</td><td>**56 (D)**</td><td>**85 (B)**</td><td colspan="2">**77 (C)**</td></tr>
<tr><td colspan="2">**Existing Threats**</td><td colspan="7">Sedimentation; Alien vegetation; Livestock watering</td></tr>
</table>

**Table 3-3 General results and associated information for YZ3**

| YZ3 | |
|---|---|
| **High Flow 2012** | |
| ***UPSTREAM*** | ***DOWNSTREAM*** |
|  |  |
| **Low Flow 2012** | |
|  |  |

| | |
|---|---|
| **River** | Mkuzase |
| **Site Description** | Situated upstream in the Mkusaze River within the boundary of the lease area. Upstream site is overgrown with marginal vegetation – canopy totally closed at approximately 70% of reach. Downstream site is situated on a road crossing which has formed a deep pool on the downstream side. Riffles and rapids present mostly downstream but some present upstream. Marginal vegetation mostly grasses and reeds. |
| **GPS co-ordinates** | S27.22263° E30.28059° |
| **Altitude (m.a.s.l)** | 1548m |
| **Quaternary Catchment** | W51A |
| **WMA (Midgley *et al.* 1994)** | WMA 6 Usutho to Mhlatuze |
| **Ecoregion** | 15.05 |
| **Ecoregion Name** | Eastern Escarpment Mountains |
| **River conservation Status (NFEPA, 2011)** | **Tributary of NFEPA River** |
| **Riparian Vegetation Type** | Grass; Reeds; Trees |
| **Geomorphological Zonation (Rowntree & Wadeson, 2000)** | Upper foothills |

| | **High Flow (March 2012)** | **Low Flow (September 2012)** |
|---|---|---|
| **Water Surface Dimensions** | Width: 5m; Depth: >1m | Width: 5m; Depth: <1m |
| **Water Turbidity (Dallas, 2005)** | Discoloured, opaque and silty | Discoloured, opaque and silty |
| **Dominant Velocity-depth Classes** | Slow deep | Slow shallow |
| **Water Quality Parameters** – **HF** | T (°C) = 18.6; pH = 7.5; EC (mS/m) = 13.7; DO (mg/l) = 7.8; DO(%) = 110.6; TDS(mg/l) = 68 | |
| **Water Quality Parameters** – **LF** | T (°C) = 13.1; pH = 7.6; EC (mS/m) = 17.6; DO (mg/l) = 8.2; DO(%) = 93.9; TDS(mg/l) = 88 | |
| **Algae Presence** | Sparse | Sparse |
| **Dominant Biotope Diversity** | Riffles; rapids; pools | Riffles; rapids; pools |
| **Other Biota** | None observed | Tadpoles |
| **Highly Sensitive Taxa** (Score 11-15) | Baetidae > 2sp | Baetidae > 2sp |

| DATE | SAMPLER | SASS5 | ASPT | No of Taxa | MIRAI | IHI | FRAI |
|---|---|---|---|---|---|---|---|
| 28/03/2012 | W. Malherbe | **170 (B)** | **5.7** | **30** | **84 (B)** | **93 (A)** | **76 (C)** |
| 04/09/2012 | W. Malherbe / A. Austin | **144 (B)** | **5.5** | **26** | **80 (B)** | **90 (A)** | **71 (C)** |
| **Existing Threats** | Sedimentation, increased instream vegetation, alien vegetation and reduced flow. | | | | | | |

**Table 3-4 General results and associated information for YZ4**

| YZ4 | |
|---|---|
| **High Flow 2012** | |
| ***UPSTREAM*** | ***DOWNSTREAM*** |
|  |  |
| **Low Flow 2012** | |
|  |  |

| | | |
|---|---|---|
| **River** | Non-perennial tributary of the Assegaai River | |
| **Site Description** | A non-perennial stream draining from within the middle of the mine lease area. The stream was not flowing during sampling period but small pools of water remained. Sedimentation quite extensive while riparian vegetation is comprised of mostly grasses with a few interspersed trees. | |
| **GPS co-ordinates** | S27.21161° E30.30601° | |
| **Altitude (m.a.s.l)** | 1430m | |
| **Quaternary Catchment** | W51A | |
| **WMA (Midgley *et al*. 1994)** | WMA 6 Usutho to Mhlatuze | |
| **Ecoregion** | 15.05 | |
| **Ecoregion Name** | Eastern Escarpment Mountains | |
| **River conservation Status (NFEPA, 2011)** | **Tributary of NFEPA River** | |
| **Riparian Vegetation Type** | Grassland | |
| **Geomorphological Zonation (Rowntree & Wadeson, 2000)** | Upper foothill | |
| | **High Flow (March 2012)** | **Low Flow (September 2012)** |
| **Water Surface Dimensions** | Width: 3-4m; Depth: <0.5m | Width: 3-5m; Depth: <0.6m |
| **Water Turbidity (Dallas, 2005)** | Silty | Silty |
| **Dominant Velocity-depth Classes** | No flow (Deep and shallow) | No flow (Deep and shallow) |
| **Water Quality Parameters** – **HF** | T (°C) = 24.6; pH = 6.9; EC (mS/m) = 11.7; DO (mg/l) = 6.3; DO (%) = 89.4; TDS (mg/l) = 59 | |
| **Water Quality Parameters** – **LF** | T (°C) = 11.5; pH = 8.1; EC (mS/m) = 18.4; DO (mg/l) = 4.4; DO (%) = 47.9; TDS (mg/l) = 92 | |
| **Algae Presence** | Common | Common |
| **Dominant Biotope Diversity** | Pools | Pools |
| **Other Biota** | None | None |

| DATE | SAMPLER | WQ | IHI | SASS5 | MIRAI | FRAI |
|---|---|---|---|---|---|---|
| 28/03/2012 | W. Malherbe | √ | x | x | x | x |
| 05/09/2012 | W. Malherbe / A. Austin | √ | x | x | x | x |
| **Existing Threats** | Sedimentation, alien vegetation, flow reduction. | | | | | |

**Table 3-5 General results and associated information for YZ5**

| YZ5 | |
|---|---|
| **High Flow 2012** | |
| ***UPSTREAM*** | ***DOWNSTREAM*** |
|  |  |
| **Low Flow 2012** | |
|  |  |

| | | |
|---|---|---|
| **River** | Mawandlane | |
| **Site Description** | Downstream of the proposed development and situated a few kilometres from Assegaai River. The receiving river for most of the proposed development. Bedrock present upstream and downstream. Pools form upstream due to wooden debris caught up within low water bridge. Downstream comprises of numerous small bedrock waterfalls and rapids making upstream movements difficult. Marginal vegetation mostly grass at the upstream area while lower down *Acacia mearnsii* are common. | |
| **GPS co-ordinates** | S27.18332° E30.36187° | |
| **Altitude (m.a.s.l)** | 1353m | |
| **Quaternary Catchment** | W51A | |
| **WMA (Midgley *et al*. 1994)** | WMA 6 Usutho to Mhlatuze | |
| **Ecoregion** | 11.02 | |
| **Ecoregion Name** | Highveld | |
| **River conservation Status (NFEPA, 2011)** | **Tributary of NFEPA River** | |
| **Riparian Vegetation Type** | Grassland; Trees | |
| **Geomorphological Zonation (Rowntree & Wadeson, 2000)** | Upper foothill | |
| | **High Flow (March 2012)** | **Low Flow (September 2012)** |
| **Water Surface Dimensions** | Width: 10-20m; Depth: 1m | Width: 5-10m; Depth: 1m |
| **Water Turbidity (Dallas, 2005)** | Discoloured | Discoloured |
| **Dominant Velocity-depth Classes** | Fast shallow and slow deep | Fast and slow shallow |
| **Water Quality Parameters** **HF** | T (°C) = 22.3; pH = 6.2; EC (mS/m) = 11.1; DO (mg/l ) = 6.9; DO (%) = 90.9; TDS (mg/l)= 55 | |
| **Water Quality Parameters** **LF** | T (°C) = 11.8; pH = 8.0; EC (mS/m) = 17.2; DO (mg/l ) = 7.6; DO (%) = 83.1; TDS (mg/l)= 86 | |
| **Algae Presence** | Common | Common |
| **Dominant Biotope Diversity** | Riffles and pools | Riffles and pools |
| **Other Biota** | None | Tadpoles |
| **Highly Sensitive Taxa** (Score 11-15) | Baetidae > 2sp; Heptageniidae | Baetidae > 2sp |

| DATE | SAMPLER | SASS5 | ASPT | No of Taxa | MIRAI | IHI | FRAI |
|---|---|---|---|---|---|---|---|
| 28/03/2012 | W. Malherbe | 172 (B) | 5.9 | 29 | 83 (B) | 86 (B) | 79.5 (B/C) |
| 05/09/2012 | W. Malherbe / A. Austin | 139 (B/C) | 5.7 | 24 | 76 (C) | 88 (B) | 77 (C) |
| **Existing Threats** | | Litter | | | | | |

According to DWAF (1996), Al is the third most abundant element in the earth's crust. It occurs primarily as alumina-silicate minerals which are too insoluble to participate readily in bio-geochemical reactions. Al is a strongly hydrolysing metal and is relatively insoluble in the neutral pH range. Under acidic (pH < 6.0) or alkaline (pH > 8.0) conditions, or in the presence of complexing ligands, elevated concentrations may be mobilised to the aquatic environment. The pH at the sites ranged between 6.2 and 8.2, indicating that the Al probably mobilised due to the presence of complexing ligands. In addition, Al can be mobilised from soils and sediments by both natural weathering and accelerated acidification processes, resulting in detectable concentrations in surface waters. The Al concentrations were mostly above the TWQR during high flow, indicating that this was due to weathering during the wet season. Given the high measured pH levels, the elevated levels of Al would have had limited toxicity.

The element Fe is naturally released into the environment from weathering of sulphide ores (pyrite, $FeS_2$) and igneous, sedimentary and metamorphic rocks. Leaching from sandstones releases iron oxides and iron hydroxides to the environment (DWAF, 1996). High concentrations of Fe were measured especially during high flow. This was possibly because Fe leached from the surrounding mountains and soils into the natural drainage channels that join the tributaries of the Assegaai River. This caused high concentrations of Fe in the surface water at all the sampling sites during high flow. Elevated Fe concentrations can lead to oxygen depletion in rivers and streams. However, the high Fe concentrations during high flow had limited effects on the DO levels at the sites.

However the increased alkalinity usually results from increased carbon dioxide in the water, which is directly related to the amount of plant life within the aquatic system that produces $CO_2$. The higher alkalinity concentrations at all the sampling sites indicated algal growth and aquatic plants (eutrophication) in the systems (**Figure 3-1**). Some signs of increased algal growth were observed at YZ2, YZ3 and YZ5. The alkalinity concentrations increased sharply during low flow when the flow and water levels were reduced in the systems.

The total hardness concentration at YZ4 was very close to the threshold of TWQR during low flow. Ca and Mg are the major components to total hardness and are naturally found in high levels. The accumulation of these constituents was probably as a result of the non-perennial characteristics of this site.

The turbidity variables indicated values within the TWQR for aquatic ecosystems except at YZ4 during low flow, which had a high turbidity as a result of a natural lack of flowing water at this site. The existing dirt roads and erosion could also lead to increased turbidity, but no increases in the levels where seen at any of the sites.

Other variables, which indicated values higher than the TWQR, were ammonium, nitrate and COD. These variables all relate to organic or nutrient enrichment. Ammonium concentrations were higher at sites YZ1, YZ2 and YZ3. Even though ammonium has little or no toxicity it does contribute to eutrophication and the production of excessive algae and nitrites in the systems.

Nitrate was slightly higher than the 1 mg/L TWQR at site YZ4. Nitrates are seldom abundant in natural surface water, because photosynthesis constantly converts them to organic nitrogen in plant cells (DWAF, 1996). At YZ4 there was a lack of aquatic plants to convert them and together with non-flowing water led to the high concentration observed at this site. However, these high concentrations of $NO_3$ are normally not toxic to aquatic life. COD is an indication of increased organic waste and the concentrations were higher than the TWQR at site YZ3, YZ4 and YZ5. These levels could be caused by manure and sewage entering the system due to livestock and rural settlements.

In addition to the impacts associated with the livestock and rural settlements, there are also discard dumps from previous coal mines in the area. These mining activities probably occurred at the end of the 19$^{th}$ century and these discard dumps have probably been there for more than 100 years. Therefore, the water quality results did not show any evidence of pollution from these old discard dumps situated upstream of site YZ2.

Overall, it was evident from the results that the baseline variable levels measured in the water were low and mostly un-impacted. There seemed to be higher levels of constituents at the sites during low flow. This indicates temporal changes in the WQ results. The naturally reduced flow and water levels therefore lead to slightly increased concentrations. However, unnatural changes in the water quality will directly affect the biological communities that include species sensitive to changes in water quality.

The species found in mountain streams are able to survive only within a very narrow range of environmental conditions. Therefore, changes to water quality in this region may have profound effects not only here but in the river ecosystem as a whole (Dallas & Day, 2004).

As such, the water quality will be an important component, especially considering the downstream NFEPA, in the management of impacts relating to the proposed development (discussed in **Section G**). No significant increases of any of these variables should be allowed due to proposed development activities.

**Table 3-6 The constituents analysed at each site during high flow and low flow 2012 and the Target Water Quality Range (TWQR)**

| | TWQR[a] | YZ1 | | YZ2 | | YZ3 | | YZ4 | | YZ5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HF2012 | LF2012 | HF2012 | LF2012 | HF2012 | LF2012 | HF2012 | LF2012 | HF2012 | LF2012 |
| ***In situ* physic-chemical variables** | | | | | | | | | | | |
| pH | 6-9 | 6.6 | 8.5 | 6.9 | 8.0 | 7.5 | 7.6 | 6.9 | 8.1 | 6.2 | 8.0 |
| DO (mg/ℓ) | >8 | 7.2 | 7.5 | 7.6 | 6.7 | 7.8 | 8.2 | 6.3 | 4.4 | 6.9 | 7.6 |
| DO (%) | 80-120 | 99 | 83.2 | 102 | 73.6 | 110.6 | 93.9 | 89.4 | 47.9 | 90.9 | 83.1 |
| Temp. (°C) | 5-30 | 21.8 | 11.5 | 21.6 | 11.7 | 18.6 | 13.4 | 24.6 | 11.6 | 22.3 | 11.8 |
| EC (mS/m) | 70* | 10.5 | 16.7 | 9.8 | 14.6 | 13.7 | 17.6 | 11.7 | 18.4 | 11.1 | 17.2 |
| TDS (mg/ℓ) | 450 | 52.5 | 83 | 49 | 73 | 68 | 88 | 59 | 92 | 55 | 86 |
| **Metals** | | | | | | | | | | | |
| Al (mg/ℓ) | 0.005 | 0.134 | <0.006 | 0.182 | <0.006 | 0.186 | <0.006 | 0.716 | <0.006 | 0.29 | <0.006 |
| Cd (mg/ℓ) | 0.15 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Co (mg/ℓ) | 0.25* | <0.002 | 0.004 | <0.002 | 0.003 | <0.002 | 0.003 | <0.002 | 0.002 | <0.002 | 0.003 |
| Cr (mg/ℓ) | 0.007 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Cu (mg/ℓ) | 0.003 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Fe (mg/ℓ) | 0.1* | 0.267 | 0.113 | 0.662 | <0.006 | 0.545 | 0.080 | **1.46** | <0.006 | **1.073** | <0.006 |
| Mn (mg/ℓ) | 0.18 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Ni (mg/ℓ) | 0.1* | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| Pb (mg/ℓ) | 0.0002 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zn (mg/ℓ) | 0.002 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 |
| Total alkalinity (mg/ℓ) | 20* | 57.7 | 87.47 | 52.7 | 70.22 | 77.3 | 103.04 | 61.5 | 91.80 | 56.2 | 72.71 |
| Total hardness (mg/ℓ) | 90 | - | 82 | - | 71 | - | 89 | - | 71 | - | 83 |
| **Ions/Salts** | | | | | | | | | | | |
| Ca (mg/ℓ) | 150* | 9.481 | 15.94 | 8.534 | 13.88 | 12.769 | 17.44 | 8.882 | 15.03 | 9.433 | 16.06 |
| Cl (mg/ℓ) | 50* | 2.3 | 6.7 | 1.9 | 5.07 | <1.408 | 5.54 | 2.3 | 7.79 | 2.7 | 3.8 |
| F (mg/ℓ) | 0.75 | - | 0.280 | - | 0.216 | - | 0.213 | - | 0.260 | - | <0.183 |
| K (mg/ℓ) | 50 | 0.554 | 1.27 | 0.496 | 1.05 | 0.591 | 1.16 | 0.787 | 2.71 | 0.944 | 1.16 |

| | TWQR[a] | YZ1 | | YZ2 | | YZ3 | | YZ4 | | YZ5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HF2012 | LF2012 | HF2012 | LF2012 | HF2012 | LF2012 | HF2012 | LF2012 | HF2012 | LF2012 |
| Mg (mg/ℓ) | 70* | 5.846 | 10.24 | 5.363 | 8.71 | 8.036 | 11.09 | 4.889 | 8.13 | 5.68 | 10.30 |
| Na (mg/ℓ) | 50* | 4.41 | 6.81 | 4.39 | 6.27 | 6.01 | 7.19 | 7.52 | 13.51 | 4.95 | 6.66 |
| **Nutrients** | | | | | | | | | | | |
| Ammonium ($NH_4$) mg/ℓ | 0.007 | 0.122 | 0.111 | 0.11 | <0.015 | 0.152 | 0.030 | <0.015 | <0.015 | <0.015 | <0.015 |
| Nitrate ($NO_3$) mg/ℓ | 1* | 0.395 | 0.417 | 0.382 | 0.402 | 0.384 | 0.295 | 1.198 | 0.780 | 0.543 | 0.591 |
| Nitrite ($NO_2$) mg/ℓ | 20* | 0.175 | 0.066 | 0.173 | 0.063 | 0.174 | 0.065 | 0.197 | 0.069 | 0.196 | 0.062 |
| Orthophosphate ($PO_4$) mg/ℓ | 0.3* | - | <0.025 | - | <0.025 | - | <0.025 | - | <0.025 | - | <0.025 |
| Sulphate ($SO_4$) mg/ℓ | 80* | <0.321 | 4.25 | <0.321 | 3.60 | <0.132 | 0.91 | <0.132 | 2.60 | <0.132 | 13.07 |
| **Organic enrichment** | | | | | | | | | | | |
| COD (mg/ℓ) | 20* | 7.9 | 32.08 | 13.1 | 32.04 | 33.49 | 7.40 | 42.25 | 39.64 | 23.04 | 12.04 |
| **Turbidity** | | | | | | | | | | | |
| Suspended Solids (SS) (mg/ℓ) | 5* | 1 | 7 | 5 | 1 | 4 | 3 | 12 | 22 | <1 | <1 |
| Turbidity (NTU) | 20 | 6.2 | 6.14 | 8.8 | 3.13 | 8.5 | 8.52 | 19.8 | 30.5 | 10.4 | 6.15 |

- Not available

* No data available from DWA (1996) therefore obtained from Kotze (2001).

DO – Dissolved Oxygen, EC – Electrical Conductivity, Temp. – Temperature; TDS – Total Dissolved Solids.

HF = High Flow; LF = Low Flow.

Figures highlighted in blue are characterised as exceeding limits that would significantly influence the aquatic integrity.

The constituents highlighted in **bold** are considered a concern.

**Table 3-7 A description of the water constituents that were present above WQ guidelines defined by DWAF (1996)**

| WQ constituent | Sites of concern | Possible sources | Description and impacts |
|---|---|---|---|
| Aluminium (Al) | All the sites | Al was occurring naturally in the soils and sediment and mobilised by natural weathering through water seepage during high flow. | Aluminium is one of the more toxic metals within a water ecosystem and is associated with numerous biochemical effects on aquatic biota. For example Al is toxic and interferes with the ionic and osmotic balance in fish. This results in respiratory problems due to the coagulation of mucus on the gills. Al also hinder Ca metabolism and change the functioning of the Ca regulating protein, calmodulin. In addition, Al interferes with ion exchange sites, especially those involved with sodium homeostasis. This in turn may lead to neuromuscular dysfunction in fish (Colvin *et al*. 2011; DWAF, 1996). Effects on fish are usually evident at concentrations higher than 0.1 mg/l (Suter & Tsao, 1996; CCME, 1999). These concentrations were observed at YZ1, YZ2 and YZ3 but the high pH levels at the sites caused limited toxicity. |
| Iron (Fe) | All the sites | Fe is naturally released into the environment from weathering of sulphide ores and igneous, sedimentary and metamorphic rocks. This was probably the case at these sites, especially during high flow when there is an increase in water seepage. | Fe is an important micronutrient but toxic at high concentrations and inhibits various enzymes. Fe compounds easily oxidize and high concentrations can result in oxygen depletion in the rivers and streams. However, the high Fe concentrations at the sites during high flow did not seem to effect the dissolved oxygen concentrations. |
| Ammonium ($NH_4$) | YZ1, YZ2 and YZ3 | Ammonium is generally formed from the decomposition of nitrogenous organic matter (Dallas & Day, 2004). In addition, atmospheric deposition of ammonia comes from the biological degradation of manure (DWAF, 1996). The $NH_4$ concentrations were probably influenced by the presence and grazing of cattle at these sites. | Ammonia occurs in either the free, un-ionized form ($NH_3$) or as ammonium ions ($NH_4^+$). The toxicity of ammonia is directly related to the concentration of the un-ionized form, which affects the respiratory system of many animals by either inhibiting cellular metabolism or by decreasing the oxygen permeability of the cell membrane (Gammeter & Frutiger, 1990). In fish, ammonia reduces hatching, growth rate and development. It also causes pathological changes in tissue of gills, liver and kidney (Hart *et al.* 1992). In contrast, the ammonium ion has little or no toxicity (Williams *et al.* 1986), though it does contribute to eutrophication and the production of excessive algae, toxic nitrites and poor oxygen levels (Dallas & Day, 2004). Ammonium usually results from decomposition of nitrogenous organic matter in the surface or ground water, and it is one of the constituents of the nitrogen cycle (McKee & Wolf, 1963). The non-toxic $NH4^+$ is converted to the highly toxic $NH_3$ at pH values greater than 8. Natural waters typically contain ammonia and ammonium compounds in concentrations below 0.1 mg/l (Dallas & Day, 2004). |
| Alkalinity | All the sites | Increased alkalinity, usually results from increased carbon | The alkalinity is a measure of the buffering capacity of the water |

| WQ constituent | Sites of concern | Possible sources | Description and impacts |
|---|---|---|---|
| | | dioxide in the water, which is directly related to the amount of plant life within the aquatic system that produces $CO_2$. Therefore an increase in the algal content will influence this alkalinity. This can also be used as an indirect measure of farming activities and eutrophication. | and the amount of anions of weak acids including $OH^-$, $CO_3^{2-}$, and bicarbonate ions. Increases in this alkalinity generally results in waters that are able to maintain high pH, even in the presence of acidic conditions. Basically below a pH of 4 all the $CO_2$ is in the form of $H_2CO_3$. At the values between 6.4 and 8.6 the proportion of rises to peak at 8.3, when $CO_3^-$ begin to appear, while $CO_3^{2-}$ significantly quantifies only at pH values approaching 10. Complex polyphenolic organics and their salts may form the major buffering system in naturally acid waters, while aluminium and its salts become effective buffering agents in waters subject to acid precipitation. |
| Nitrate ($NO_3$) | YZ4 | Even though not abundant in surface water, nitrates are often found in high levels in ground water. Topographical data indicates YZ4 is the lowest point, on the tributary of the Assegaai River, in the proposed surface infrastructure. Therefore, ground water might have influenced the concentration of $NO_3$ in the surface water. Another possible source might include the previous cultivated land in the area where runoff and fertilizers might have accumulated in this non-perennial site. | Nitrates are seldom abundant in natural surface water, because photographsynthesis constantly converts them to organic nitrogen in plant cells (DWAF, 1996). At YZ4 there was a lack of aquatic plants to convert them and together with non-flowing water led to the high concentration observed at this site. However, high concentrations of $NO_3$ are normally not toxic. |
| COD | YZ3, YZ4 and YZ5 | Increased COD is an indication of increased organic waste, which is commonly associated with sewage and manure. The cows and cattle grazing at these sites could have influenced these concentrations. | The potential of organic wastes to deplete oxygen is commonly measured as COD. This is then used as an indirect measure of organic enrichment that changes the natural biotic assemblages within the aquatic ecosystems. |
| Turbidity | YZ4 | Increased turbidity and siltation are caused by soil disturbances, erosion and drainage which cause sediment to enter the stream or river. These lead to an increase in suspended solids (SS) entering water bodies. The SS also increased due to non-flowing conditions at YZ4. | Turbidity is influenced by SS. Increased SS will affect light penetration. Decreased light penetration will lead to decreases in primary production and food availability will diminish for organisms in the food chain. Benthic invertebrates will be affected because it changes the suitability of the substrate for some taxa, increase drift, affects respiration and feeding activities. Fish can be affected by having physiological effects (impairment of gill function or reduced resistance to disease), reduction in spawning habitat development hindering, change in migration patterns, reduction in food and intervention with hunting (Dallas & Day, 2004). |

## 3.3. Habitat Integrity

The habitat integrities for the selected sites on the Mawandlane and Mkusaze Rivers can be seen in **Table 3-8**. With very few impacts on the system the instream and riparian habitats were classified as being largely natural (B) to natural (A). The exceptions were YZ2 and YZ3, which had more impacted riparian habitats and were classified as moderately modified (C) during low flow.

The decreased habitat integrity at YZ2 was due to significant erosion, decrease in indigenous vegetation and an increase in alien vegetation in the form of *Acacia mearnsii* (Black Wattle) and *Acacia melanoxolon* (Australian Blackwood). A small cluster of these trees were present in the riparian zone which has resulted in increased woody debris at the site. There are also some signs of sedimentation and erosion at the site. At YZ3 the decrease in riparian habitat integrity was as a result of considerable erosion and moderate flow and channel modifications due to road crossing and increased aquatic vegetation. These modifications only slightly influenced the instream habitat, and the habitat integrity remained largely natural at this site.

In general, as shown in **Figure 3-1**, the impacts on habitat integrity at the sites were the following:

- Increase in alien vegetation and as a result a decrease in natural vegetation.
- Erosion of the banks.
- Impacts on water quality – possibly due to poor land use and leaching of iron and aluminium from the surrounding mountains and soils, increasing the levels in the surface water especially during the rainy season.
- Channel and flow modifications due to roads within the instream channel and in the riparian zone.

**Table 3-8 The instream and riparian habitat integrities for each aquatic sampling site**

| | YZ1 | | YZ2 | | YZ3 | | YZ5 | |
|---|---|---|---|---|---|---|---|---|
| | HF 2012 | LF 2012 | HF 2012 | LF 2012 | HF 2012 | LF 2012 | HF 2012 | LF 2012 |
| **Instream Habitat** | | | | | | | | |
| IH % | 95 | 92 | 87 | 85 | 93 | 90 | 86 | 88 |
| IH Class | A | A | B | B | A | A | B | B |
| Impacts | Sedimentation, bed modification | | Alien macrophytes, sedimentation, livestock watering | | WQ, Reduced flow, sedimentation, increased instream vegetation | | WQ, rubbish dumping | |
| **Riparian Habitat** | | | | | | | | |
| RH % | 93 | 91 | 77 | 62 | 82 | 72 | 90 | 93 |
| RH Class | A | A | C | C | B | C | A | A |
| Impacts | Alien vegetation, overgrazing, bank erosion | | Alien vegetation, decrease in indigenous vegetation, bank erosion | | Alien vegetation, bank erosion | | Alien vegetation | |

Even though these habitat modifications were moderate, it indirectly changed the biotope availability, velocity-depth flow structures and water quality, which slightly influenced the biotic component of the ecosystem at these sites. Spatially, the sites had relatively similar instream and riparian integrity scores, probable due to the similarity of the sources of impacts. Temporal comparisons between high and low flow, showed only slight seasonal fluctuations.

Increased algae

Cows grazing and livestock watering

WQ – Fe seeping into the rivers

Erosion

Alien vegetation in riparian zone
– Black Wattle (*Acacia meamsii*)

Alien vegetation in riparian zone
– Australian Blackwood (*Acacia melanoxolon*)

**Figure 3-1 Current impacts observed at the sites throughout the study area**

## 3.4. Macro-invertebrates

***Macro-invertebrate Habitat Availability***

The dominant biotope diversities for each site are presented in **Table 3-9**. The tributaries of the Assegaai i.e. Mkuzase and Mawandlane Rivers were typical mountain streams and foothill-cobbles beds, mostly dominated by 1st and 2nd stream order. Bedrock was occasionally present, but the rivers were dominated by cobbles/pebbles with boulders and GSM. The shallow water habitat was mostly cobble, riffle and bedrock rapids. All three biotopes-groups were present. The most common was with stones (in and out of current), then marginal vegetation (in and out of current) but GSM was sparse.

**Table 3-9 The dominant biotope diversities for each site by means of Dallas (2005)**

| | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|
| **Invertebrate habitat** | | | | |
| Stones in current (SIC) | 3 (run) | 1 (run) | 1 | 1 (run) |
| Stones out of current (SOOC) | 3 (pools) | 3 (pools) | 4 (pools) | 2 (pools) |
| Bedrock | 2 | 0 | 1 | 3 |
| Aquatic Vegetation | 1 (algae) | 0 | 0 | 1 (algae) |
| Marginal Vegetation in Current | 2 (grasses) | 1 (grasses) | 3 (grasses) | 1 (grasses) |
| Marginal Vegetation out of Current | 3 (grasses) | 3 (grasses) | 2 (grasses) | 3 (grasses) |
| Gravel, sand and mud (GSM) | 1 (in channel) | 1 (in channel) | 2 (in channel) | 1 (in channel) |
| 0=absent, 1=rare, 2=sparse, 3=moderate, 4=abundant and 5=very abundant | | | | |

***SASS5***

The macro-invertebrate assessments were completed using the SASS5 sampling methodology and interpreted using the interpretation guidelines as specified by Dallas (2007). The results of this assessment, for the selected bio-monitoring sites in the proposed AYCP, are provided in **Table 3-10**. The family assemblages are represented in **Appendix A**. The macro-invertebrate integrity varied from largely natural (B) to seriously modified (E) according to the SASS5 interpretation guidelines for the upper reaches of the Eastern Escarpment Mountains Eco-region.

**Table 3-10 Macro-invertebrate integrity assessments using SASS, ASPT and MIRAI scores for reference, historical and current assemblages**

| | | YZ1 | | YZ2 | | YZ3 | | YZ5 | |
|---|---|---|---|---|---|---|---|---|---|
| | | HF | LF | HF | LF | HF | LF | HF | LF |
| | Ref[a] | 2012 | 2012 | 2012 | 2012 | 2012 | 2012 | 2012 | 2012 |
| SASS5 Score | 230 | 142 | 105 | 119 | 61 | 170 | 144 | 172 | 139 |
| ASPT | 5.8 | 5.5 | 5.5 | 5.4 | 4.6 | 5.7 | 5.5 | 5.9 | 5.8 |
| PES | | B | C/D | C | E | B | B | B | C |
| No. of families | 40 | 26 | 19 | 22 | 13 | 30 | 26 | 29 | 24 |
| No. of airbreathers | | 8 | 5 | 7 | 3 | 12 | 10 | 8 | 7 |
| % of airbreathers | | 31% | 26% | 32% | 23% | 40% | 38% | 28% | 29% |
| Abundance of families > 100 | | - | Baetidae | - | - | - | - | - | - |
| MIRAI Score | - | 80 | 72 | 73 | 56 | 84 | 80 | 83 | 76 |
| MIRAI EC | - | B | C | C | D | B | B | B | C |

- Not available
a-Reference obtained from historical data, functional feeding groups and Ecoregion
HF = High Flow; LF = Low Flow

The SASS5 and ASPT scores were used to interpret the impacts on the community assemblages in terms of spatial and temporal variations. During high flow, the sites YZ1, YZ3 and YZ5 were classified as largely natural while YZ2 was moderately modified. The highest SASS5 score and ASPT were calculated for site YZ5. The largely natural macro-invertebrate community at these sites are reflected in the presence of sensitive families like the Heptageniidae, Leptophlebiidae, Tricorythidae, Athericidae and Ecnomidae.

During low flow the SASS5 scores and ASPT decreased considerably, causing YZ1 and YZ5 to become moderately modified and YZ2 seriously modified. However the site YZ3 stayed largely natural. It is clear that these trends are related to seasonal variation. This was seen as most of sensitive taxa were still present although the amount of species decreased. This was caused by the reduced flow and water levels during low flow which influenced the habitat availability for these macro-invertebrates.

Site YZ1 was close to being classified as moderately modified but this can possibly be attributed to its river type, which is a mountain stream. Mountain streams often have a lower productivity which can result in a decrease biological community. However, the presence of the sensitive families including the Athericidae, Chlorocyphidae, Leptophlebiidae, Tricorythidae and Psephenidae, indicated that the water quality is largely natural.

Site YZ2 had the lowest SASS5 score and ASPT value within the study area and this can be related to the decreased habitat quality at the site. As mentioned before (**Table 3-8**), the decreased habitat was due to sedimentation and the impact of alien vegetation on the river reach. The extra debris in the system from the alien vegetation could influence the organic enrichment at this site. However, the increased COD levels are only observed during low flow. Therefore, the water quality at the site was still in a good condition as sensitive families including the Dixidae, Tricorythidae and Leptophlebiidae were still present at the site. In addition, the abundance of species that prefer organic enriched waters like earthworms, flatworms, leeches and biting midges were very low at this site and confirmed the good WQ.

***MIRAI***

MIRAI measures the response of the macro-invertebrates to certain drivers, namely flow, habitat and water quality. The MIRAI scores and associated EC scores for each sampling site are presented in **Table 3-10**. The scores of the sites ranged between largely natural (B) and largely modified (D). The Reference list derived for the MIRAI index had a maximum SASS5 and ASPT score of 240 and 5.8 respectively.

Three of the sites (YZ1, YZ3 and YZ5) were largely natural during high flow. These sites had a high number of families and sensitive taxa present and a low number of tolerant species. The site YZ2 was largely modified, during high flow, compared to reference conditions. These modifications were due to a lower number of families present (13 families) in comparison to the reference assemblage (40 families). However, the abundances of these families were also similar to the Reference list and most of the sensitive species i.e. Leptophlebiidae and Tricorythidae were still present at this site.

There was a slight decrease in the MIRAI scores during the low flow assessment at YZ1, YZ2 and YZ5. All three of these sites decreased to become moderately modified. YZ3, in contrast, remained largely natural. The drivers associated with these slight temporal changes were flow and habitat. There was a clear reduction in flow and water levels during the low flow field sampling. This caused slightly reduced habitat availabilities such as stones and vegetation in current, which led to a reduction in species that prefer these habitats.

These modifications were natural seasonal changes and should not be misinterpreted. The PES of the aquatic systems as a whole is still largely natural despite the decreased family diversity during low flow. It will return to the largely natural state during high flow again due to limited local impacts.

A further indication that these macro-invertebrate community structures were only slightly impacted on, was through the assessment of the abundances of present families. The majority of families were present in acceptable abundances (1-100) at all of the sampling sites.

However, a high abundance of more than two species of Baetidae (+/- 200) was noted at YZ1. These macro-invertebrates are strong swimmers and were mainly sampled in the stones in current biotope where oxygen levels were high (**Table 3-6**). This family of scrapers were most likely abundant due to the algae content in the Mawandlane River. Therefore, in addition to the ideal habitat condition there was no shortage of food supply for this family with the increased algae, detritus, diatoms, midge larvae, protozoans and rotifers (DeMoore *et al.* 2003) at this site. The presence and abundances of sensitive species also indicate good WQ and flow levels in these systems. The low percentage of air-breathers (26%-40%) also highlights sufficient DO concentrations at all of the sampling sites.

## 3.5. Ichthyofauna

***Fish Habitat Availability***

The location of the study area is within the upper reaches of the Usutu River catchment causing the Assegaai River and its tributaries to have a diverse number of habitats. Therefore, the sampling sites had abundant fast shallow, slow shallow and slow deep habitats (**Table 3-11**).

**Table 3-11 The velocity depth classes for each site by means of Dallas (2005).**

| | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|
| **Fish habitat** | | | | |
| Slow-deep | 2 | 3 | 3 | 2 |
| Fast-deep | 0 | 0 | 0 | 0 |
| Slow-shallow | 4 | 4 | 4 | 4 |
| Fast-shallow | 4 | 2 | 2 | 3 |
| 0=absent, 1=rare, 2=sparse, 3=moderate, 4=abundant and 5=very abundant | | | | |

***Fish Reference List***

The Reference list of expected fish species and their relative abundance at each site was compiled using FROC (Kleynhans *et al*. 2008) for the RHP site on the Assegaai River (RHP Code: W5ASSE-HEYSH), and other literature sources. According to this, ten fish species are expected to occur within the Assegaai River and its tributaries (**Table 3-12**), and include: species that should occur in quaternary catchment W51A included *Anguilla mossambica*, *Amphilius uranoscopus*, *Barbus anoplus, Barbus argenteus, Barbus brevipinnis*, *Chiloglanis emarginatus*, *Labeobarbus polylepis*, *Pseudocrenilabrus philander*, *Tilapia sparmanii* and *Varicorhinus nelspruitensis*.

**Table 3-12 Expected and sampled fish species in the AYCP study area**

| FAMILY | SPECIES | COMMON NAME | STATUS | SAMPLED |
|---|---|---|---|---|
| ANGUILLIDAE | *Anguilla mossambica* | Longfin eel | NE | No |
| AMPHILIIDAE | *Amphilius uranoscopus* | Stargazer mountain catfish | LC | Yes |
| CICHLIDAE | *Pseudocrenilabrus philander* | Southern mouthbrooder | LC | No |
| CICHLIDAE | *Tilapia sparrmanii* | Banded tilapia | LC | No |
| CYPRINIDAE | *Barbus anoplus* | Chubbyhead barb | LC | Yes |
| CYPRINIDAE | *Barbus argenteus* | Rosefin barb | LC | No |
| CYPRINIDAE | *Barbus brevipinnis** | Shortfin barb | **NT** | No |
| CYPRINIDAE | *Labeobarbus polylepis* | Bushveld Smallscale yellowfish | LC | Yes |
| CYPRINIDAE | *Varicorhinus nelspruitensis** | Incomati chiselmouth | **NT** | No |
| MOCHOKIDAE | *Chiloglanis emarginatus** | Pongolo suckermouth | **NT** | No |
| * - Sensitive species; LC = Least concern; NE = Not evaluated; **NT = Near threatened** | | | | |

***Sampled Fish Species***

The fish community was assessed using electro-shocking and fyke nets during the aquatic assessment. Three of the ten expected fish species were sampled in the current study and presented in **Table 3-13** and **Figure 3-2**. This included the indigenous species namely *A. uranoscopus*, *B. anoplus* and *L. polylepis.*

The Stargazer Mountain Catfish (*A. uranoscopus*) prefer clear fast-flowing deep and shallow water in rocky habitats. This species is intolerant to no-flow and modified WQ conditions. Their migrations are also very local, only within reaches of the river (Kleynhans *et al*. 2008; Skelton, 2001) and were sampled in the Mawandlane and Mkuzase Rivers.

The Bushveld Smallscale Yellowfish (*L. polylepis*) prefer good habitats with fast flowing water and deep pools (Kleynhans *et al*. 2008; Skelton, 2001; Scott *et al*. 2006) and based on this were sampled in the Mawandlane River where these habitats were permanently present and water quality was good.

The Chubbyhead Barb (*B. anoplus*) was sampled at all of the sites, especially in the slow flowing water and pools with marginal and aquatic vegetation which are their preferred habitat. They migrate between river reaches and their lack of sensitivity to flow further indicates why they occurred at all of the sites.

Chubbyhead Barb
(*Barbus anoplus*)

Bushveld Smallscale Yellowfish
(*Labeobarbus polylepis*)

Stargazer Mountain Catfish
*Amphilius uranoscopus*

**Figure 3-2 Photographs of indigenous fish species that were caught in the study area**

***Species not sampled***

The Banded Tilapia (*T. sparrmanii*) and Southern Mouthbrooder (*P. philander*) both prefer slow flowing, quiet and/or standing water with lots of vegetation. The fast flowing water in these systems could have been the reason why neither of these species was sampled at any of the sites. The Rosefin Barb (*B. argenteus*) was also not sampled at any of the sites, even though this species prefers riffles in clear rocky streams and inhabits pools. Therefore, the reason for the lack of these species was not clear

In addition, the Longfin Eel (*A. mossambica*) was not sampled during this study. Potential instream barriers i.e. waterfalls further downstream of these sites might have prevented migration of this species. Another possibility is that this species normally migrates during the summer season back to the ocean (Skelton, 2001), and because neither of the sampling runs occurred during summer, it might explain their absence in the study area during sampling.

**Table 3-13 Reference and current fish frequency of occurrence**

| FISH SPECIES | | REFERENCE | | Sampling sites – High Flow 2012 | | | | Sampling sites – Low Flow 2012 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FROC | Abundance | YZ1 | YZ2 | YZ3 | YZ5 | YZ1 | YZ2 | YZ3 | YZ5 |
| ***# of indigenous species*** | | | | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 3 |
| ***FRAI score %*** | | | | 79.5 | 79.5 | 75.6 | 79.5 | 77.0 | 77.0 | 71.3 | 77.0 |
| ***FRAI EC*** | | | | **B/C** | **B/C** | **C** | **B/C** | **C** | **C** | **C** | **C** |
| **Total min sampled** | | | | 105 | 60 | 80 | 60 | 40 | 55 | 60 | 70 |
| *Anguilla mossambica* | Longfin Eel | 3 | 1 | - | - | - | - | - | - | - | - |
| *Amphilius uranoscopus* | Stargazer Mountain Catfish | 4 | 2 | 8 | 2 | - | - | 2 | - | 15 | 1 |
| *Barbus anoplus* | Chubbyhead Barb | 5 | 2 | 12 | 16 | 11 | 4 | 9 | 17 | 4 | 11 |
| *Barbus argenteus* | Rosefin Barb | 4 | 2 | - | - | - | - | - | - | - | - |
| *Barbus brevipinnis** | Shortfin Barb | 3 | 3 | - | - | - | - | - | - | - | - |
| *Chiloglanis emarginatus** | Phongolo Suckermouth | 2 | 4 | - | - | - | - | - | - | - | - |
| *Labeobarbus polylepis* | Smallscale Yellowfish | 5 | 5 | - | 13 | - | 37 | - | 5 | - | 6 |
| *Pseudocrenilabrus philander* | Southern Mouthbrooder | 5 | 3 | - | - | - | - | - | - | - | - |
| *Tilapia sparrmanii* | Banded Tilapia | 3 | 3 | - | - | - | - | - | - | - | - |
| *Varicorhinus nelspruitensis** | Incomati Chiselmouth | 3 | 3 | - | - | - | - | - | - | - | - |

- Not sampled
*Conservation Important species

### *Sensitive Fish Species*

The ten potentially occurring fish species include three Conservation Important (CI) species, namely *C. emarginatus* (Phongolo Suckermouth), *B. brevipinnis* (Shortfin Barb) and *V. nelspruitensis* (Incomati Chiselmouth). Engelbrecht *et al*. (2007) classify *V. nelspruitensis and B. brevipinnis* as Near Threatened, and *C. emarginatus* is regarded as a CI species by the Mpumalanga Tourism and Parks Agency (MTPA) (**Figure 3-3**).

*Varicorhinus nelspruitensis* occurs in the headwaters of the Incomati and Phongolo Rivers in Mpumalanga and KwaZulu-Natal as well as in Swaziland. There are numerous populations located in the upper catchments, but these are generally small and impacted upon by sedimentation, agriculture, alien fish and illegal gill netting (Engelbrecht *et al*. 2007). These fish need larger escarpment streams with reliable water flow and rocky substrates to ensure continued population stability. During this study, *V. nelspruitensis* was not sampled at any of the smaller systems (YZ1 – YZ3) nor in the larger system at YZ5. This was indeed expected at YZ1 – YZ3, but not at the site YZ5 that fulfilled the good habitat requirements of this species. The RHP site on the Assegaai River is located approximately 4km downstream of the study area, and *V. nelspruitensis* has been sampled there in the past. It may, therefore, occur on site.

*Barbus brevipinnis* is classified as Near Threatened by the IUCN due to its small area of occupancy, as well as, the decline in habitat range and quality due to upstream activities (Engelbrecht *et al*. 2007). These upstream activities include sedimentation, water abstraction, effect of dams and predation by trout. *B. brevipinnis* generally occurs in the headwater streams of the Phongolo and Sabie Sand systems where it is typically associated with banks, root stocks and marginal vegetation. Although not sampled during the current survey it was recently sampled at the RHP site on the Assegaai River approximately 4km downstream of YZ4. The tributaries of the Assegaai River consist of numerous small waterfalls that might have hindered fish migrations and this species also migrates very locally between river reaches which might explain its absence at the sites.

*Chiloglanis emarginatus* is not classified as threatened by the IUCN (Engelbrecht *et al*. 2007), but it is listed as a CI species by the MTPA. This is due to the decrease in its abundance, as well as, its extinction in its type locality in the Lekkerloop stream (GPS coordinates: S25.98333° E30.65000° – approximately 140 km from the study site). This is due to excessive water extraction by farmers during the low flow seasons (Engelbrecht *et al*. 2007). Furthermore, *C. emarginatus* are also more abundant in Swaziland than in South Africa and as such was deemed a Least Concern by the IUCN. Although not sampled within the small streams in the specific study area it is expected to occur at the RHP site downstream in the Assegaai River, and any impacts on its tributaries could potentially affect the Assegaai River (**Figure 3-3**).

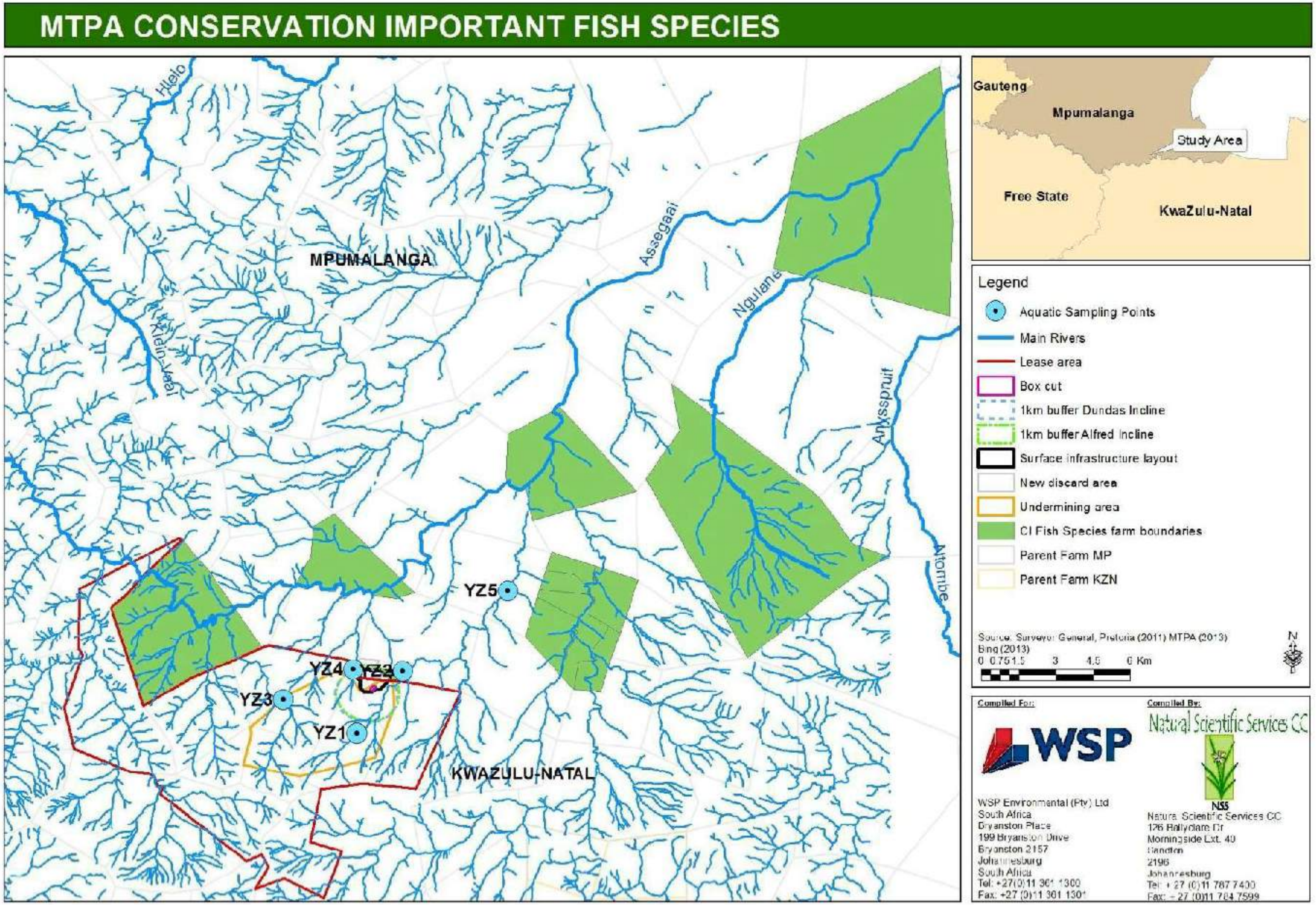



**Figure 3-3** **Farms in the study area where Conservation Important fish species have been recorded**

***FRAI***

FRAI scores were calculated to determine the frequency of occurrence of potentially occurring fish species in the Mkusaze and Mawandlane Rivers. The FRAI results indicated that sites YZ1, YZ2 and YZ5 are largely natural/moderately modified, while the YZ3 site is modified. These slightly lower EC scores were due to the decreased frequency of occurrence of the potentially occurring fish species in these systems.

During low flow, all the FRAI scores decreased to moderately modified due to a decrease in abundances and number of species present. These modifications were as a result of decreased flow, velocity-depth and cover during low flow. This indicates natural seasonal changes in these systems. It must also be noted that the natural breeding period of fish in the area is during the summer season. Therefore, fish activity is usually much greater during high flow compared to the low flow periods. In addition, it is expected that all of the reference species still occur within these systems although they were not sampled during the two surveys.

The general fish habitat availability was good with numerous flow types, substrate size classes, velocity-depth classes as well as marginal vegetation present at each site. The fish species namely *B. argenteus, P. philander* and *T. sparmanii* that were not sampled are considered tolerant. These species are still expected to be present, as a result of the good habitat quality conditions, but possibly in a lesser abundance as seen at the RHP site on the Assegaai River.

# 4. Appendices

## 4.1. Appendix 1 High and low flow (2012) SASS5 data

**Table 4-1 Macro-invertebrates sampled in high flow 2012**

| ATTRIBUTES / MACRO-INVERTEBRATES | Sensitivity Score | REF | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|---|---|
| **SASS5 Score** | | **230** | **142** | **119** | **170** | **168** |
| **No of taxa** | | **40** | **26** | **22** | **30** | **29** |
| **ASPT** | | **5.8** | **5.5** | **5.4** | **5.7** | **5.8** |
| **No of airbreathers** | | **14** | **8** | **7** | **12** | **8** |
| **% of airbreathers** | | **35%** | **31%** | **32%** | **40%** | **28%** |
| **EC** | | **A** | **B** | **C** | **B** | **B** |
| **PORIFERA (Sponge)** | 5 | | | | | |
| **COELENTERATA (Cnidaria)** | 1 | | | | | |
| **TURBELLARIA (Flatworms)** | 3 | 1 | A | A | A | |
| **ANNELIDA** | | | | | | |
| Oligochaeta (Earthworms) | 1 | A | A | A | | A |
| Hirudinea (Leeches) | 3 | | | | | |
| **CRUSTACEA** | | | | | | |
| Amphipoda (Scuds) | 13 | | | | | |
| Potamonautidae* (Crabs) | 3 | A | B | A | B | A |
| Atyidae (Freshwater Shrimps) | 8 | 1 | | | | |
| Palaemonidae (Freshwater Prawns) | 10 | | | | | |
| **HYDRACARINA (Mites)** | 8 | 1 | | | 1 | B |
| **PLECOPTERA (Stoneflies)** | | | | | | |
| Notonemouridae | 14 | | | | | |
| Perlidae | 12 | | | | | |
| **EPHEMEROPTERA (Mayflies)** | | | | | | |
| Baetidae 1sp | 4 | | | | | |
| Baetidae 2spp | 6 | | | | | |
| Baetidae >2spp | 12 | B | B | B | B | B |
| Caenidae (Squaregills/Cainfles) | 6 | A | A | A | 1 | A |
| Ephemeridae | 15 | | | | | |
| Heptageniidae (Flatheaded mayflies) | 13 | A | | | | A |
| Leptophlebiidae (Prongills) | 9 | A | B | A | 1 | A |
| Oligoneuridae (Brushlegged mayflies) | 15 | | | | | |
| Polymitarcyidae (Pale Burrowers) | 10 | | | | | |
| Prosopistomatidae (Water specs) | 15 | | | | | |
| Teloganodidae SWC (Spiny Crawlers) | 12 | | | | | |
| Tricorythidae (Stout Crawlers) | 9 | A | A | A | B | A |
| **ODONATA (Dragonflies & Damselflies)** | | | | | | |
| Calopterygidae ST,T (Demoiselles) | 10 | | | | | |
| Chlorocyphidae (Jewels) | 10 | 1 | | | | 1 |
| Synlestidae (Chlorolestidae)(Sylphs) | 8 | 1 | | | 1 | |
| Coenagrionidae (Sprites and blues) | 4 | A | A | A | A | A |
| Lestidae (Emerald Damselflies/Spreadwings) | 8 | | | | | |
| Platycnemidae (Stream Damselflies) | 10 | | | | | |
| Protoneuridae (Threadwings) | 8 | | | | | |
| Aeshnidae (Hawkers & Emperors) | 8 | A | B | A | A | A |
| Corduliidae (Cruisers) | 8 | | | | | |
| Gomphidae (Clubtails) | 6 | A | B | A | B | A |

| ATTRIBUTES / MACRO-INVERTEBRATES | Sensitivity Score | REF | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|---|---|
| Libellulidae (Darters/Skimmers) | 4 | A | | | A | 1 |
| **LEPIDOPTERA (Aquatic Caterpillars/Moths)** | | | | | | |
| Crambidae (Pyralidae) | 12 | | | | | |
| **HEMIPTERA (Bugs)** | | | | | | |
| Belostomatidae* (Giant water bugs) | 3 | 1 | | | 1 | 1 |
| Corixidae* (Water boatmen) | 3 | A | B | A | B | A |
| Gerridae* (Pond skaters/Water striders) | 5 | A | A | A | A | |
| Hydrometridae* (Water measurers) | 6 | | | | | |
| Naucoridae* (Creeping water bugs) | 7 | 1 | | | A | A |
| Nepidae* (Water scorpions) | 3 | | | | | |
| Notonectidae* (Backswimmers) | 3 | A | A | 1 | A | 1 |
| Pleidae* (Pygmy backswimmers) | 4 | 1 | | | 1 | |
| Veliidae/M...veliidae* (Ripple bugs) | 5 | A | A | 1 | A | A |
| **MEGALOPTERA (Fishflies, Dobsonflies and Alderflies)** | | | | | | |
| Corydalidae (Fishflies & Dobsonflies) | 8 | | | | | |
| Sialidae (Alderflies) | 6 | | | | | |
| **TRICHOPTERA (Caddisflies)** | | | | | | |
| Dipseudopsidae | 10 | | | | | |
| Ecnomidae | 8 | | | | | 1 |
| Hydropsychidae 1 sp | 4 | | | | 1 | |
| Hydropsychidae 2 sp | 6 | A | B | A | | A |
| Hydropsychidae > 2 sp | 12 | | | | | |
| Philopotamidae | 10 | | | | | |
| Polycentropodidae | 12 | | | | | |
| Psychomyiidae/Xiphocentronidae | 8 | | | | | |
| **Cased caddis:** | | | | | | |
| Barbarochthonidae SWC | 13 | | | | | |
| Calamoceratidae ST | 11 | | | | | |
| Glossosomatidae SWC | 11 | | | | | |
| Hydroptilidae | 6 | | | | | |
| Hydrosalpingidae SWC | 15 | | | | | |
| Lepidostomatidae | 10 | | | | | |
| Leptoceridae | 6 | 1 | | | | A |
| Petrothrincidae SWC | 11 | | | | | |
| Pisuliidae | 10 | | | | | |
| Sericostomatidae SWC | 13 | | | | | |
| **COLEOPTERA (Beetles)** | | | | | | |
| Dytiscidae/Noteridae* (Diving beetles) | 5 | A | 1 | 1 | B | A |
| Elmidae/Dryopidae* (Riffle beetles) | 8 | 1 | | 1 | 1 | |
| Gyrinidae* (Whirligig beetles) | 5 | A | B | | A | A |
| Haliplidae* (Crawling water beetles) | 5 | | | | 1 | |
| Helodidae (Marsh beetles) | 12 | | | | | |
| Hydraenidae* (Minute moss beetles) | 8 | | | | | |
| Hydrophilidae* (Water scavenger beetles) | 5 | 1 | | | | |
| Limnichidae (Marsh-Loving Beetles) | 10 | | | | | |
| Psephenidae (Water Pennies) | 10 | 1 | 1 | | 1 | 1 |
| **DIPTERA (Flies)** | | | | | | |
| Athericidae (Snipe flies) | 10 | 1 | 1 | | | |
| Blephariceridae (Mountain midges) | 15 | | | | | |
| Ceratopogonidae (Biting midges) | 5 | A | 1 | | A | A |
| Chironomidae (Midges) | 2 | A | A | A | A | A |
| Culicidae* (Mosquitoes) | 1 | 1 | 1 | 1 | | A |
| Dixidae* (Dixid midge) | 10 | | | A | | |
| Empididae (Dance flies) | 6 | | | | | |

| ATTRIBUTES / MACRO-INVERTEBRATES | Sensitivity Score | REF | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|---|---|
| Ephydridae (Shore flies) | 3 | | | | | |
| Muscidae (House flies, Stable flies) | 1 | | | | | |
| Psychodidae (Moth flies) | 1 | 1 | A | A | | A |
| Simuliidae (Blackflies) | 5 | 1 | | | | |
| Syrphidae* (Rat tailed maggots) | 1 | | | | | |
| Tabanidae (Horse flies) | 5 | 1 | 1 | | | |
| Tipulidae (Crane flies) | 5 | 1 | A | 1 | A | A |
| **GASTROPODA (Snails)**<br>Ancylidae (Limpets) | 6 | 1 | A | | A | |
| Bulininae* | 3 | | | | | |
| Hydrobiidae* | 3 | | | | | |
| Lymnaeidae* (Pond snails) | 3 | | | | | |
| Physidae* (Pouch snails) | 3 | | | | | |
| Planorbinae* (Orb snails) | 3 | 1 | | | | |
| Thiaridae* (=Melanidae) | 3 | | | | | |
| Viviparidae* ST | 5 | | | | | |
| **PELECYPODA (Bivalves)**<br>Corbiculidae (Clams) | 5 | | | | | |
| Sphaeriidae (Pill clams) | 3 | | | | | |
| Unionidae (Perly mussels) | 6 | | | | | |
| * airbreathers; Abundances: 1 = 1; A = 2-10; B = 10-100; D =>1000<br>REF = Reference; SWC = South Western Cape; T = Tropical; ST = Sub-tropica. | | | | | | |

**Table 4-2 Macro-invertebrates sampled in low flow 2012**

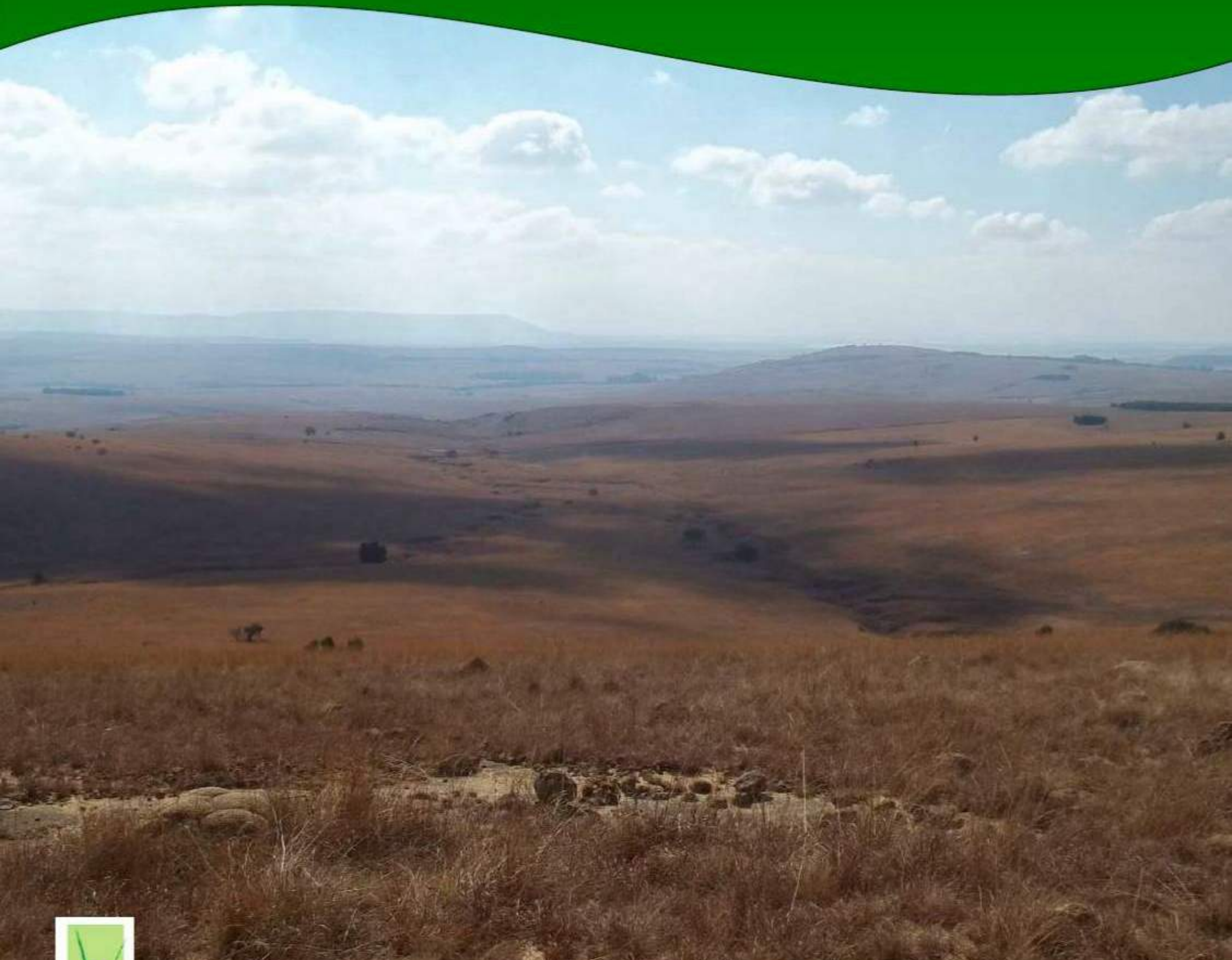
| | Sensitivity Score | REF | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|---|---|
| **SASS Score** | | **230** | **105** | **61** | **144** | **139** |
| **No of Taxa** | | **40** | **19** | **13** | **26** | **24** |
| **ASPT** | | **5.8** | **5.5** | **4.6** | **5.5** | **5.7** |
| **No of airbreathers** | | **14** | **5** | **3** | **10** | **7** |
| **% of airbreathers** | | **35%** | **26%** | **23%** | **38%** | **29%** |
| **EC** | | **A** | **D** | **E** | **B** | **C** |
| **PORIFERA (Sponge)** | 5 | | | | | |
| **COELENTERATA (Cnidaria)** | 1 | | | | | |
| **TURBELLARIA (Flatworms)** | 3 | 1 | | 1 | A | 1 |
| **ANNELIDA**<br>Oligochaeta (Earthworms) | 1 | A | 1 | | | 1 |
| Hirudinea (Leeches) | 3 | | | | | |
| **CRUSTACEA**<br>Amphipoda (Scuds) | 13 | | | | | |
| Potamonautidae* (Crabs) | 3 | A | 1 | 1 | 1 | 1 |
| Atyidae (Freshwater Shrimps) | 8 | 1 | | | | |
| Palaemonidae (Freshwater Prawns) | 10 | | | | | |
| **HYDRACARINA (Mites)** | 8 | 1 | | | | 1 |
| **PLECOPTERA (Stoneflies)**<br>Notonemouridae | 14 | | | | | |
| Perlidae | 12 | | | | | |
| **EPHEMEROPTERA (Mayflies)**<br>Baetidae 1sp | 4 | | | | | |
| Baetidae 2spp | 6 | | | B | | |
| Baetidae >2spp | 12 | B | C | | A | B |
| Caenidae (Squaregills/Cainfles) | 6 | A | 1 | B | B | B |
| Ephemeridae | 15 | | | | | |
| Heptageniidae (Flatheaded mayflies) | 13 | A | | | | |

| | Sensitivity Score | REF | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|---|---|
| Leptophlebiidae (Prongills) | 9 | A | B | B | 1 | A |
| Oligoneuridae (Brushlegged mayflies) | 15 | | | | | |
| Polymitarcyidae (Pale Burrowers) | 10 | | | | | |
| Prosopistomatidae (Water specs) | 15 | | | | | |
| Teloganodidae SWC (Spiny Crawlers) | 12 | | | | | |
| Tricorythidae (Stout Crawlers) | 9 | A | 1 | B | B | B |
| **ODONATA (Dragonflies & Damselflies)**<br>Calopterygidae ST,T (Demoiselles) | 10 | | | | | |
| Chlorocyphidae (Jewels) | 10 | 1 | 1 | | | |
| Synlestidae (Chlorolestidae)(Sylphs) | 8 | 1 | | | A | |
| Coenagrionidae (Sprites and blues) | 4 | A | A | A | A | A |
| Lestidae (Emerald Damselflies/Spreadwings) | 8 | | | | | |
| Platycnemidae (Stream Damselflies) | 10 | | | | | |
| Protoneuridae (Threadwings) | 8 | | | | | |
| Aeshnidae (Hawkers & Emperors) | 8 | A | A | | A | A |
| Corduliidae (Cruisers) | 8 | | | | | 1 |
| Gomphidae (Clubtails) | 6 | A | A | 1 | A | A |
| Libellulidae (Darters/Skimmers) | 4 | A | | | 1 | A |
| **LEPIDOPTERA (Aquatic Caterpillars/Moths)**<br>Crambidae (Pyralidae) | 12 | | | | | |
| **HEMIPTERA (Bugs)**<br>Belostomatidae* (Giant water bugs) | 3 | 1 | | | | |
| Corixidae* (Water boatmen) | 3 | A | | A | A | |
| Gerridae* (Pond skaters/Water striders) | 5 | A | | | 1 | |
| Hydrometridae* (Water measurers) | 6 | | | | | |
| Naucoridae* (Creeping water bugs) | 7 | | | | 1 | |
| Nepidae* (Water scorpions) | 3 | | 1 | | | |
| Notonectidae* (Backswimmers) | 3 | A | 1 | | | |
| Pleidae* (Pygmy backswimmers) | 4 | 1 | | | B | |
| Veliidae/M...veliidae* (Ripple bugs) | 5 | A | | | A | A |
| **MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)**<br>Corydalidae (Fishflies & Dobsonflies) | 8 | | | | | |
| Sialidae (Alderflies) | 6 | | | | | |
| **TRICHOPTERA (Caddisflies)**<br>Dipseudopsidae | 10 | | | | | |
| Ecnomidae | 8 | | | | | |
| Hydropsychidae 1 sp | 4 | | A | 1 | | |
| Hydropsychidae 2 sp | 6 | A | | | A | A |
| Hydropsychidae > 2 sp | 12 | | | | | |
| Philopotamidae | 10 | | | | | |
| Polycentropodidae | 12 | | | | | |
| Psychomyiidae/Xiphocentronidae | 8 | | | | | |
| **Cased caddis:**<br>Barbarochthonidae SWC | 13 | | | | | |
| Calamoceratidae ST | 11 | | | | | |
| Glossosomatidae SWC | 11 | | | | | |
| Hydroptilidae | 6 | | | | | |
| Hydrosalpingidae SWC | 15 | | | | | |
| Lepidostomatidae | 10 | | | | | |
| Leptoceridae | 6 | 1 | | | | 1 |
| Petrothrincidae SWC | 11 | | | | | |
| Pisuliidae | 10 | | | | | |
| Sericostomatidae SWC | 13 | | | | | |

| | Sensitivity Score | REF | YZ1 | YZ2 | YZ3 | YZ5 |
|---|---|---|---|---|---|---|
| **COLEOPTERA (Beetles)** | | | | | | |
| Dytiscidae/Noteridae* (Diving beetles) | 5 | A | 1 | | A | A |
| Elmidae/Dryopidae* (Riffle beetles) | 8 | 1 | | | | 1 |
| Gyrinidae* (Whirligig beetles) | 5 | A | 1 | | | A |
| Haliplidae* (Crawling water beetles) | 5 | | | | | |
| Helodidae (Marsh beetles) | 12 | | | | | |
| Hydraenidae* (Minute moss beetles) | 8 | | | | | |
| Hydrophilidae* (Water scavenger beetles) | 5 | 1 | | | A | |
| Limnichidae (Marsh-Loving Beetles) | 10 | | | | | |
| Psephenidae (Water Pennies) | 10 | 1 | | | | |
| **DIPTERA (Flies)** | | | | | | |
| Athericidae (Snipe flies) | 10 | 1 | | | 1 | |
| Blepharoceridae (Mountain midges) | 15 | | | | | |
| Ceratopogonidae (Biting midges) | 5 | A | 1 | A | A | A |
| Chironomidae (Midges) | 2 | A | A | A | A | B |
| Culicidae* (Mosquitoes) | 1 | 1 | | A | 1 | A |
| Dixidae* (Dixid midge) | 10 | | | | | 1 |
| Empididae (Dance flies) | 6 | | | | | |
| Ephydridae (Shore flies) | 3 | | | | | |
| Muscidae (House flies, Stable flies) | 1 | | | | | |
| Psychodidae (Moth flies) | 1 | 1 | | | | |
| Simuliidae (Blackflies) | 5 | 1 | A | | | 1 |
| Syrphidae* (Rat tailed maggots) | 1 | | | | | |
| Tabanidae (Horse flies) | 5 | 1 | | | | |
| Tipulidae (Crane flies) | 5 | 1 | 1 | | 1 | |
| **GASTROPODA (Snails)** | | | | | | |
| Ancylidae (Limpets) | 6 | 1 | | | A | |
| Bulininae* | 3 | | | | | |
| Hydrobiidae* | 3 | | | | | |
| Lymnaeidae* (Pond snails) | 3 | | | | | |
| Physidae* (Pouch snails) | 3 | | | | | |
| Planorbinae* (Orb snails) | 3 | 1 | | | 1 | |
| Thiaridae* (=Melanidae) | 3 | | | | | |
| Viviparidae* ST | 5 | | | | | |
| **PELECYPODA (Bivalves)** | | | | | | |
| Corbiculidae (Clams) | 5 | | | | | |
| Sphaeriidae (Pill clams) | 3 | | | | | |
| Unionidae (Perly mussels) | 6 | | | | | |

* airbreathers; Abundances: 1 = 1; A = 2-10; B = 10-100; D =>1000
REF = Reference; SWC = South Western Cape; T = Tropical, ST = Sub-tropica.

# Section E: Wetland Assessment



NATURAL SCIENTIFIC SERVICES

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# SECTION E: WETLAND ASSESSMENT

## 1. Introduction

Natural Scientific Services CC (NSS) was contracted by WSP to perform Biodiversity Scoping, Baseline and Impact Assessments for selected aspects of the proposed ATHA Yzermyn Coal Project (AYCP). **Section E** of this report details the Baseline Wetland Assessment, which involved desktop- and field-based investigation (including delineation) of wetlands for selected aspects of the AYCP. Potential impacts on wetlands of the AYCP and recommended measures to mitigate these impacts are discussed in **Section G**.

The NWA (Act No. 36 of 1998) defines a wetland as:

*"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".*

Under the Convention on Wetlands (Ramsar, Iran, 1971) "wetlands" are defined by Articles 1.1 and 2.1 as shown below:

Article 1.1:
"*For the purpose of this Convention wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*."

Article 2.1 provides that wetlands:
"*may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands*".

# 2. Methodology

The wetland assessment was based on the SoW as outlined in the NSS proposals: 1877 (19 February 2013) and 1933 (11 July 2013). The assessment includes both a desktop and field based investigation of wetlands within the current (new) surface infrastructure area and proposed discard area (areas hereon referred to as the Study Area). A desktop wetland delineation was also undertaken for the wetlands within the greater undermining area.

## 2.1. Desktop Research

A desktop study and investigation of Google Earth aerial imagery was undertaken prior to the field investigation to identify potential wetland areas within the study area. In addition to Google Earth imagery, the following background information was taken into consideration:

- 20m Contour data (supplied by WSP);
- Geohydrological Impact Assessment (WSP, 2013a);
- Land Use, Soil and Land Capability Assessment (WSP, 2013b)

Based on the available information, a desktop delineation was also undertaken for the wetland areas in the greater underground mining area. Unfortunately the Land Use, Soil and Land Capability Assessment (WSP, 2013) did not provide a site specific soils map that could be used as part of the desktop mapping for the greater underground mining area.

## 2.2. Fieldwork

The wetland assessment was undertaken from 15-17 July 2013 for the current (new) surface infrastructure and proposed discard areas (**Section A: Figure 2-1**).

### 2.2.1 ***Wetland Classification***

The recently published 'Classification system for Wetlands and other Aquatic Ecosystems in South Africa' (hereafter referred to as the 'Classification System') was used to define the wetland types identified within the Study Area (Ollis *et al*, 2013). The ecosystems included in the Classification System encompass all those that the Ramsar Convention defines as 'wetlands' and includes all aquatic ecosystems, including wetlands, although excludes marine systems. The Classification System has 3 broad inland systems: Rivers, Wetlands and Open Waterbodies. As with the Kotze *et al* (2007) classification of wetlands, using hydro-geomorphic (HGM) units, the revised Classification System identifies that hydrology and geomorphology are the two fundamental features that determine the way in which an inland aquatic ecosystem functions (Ollis *et al*, 2013). The inland component has a six-tiered structure which is provided in **Appendix 1**, with the classification of inland wetland systems into HGM Units (**Figure 2-1**) being the fundamental classification.

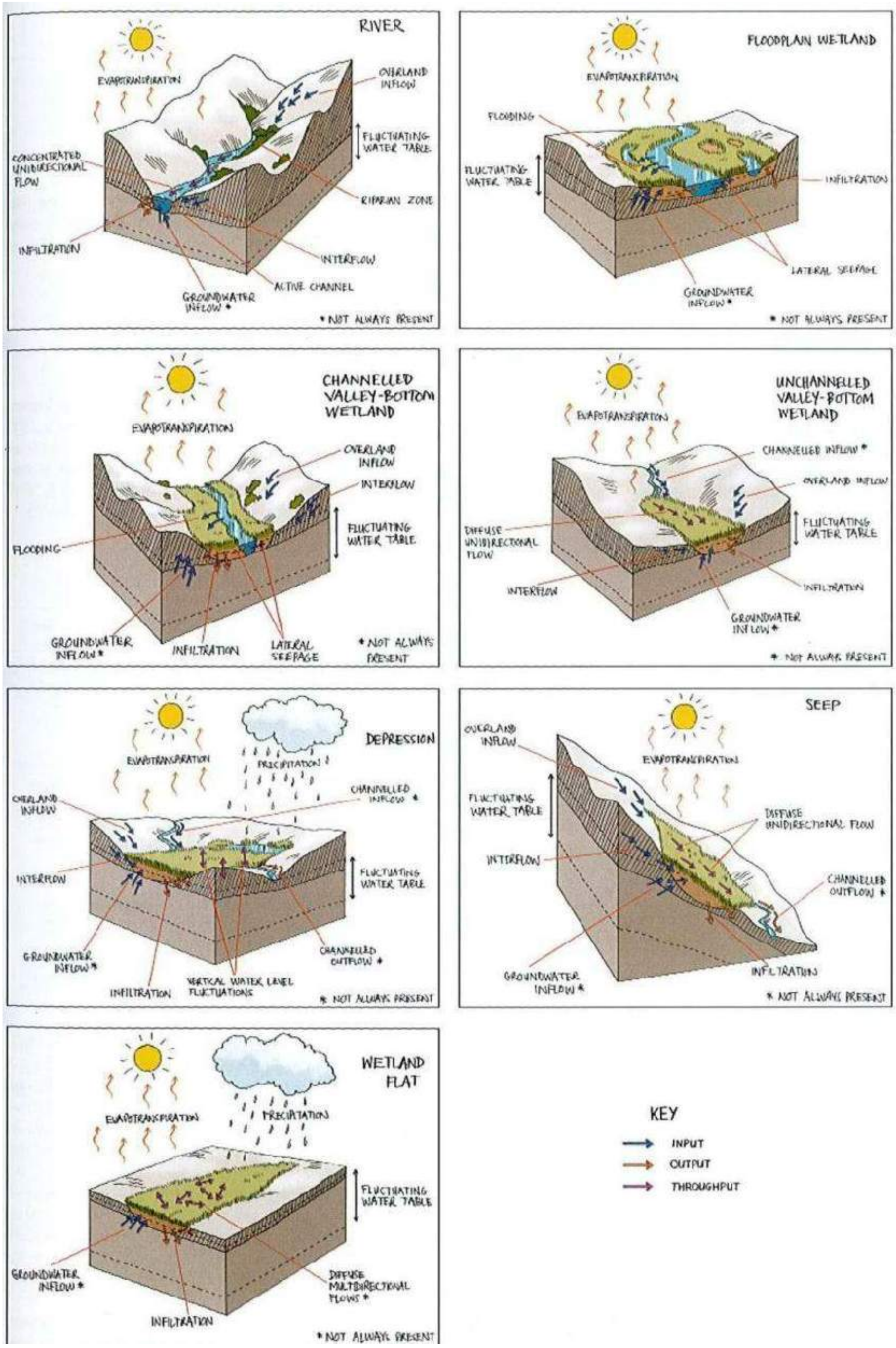



**Figure 2-1 Primary HGM types, highlighting dominant water inputs, throughputs & outputs (Ollis *et al.* 2013)**

### 2.2.2 *Wetland Delineation*

The wetland delineation methodology used was the same as the one outlined in the DWA Guideline "*A practical field procedure for identification and delineation of wetlands and riparian areas*" (DWAF, 2005). The following four indicators, as described by DWAF (2005), were considered:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation;
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

The study sites were traversed, on foot, with soil samples, within the top 50cm of the soil profile, taken using a hand auger along transects leading away from the wetlands. The soil samples were then assessed for the above wetland indicators. Each auger point sampled on site was marked with a handheld Global Positioning System (GPS) device (Geographic projection, WGS 84 Datum).

### 2.2.3 *Habitat Integrity and Present Ecological State*

The PES of the wetlands identified within the study area were assessed using the Level 1 WET-HEALTH tool, as described by Macfarlane *et al* (2008). The WET-HEALTH tool is designed to assess the health or integrity of a wetland. In assessing the health of the wetlands, the tool uses indicators based on the main wetland drivers: geomorphology, hydrology and vegetation. McFarlane *et al* (2008) describe the application and methodology of WET- HEALTH as follows:

The system uses:

- An impact-based approach for those activities that do not produce clearly visible responses in wetland structure and function. The impact of irrigation or aforestation in the catchment, for example, produces invisible impacts on water inputs. This is the main approach used in the hydrological assessment.
- An indicator-based approach for activities that produce clearly visible responses in wetland structure and function such as the presence of erosion gullies or alien plant species. This approach is mainly used in the assessment of geomorphological and vegetation health.

The wetland is first classified into hydrogeomorphic (HGM) units (as discussed above). Each HGM unit is then assessed separately for hydrological, geomorphological and vegetation health based on extent, intensity and magnitude of impact. This is translated into a health score.
The approach, as defined by Macfarlane *et al* (2008) is as follows:

- The extent of impact is measured as the proportion of a wetland and/or its catchment that is affected by an activity. Extent is expressed as a percentage.
- The intensity of impact is estimated by evaluating the degree of alteration that results from a given activity.
- The magnitude of impact for individual activities is the product of extent and intensity.
- The magnitude of individual activities in each HGM unit is combined in a structured and transparent way to calculate the overall impact of all activities that affect hydrological, geomorphological or vegetation health. Present State health categories are scored on a scale of A-F (**Table 2-1**).

Using a combination of threat and/or vulnerability, an assessment is also made in each module on the likely Trajectory of Change within the wetland (**Table 2-2**). Overall health of the wetland is then presented for each module by jointly representing the Present State and likely Trajectory of Change. This approach not only provides an indication of hydrological, geomorphological and vegetation health, but also highlights the key causes of wetland degradation.

**Table 2-1 Impact Scores and Present Ecological State categories**

| ECOLOGICAL CATEGORY | DESCRIPTION | COMBINED IMPACT SCORE |
|---|---|---|
| A | **Unmodified, natural** | 0-0.9 |
| B | **Largely natural with few modifications**. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place. | 1-1.9 |
| C | **Moderately modified**. A moderate change in ecosystem processes and loss of natural habitat has taken place but the natural habitat remains predominantly intact. | 2-3.9 |
| D | **Largely modified**. A large change in ecosystem processes and loss of natural habitat and biota has occurred. | 4-5.9 |
| E | **Seriously modified**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable. | 6-7.9 |
| F | **Critically modified**. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota. | 8-10 |

**Source:** Modified from Macfarlane *et al* (2008)

**Table 2-2 Trajectory of change classes, scores and symbols**

| TRAJECTORY CLASS | DESCRIPTION | CHANGE SCORE | CLASS RANGE* | SYMBOL |
|---|---|---|---|---|
| **Improve markedly** | Condition is likely to improve substantially over the next five years | 2 | 1.1 to 2 | ↑↑ |
| **Improve** | Condition is likely to improve over the next five years | 1 | .3 to 1 | ↑ |
| **Remains stable** | Condition is likely to remain stable over the next five years | 0 | -0.2 to +0.2 | → |
| **Deterioration slight** | Condition is likely to deteriorate slightly over the next five years | -1 | -0.3 to -1 | ↓ |
| **Deterioration substantial** | Condition is likely to deteriorate substantially over the next five years | -2 | -1.1 to 2 | ↓↓ |

**Source:** Modified from Macfarlane *et al* (2008)

* Used when determining a trajectory score for a wetland comprising several HGM units

### 2.2.4 *Wetland Functionality*

The WET – EcoServices tool is a technique for rapidly assessing ecosystem services supplied by wetlands (Kotze *et al.* 2008). This tool has been designed for inland palustrine wetlands, i.e. marshes, floodplains, vleis and seeps and has been developed to help assess the goods and services that individual wetlands provide to support planning and decision-making.

The wetland benefits included in the WET-EcoServices model are selected based on their importance for South African wetlands, and how readily these can be assessed. Benefits such as groundwater recharge / discharge and biomass export may be important but are difficult to characterise at a rapid assessment level, and have thus been excluded. **Table 2-3** identifies and describes the ecosystem services assessed during the rapid field assessment.

**Table 2-3 Ecosystem services assessed using the WET-EcoServices model (Kotze et al. 2008).**

| | | | | | |
|---|---|---|---|---|---|
| Ecosystem Services supplied by Wetlands | Indirect Benefits | Regulating & supporting benefits | | Flood attenuation | The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream |
| | | | | Streamflow regulation | Sustaining streamflow during low flow periods |
| | | | Water quality enhancements | Sediment trapping | The trapping and retention in the wetland of sediment carried by runoff waters |
| | | | | Phosphate assimilation | Removal by the wetland of phosphates carried by runoff waters |
| | | | | Nitrate assimilation | Removal by the wetland of nitrates carried by runoff waters |
| | | | | Toxicant assimilation | Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff water |
| | | | | Erosion control | Controlling of erosion at the wetland site, principally through the protection provided by vegetation |
| | | | | Carbon storage | The trapping of carbon by the wetland, principally as soil organic matter |
| | | **Biodiversity maintenance** | | | Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity |
| | | *Biodiversity maintenance is not an ecosystem service as such, but encompasses attributes widely acknowledged as having potentially high value to society* | | | |
| | Direct Benefits | Provisioning benefits | | Provision of water for human use | The provision of water extracted directly from the wetland for domestic, agriculture or other purposes |
| | | | | Provision of harvestable resources | The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc. |
| | | | | Provision of cultivated foods | The provision of areas in the wetland favourable for the cultivation of foods |
| | | Cultural benefits | | Cultural heritage | Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants |
| | | | | Tourism and recreation | Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife |
| | | | | Education and research | Sites of value in the wetland for education or research |

### 2.2.5 *Ecological Importance and Sensitivity*

The EIS assessment was conducted according to the DWAF (1999) guidelines. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The EIS provides a guideline for determination of the Ecological Management Class (EMC).

A series of 10 determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance (**Table 2-4**). The median of the determinants is then used to assign the Ecological Management Class (EMC) for a wetland (**Table 2-5**).

The determinants assessed include:

PRIMARY DETERMINANTS

- Rare & Endangered Species (interpreted as Red Data species and other conservation important species)
- Populations of Unique Species
- Species / Taxon Richness
- Diversity of Habitat Types or Features
- Migration route/breeding and feeding site for wetland species
- Sensitivity to Changes in the Natural Hydrological Regime
- Sensitivity to Water Quality Changes
- Flood Storage, Energy Dissipation & Particulate/Element Removal

MODIFYING DETERMINANTS

- Protected Status
- Ecological Integrity

**Table 2-4 Scoring Guideline**

| Score guideline: | Confidence rating: |
|---|---|
| Very high = 4; | Very high confidence = 4; |
| High = 3, | High confidence = 3; |
| Moderate = 2; | Moderate confidence = 2; |
| Marginal/Low = 1; | Marginal/low confidence = 1 |
| None = 0 | |

**Table 2-5 Ecological importance and sensitivity categories - Interpretation of median scores for biotic and habitat determinants**

| Range of Median | Ecological Importance and Sensitivity Category (EIS) | Recommended EMC |
|---|---|---|
| >3 and <=4 | Very high<br>Wetlands that are considered ecologically important and sensitive on a national / international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers. | A |
| >2 and <=3 | High<br>Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers. | B |
| >1 and <=2 | Moderate<br>Wetlands that are considered to be ecologically important and sensitive | C |

| Range of Median | Ecological Importance and Sensitivity Category (EIS) | Recommended EMC |
|---|---|---|
| | on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers. | |
| >0 and <=1 | Low/marginal<br>Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers. | D |

## 2.3. Study Limitations

- Wetland assessment techniques used are subjective;
- No detailed wetland assessment was undertaken in the greater area to be impacted upon by the underground mining and associated cone of depression from the dewatering activities or the groundwater contamination plume (WSP, 2013a) ;
- No survey work was performed for roads, pipelines, power lines, conveyer systems or any other infrastructure beyond the boundaries of the current proposed surface infrastructure area (including the proposed discard area);
- No detailed information on the AYCP was available until recently, and the boundaries of the lease, underground mining and surface infrastructure areas changed during the course of this Assessment. Consequently, field surveys for the wetland investigation for the new surface infrastructure area and proposed coal discard area were undertaken in winter. The winter field investigation limited the use of vegetation indicators for the assessment;
- The source of water for the wetlands identified within the study area and within the greater cone of depression is unknown (WSP, 2013a).

# 3. Results

The results of the wetland assessment are discussed in detail in the sections below:

## 3.1. Wetland Classification

Three types of inland wetlands (HGM Units) were identified within the Study Area (Ollis *et al*, 2013);

- Rivers: A linear landform with clearly discernable bed and banks, which permanently or periodically carries a concentrated flow of water;
- Channelled Valley Bottom Systems associated with the above mentioned rivers: A valley-bottom wetland with a river channel running through it; and
- Seeps. A wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity driven), unidirectional movement of water and material down-slope. Both types of seeps were identified within the study area:
  - Seep without a channelled outflow: Water exits from the seep without channelled outflow by means of a combination of diffuse surface flow, interflow, evaporation and infiltration.
  - Seep with a channelled outflow: Water exits from a seep with channelled outflow mostly be means of concentrated surface flow.

The wetland HGM units identified within the Study Area are illustrated in **Figure 3-1** with examples shown in **Figure 3-2**, **Figure 3-3** and **Figure 3-4**.

The conceptual geohydrological model (WSP, 2013a) identifies three groundwater bodies within the study area:

- Perched Aquifer. Perched on low permeability material in the weathered zone or in colluvium;
- Shallow Aquifer. Perched on hard rock at the base of the weathered zone; and
- Deep Aquifer. Held in fractures and geological contacts.

According to WSP (2013a) all of the above mentioned water bodies may be a source of water for the wetlands within the study area. Groundwater perched on low permeability material in the weathered zone or in colluvium may be a source of water to hillside seeps and springs. The wetlands are also fed from springs and shallow groundwater from the higher topography to the south of the adit and plant site. Groundwater on horizontal and semi-horizontal contacts between different rock types may also be a source for springs. Springs appear to be associated with the dolerite sill that is present at higher altitudes in the project area. The springs are considered to be fed by water bodies perched on the dolerite.

The location of the springs identified during the groundwater investigation are highlighted in **Figure 3-8**). Additional springs, not included in the groundwater assessment, were identified by NSS during the wetland investigation. On the eastern bank of both main watercourses, flowing through the surface infrastructure area, within the plinthic catena's, large areas were identified that had a patchy mosaic of seep zones. These areas have been mapped on a broad scale as seep zones as opposed to mapping each individual seep patch. Although a patchy mosaic the wetlands act as a unit caused by subsurface discontinuities in geological units and a relatively impervious subsoil layer impeding the infiltration of rain derived water into the ground.

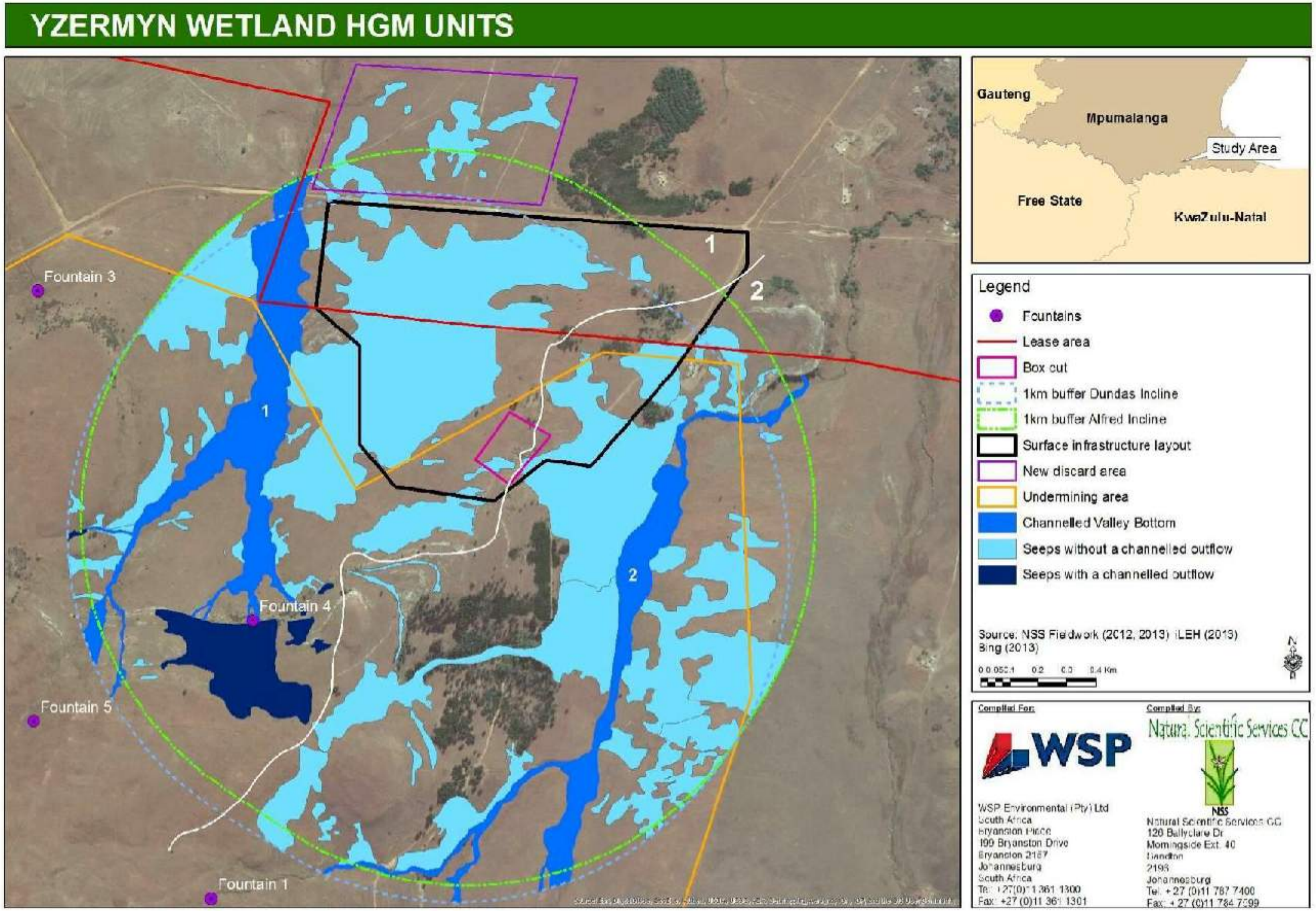



**Figure 3-1** **Wetland HGM Units**

**Figure 3-2 Examples of River inland wetland systems identified on site**


**Figure 3-3 Examples of the Channelled Valley Bottom inland wetland systems identified on site**


**Figure 3-4 Examples of the Seep inland wetland systems identified on site**

## 3.2. Wetland Extent

The wetland extent within the Study Area was determined using a combination of the DWAF (2005) delineation guidelines and a desktop assessment. The extent of the wetlands, per HGM Unit identified, has been highlighted in **Table 3-1**. The river and associated channelled valley bottom wetlands have been combined into one HGM Unit. Examples of the wetland indicators used have been highlighted in **Figure 3-5** and **Figure 3-6.**

The wetland extent within the Study Area is approximately 180ha, which equates to approximately 42% of the study area being wetland. The extent of wetlands within the greater underground mining area were delineated from a desktop perspective only, with the overall wetland extent (underground mining area and surface infrastructure footprint) being approximately 668 ha in extent, 40% of the area.

**Table 3-1 Wetland Extent per HGM Unit**

| Wetland ID No | Wetland HGM Unit | Wetland Area (ha) |
|---|---|---|
| System 1 | River and associated Channelled Valley Bottom Wetland | 19.8 |
| | Seep without a channelled outflow | 74.2 |
| | Seep with a channelled outflow | 9.2 |
| **Sub Total** | | **103.3** |
| System 2 | River and associated Channelled Valley Bottom Wetland | 12.6 |
| | Seep without a channelled outflow – West Bank | 42.4 |
| | Seep without a channelled outflow – East Bank | 22.8 |
| **Sub Total** | | **77.8** |
| **TOTAL** | | **181.1** |

GPS Point 52

GPS Point 62

GPS Point 93

GPS Point 126

**Figure 3-5 Examples of Soil Wetness Indicators found within the study area**

*Stiburus alopecuroides* (Pongwa Grass) – Facultative wetland species

*Helichrysum aureonitens* (Golden Everlasting) Moist Grasslands

*Bulbostylis hispidula* – Seasonally wet grassland

*Gunnera perpensa* – Occurs naturally in wet marshy soils

*Lobelia flacida* - Moist Grasslands

*Xyris capensis* – Wet places in mountain valleys and swamps

**Figure 3-6 Examples of vegetation indicators found within the study area**

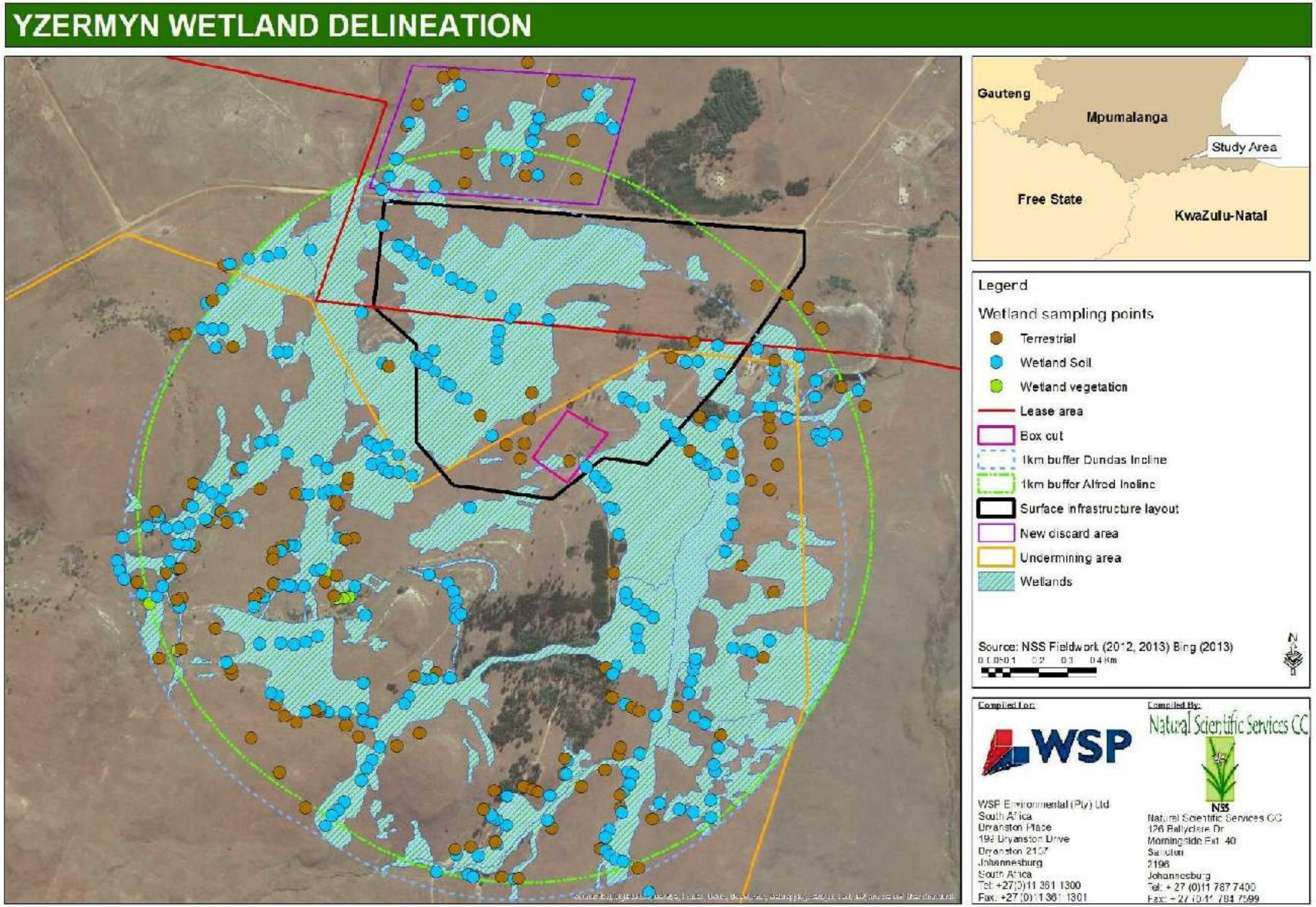



**Figure 3-7** **Wetland Sampling Points and Extent within the Surface Infrastructure Footprint**

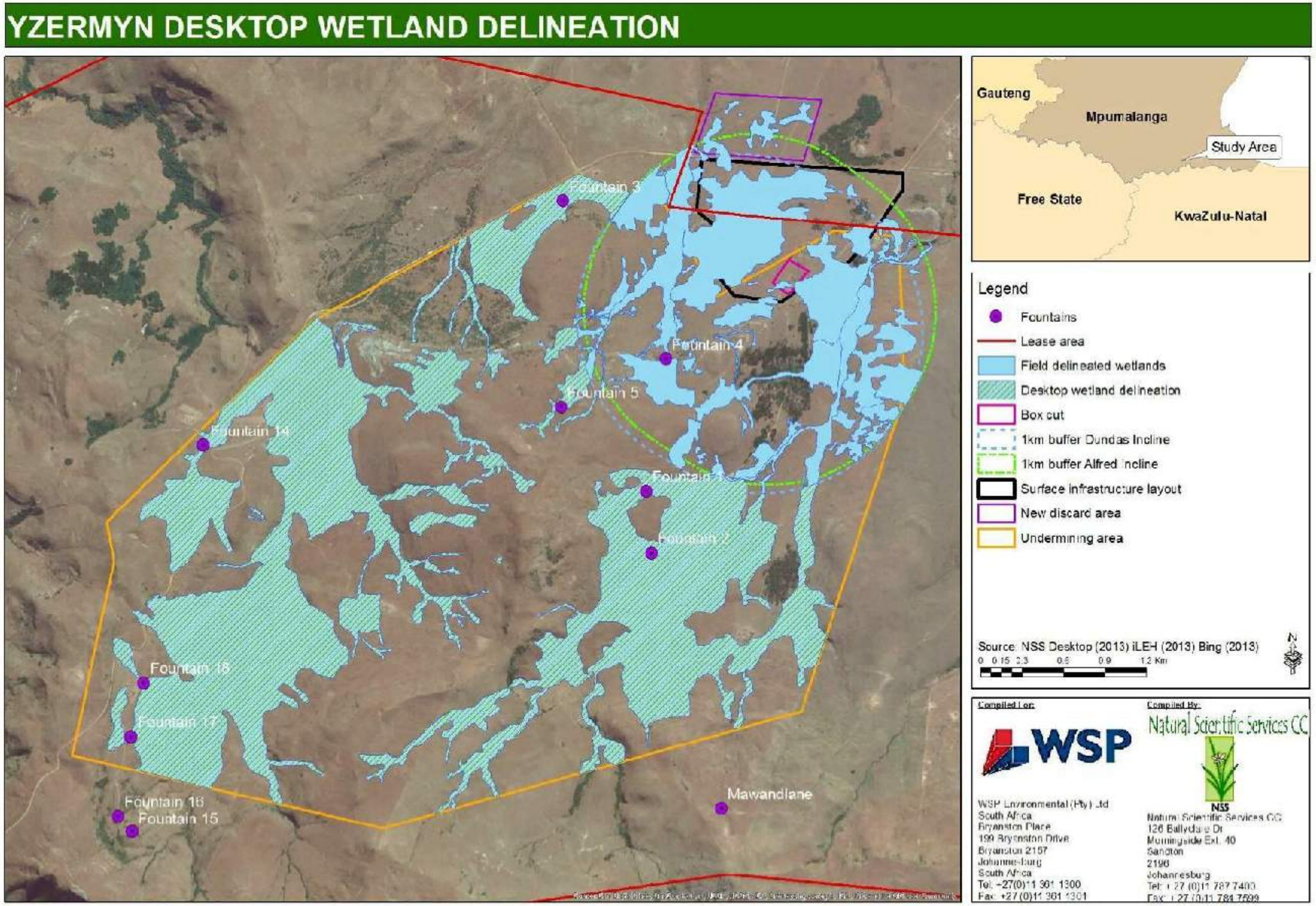



**Figure 3-8** **Wetland Extent within Underground Mining Area and Surface Infrastructure Footprint**

## 3.3. Ecological State of Wetlands

The wetlands have been assessed as per the systems highlighted in **Table 3-1**. The current impacts, although *very* limited and minor in extent, have been discussed below, per main wetland driver, with examples shown in **Figure 3-9** and **Figure 3-10**. The impacts are similar between System 1 and System 2, with System 2 being slightly more impacted on due to extensive stands of alien invasive vegetation within the seep wetland on the western bank. **Table 3-2** and **Table 3-3** highlight the results of the WET-HEALTH assessment.

**Table 3-2 Summary of the overall health of wetland System 1 based on impact and change score**

| HGM Unit | Ha | Extent (%) | Hydrology | | Geomorphology | | Vegetation | |
|---|---|---|---|---|---|---|---|---|
| | | | Impact Score | Change Score | Impact Score | Change Score | Impact Score | Change Score |
| Channelled Valley Bottom | 20 | 19 | 0.0 | -2 | 0.4 | -2 | 0.2 | -2 |
| Seep without a Channelled Outflow | 74 | 72 | 0.0 | -2 | 0.1 | -2 | 0.2 | -2 |
| Seep with a Channelled Outflow | 9 | 9 | 0.0 | -2 | 0.1 | -2 | 0.4 | -2 |
| **Area weighted impact scores*** | | | **0.0** | **-2.0** | **0.1** | **-2.0** | **0.2** | **-2.0** |
| **PES Category (Table 2-1)** | | | **A** | ↓↓ | **A** | ↓↓ | **A** | ↓↓ |

**Table 3-3 Summary of the overall health of wetland System 2 based on impact and change score**

| HGM Unit | Ha | Extent (%) | Hydrology | | Geomorphology | | Vegetation | |
|---|---|---|---|---|---|---|---|---|
| | | | Impact Score | Change Score | Impact Score | Change Score | Impact Score | Change Score |
| Channelled Valley Bottom | 13 | 16 | 1.0 | -2 | 0.6 | -2 | 0.9 | -2 |
| Seep without a Channelled Outflow - West Bank | 42 | 55 | 1.0 | -2 | 0.1 | -2 | 2.3 | -2 |
| Seep without a Channelled Outflow - East Bank | 23 | 29 | 0.0 | -2 | 0.1 | -2 | 0.3 | -2 |
| **Area weighted impact scores*** | | | **0.7** | **-2.0** | **0.1** | **-2.0** | **1.5** | **-2.0** |
| **PES Category (Table 2-1)** | | | **A** | ↓↓ | **A** | ↓↓ | **B** | ↓↓ |

### 3.3.1 *Hydrological Impacts*

Current hydrological impacts are summarised below and examples presented in **Figure 3-10**:

- Within the catchments:
  - Reduction in flow due to stands of alien invasive species, for example *Acacia mearnsii* (Black Wattle), *Acacia melanoxolon* (Australian Blackwood), two Populus spp (Poplar). These stands were greater in extent in System 2.
  - A small increase in flood peaks due to hardened surfaces, for example sand roads. The increase however has no discernable effect on flood peaks.
- Within HGM Units:
  - Erosion channels forming within heavily used cattle tracks;
  - Slight modification of channels at road crossings, with the roads acting as the only impeding features within the systems ;
  - Infilling at road crossing;
  - Increased on site water use by stands of alien and invasive species (specifically on System 2).

### 3.3.2 *Geomorphological Impacts*

Current geomorphological impacts are listed below and examples shown in **Figure 3-10**:

- Evidence of sedimentation, particularly at aquatic sampling point YZ2, downstream of the undermining area on System 2 **– Section D**;
- Erosion along existing cattle paths;
- The 2011 Google Earth imagery shows evidence of a "landslide" on System 1, the system had however recovered by the July 2013 field investigation with a healthy vegetation cover re-established (**Figure 3-9**).

2011 2013

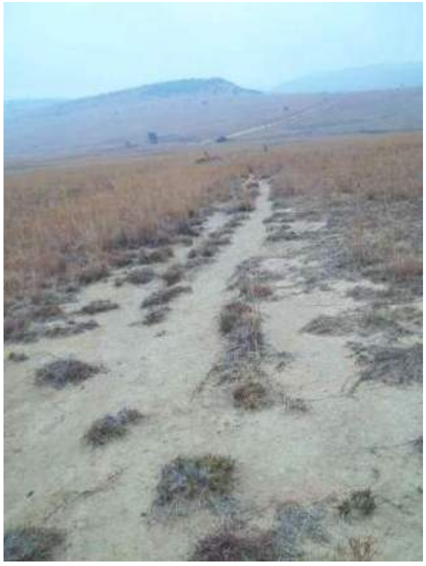
**Figure 3-9 Evidence of a "Landslide" and associated erosion and deposition (2011) and the recovered system (2013)**

### 3.3.3 *Vegetation Impacts*

The main impacts on site were related to vegetation, with these still being very minor (**Figure 3-10**):

- Stands of Black Wattle, Australian Blackwood, Poplar and *Eucalyptus* Trees (particularly along System 2);
- *Acacia melanoxolon* within the riparian fringe of the headwater stream in System 1;
- Seep areas harvested for thatching grass;
- Google Earth imagery shows evidence of historical agricultural practices, however, the vegetation within these areas has recovered successfully, with only a few pioneer species present.

Road crossings within greater undermining area



Hardened surfaces due to access roads within the proposed discard area

Erosion channels starting to form along existing cattle tracks

Erosion within the greater undermining area

Sedimentation at Aquatic Sampling Site YZ2 – Section D (downstream of Study Area)

Large stands of Poplars – System 2

Large stands of Black Wattle and Australian Blackwood – System 2

Potential harvesting of thatching grass – System 1

**Figure 3-10 Examples of current impacts within the wetland systems identified on site**

## 3.4. Ecological Importance and Sensitivity

Both the Seep wetlands (Wetland 1) and the Channelled Valley Bottom wetlands (Wetland 2) score a VERY HIGH in terms of Ecological Importance and Sensitivity (EIS), (**Table 3-4**). The reasons for the VERY HIGH rating are the protected areas proposed and within the vicinity of the site (**Section F**), the current integrity of the site and the numerous CI species identified (**Section B, C** and **D**).

**Table 3-4 Ecological Importance and Sensitivity**

| DETERMINANT | Wetland 1 | Wetland 2 |
|---|---|---|
| **PRIMARY DETERMINANTS** | | |
| 1. Rare & Endangered Species | 4 | 4 |
| 2. Populations of Unique Species | 4 | 4 |
| 3. Species/taxon Richness | 4 | 4 |
| 4. Diversity of Habitat Types or Features | 2 | 3 |
| 5. Migration route/breeding and feeding site for wetland species | 1 | 2 |
| 6. Sensitivity to Changes in the Natural Hydrological Regime | 3 | 3 |
| 7. Sensitivity to Water Quality Changes | 3 | 3 |
| 8. Flood Storage, Energy Dissipation & Particulate/Element Removal | 3 | 2 |
| **MODIFYING DETERMINANTS** | | |
| 9. Protected Status | 3 | **3** |
| 10. Ecological Integrity | 4 | 4 |
| | | |
| **TOTAL** | **31** | **32** |
| **MEDIAN** | **3.1** | **3.2** |
| | | |
| **Overall Ecological Sensitivity and Importance** | **Very High** | **Very High** |
| **Ecological Management Class** | **A** | **A** |

* Wetland 1 – Seep Wetlands; Wetland 2 – Channelled Valley Bottom Wetlands

## 3.5. Wetland Eco-Services

The results of the Wet-Ecoservices assessment are illustrated in **Figure 3-11**. The maintenance of biodiversity scored HIGH in terms of integrity and noteworthiness for both the seep wetlands and the channelled valley bottom wetlands. The aspects contributing to this high rating are discussed in detail in **Section B**, **C** and **D**. Erosion control scored HIGH for both opportunity and effectiveness in supplying the service in the seeps and the channelled valley bottom systems. In accordance with Kotze *et al* (2008) seep wetlands are normally associated with groundwater discharges, although flow through them may be supplemented by surface water contribution. They are expected to contribute to some surface flow attenuation early in the season (until soils are saturated). This 'plugging' effect increases the storage capacity of the slope above the wetland, and prolongs the contribution of water to the stream system during low flow periods. As would be expected in this region, tourism and recreation also scored HIGH for the ecosystem services the wetlands provide, this is highlighted further in **Section F**, which highlights the various Protected Environments in the area.

Although the opportunity to provide some ecosystem services may not have been HIGH, the effectiveness in the wetland type in supplying the services is HIGH, for example phosphate trapping and nitrate removal in the seeps. Seepage wetlands are known to supply a number of water quality enhancement benefits, e.g.: removal of excess nutrients and organic pollutants, removal of nitrogen, etc (Kotze *et al*, 2008).

Due to the pristine nature of the area and the land capability, the opportunities to provide future additional benefits is very low, however the threats to future benefits are extremely high due to the proposed mining in the area. The impacts on the wetlands and the resultant loss or reduction in the supply of eco-services are discussed in detail in **Section G**.

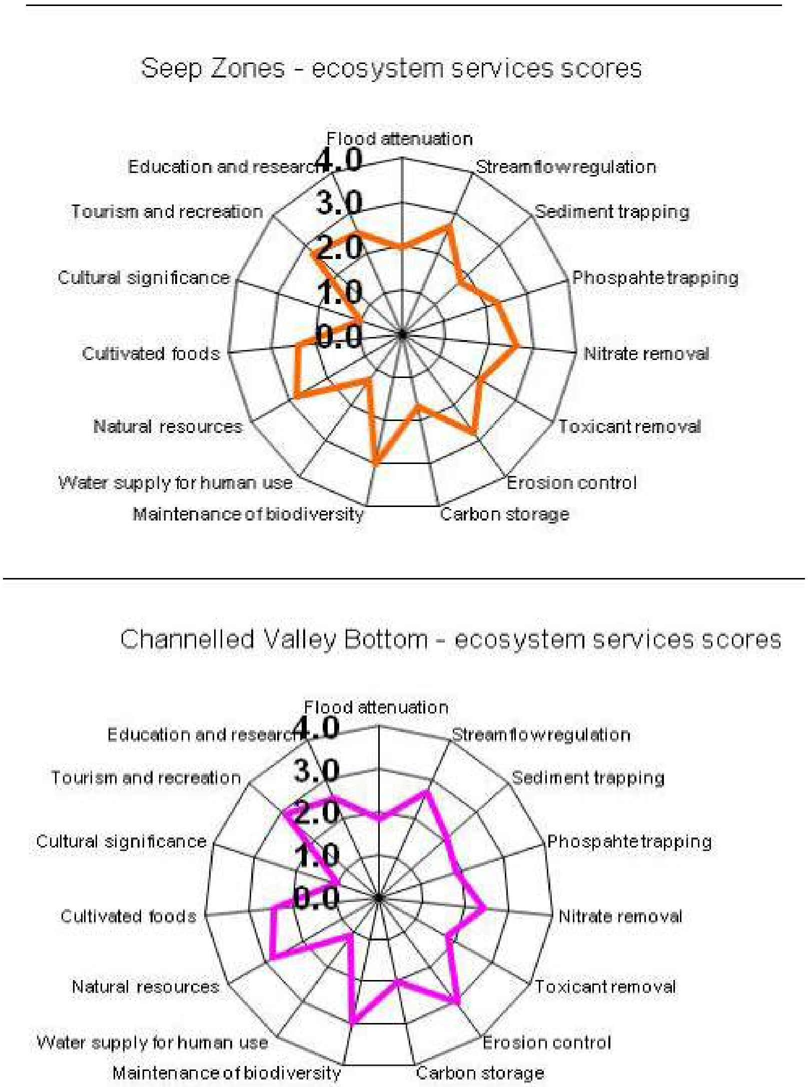
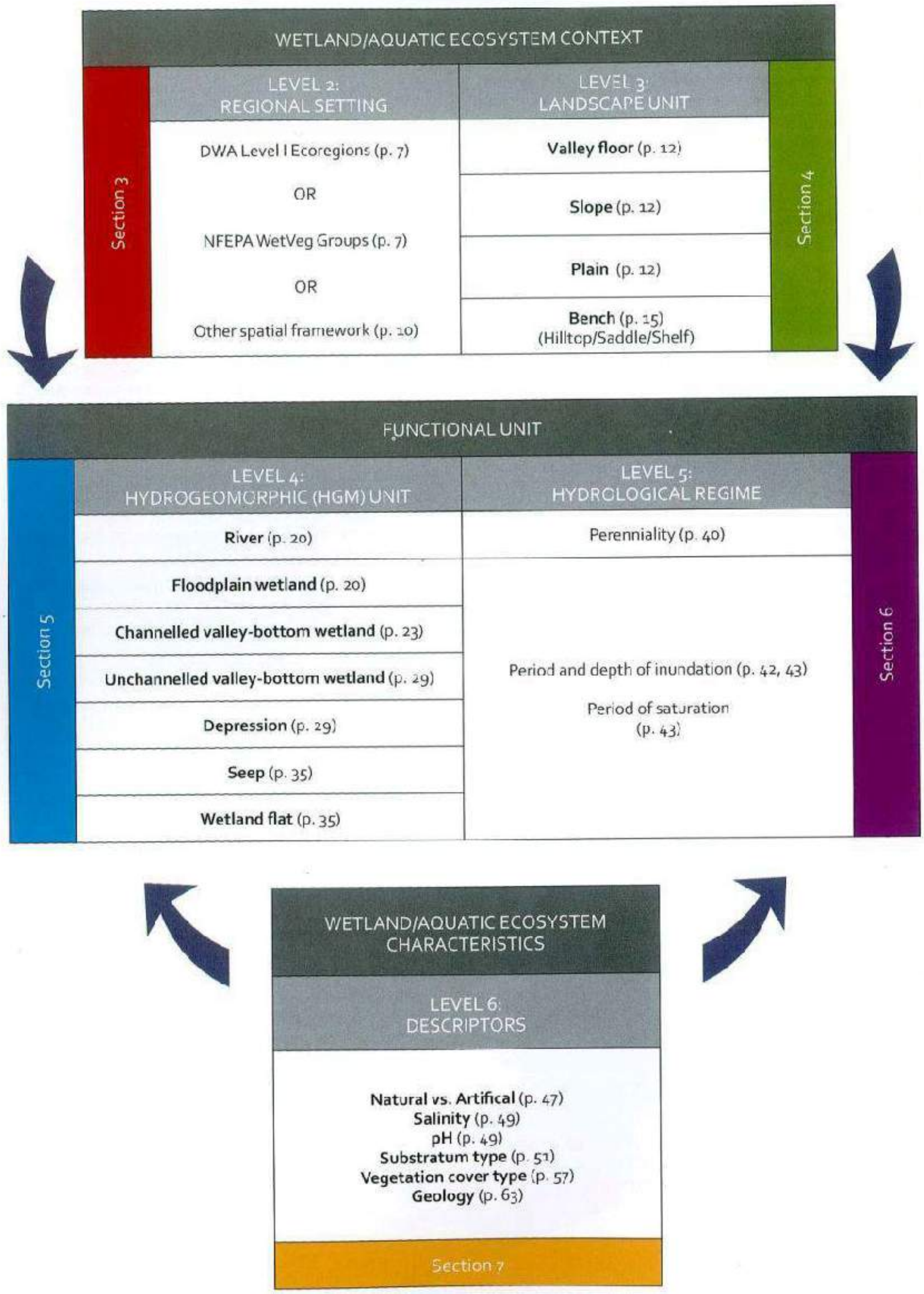



**Figure 3-11 Wetland Eco-Services**

# 4. Appendices

## 4.1. Appendix 1 Inland Wetland Classification System (Ollis *et al*, 2013)



# Section F: Sensitivity Assessment

NATURAL SCIENTIFIC SERVICES

## SECTION F: TABLE OF CONTENTS



## SECTION F: LIST OF TABLES



## SECTION F: LIST OF FIGURES

# SECTION F: SENSITIVITY ASSESSMENT

## 1. Introduction

In South Africa 40%-60% of the Grassland Biome has been permanently transformed or severely degraded by cultivation, afforestation, urbanization, mining and erosion (Low & Rebelo 1996; Mucina & Rutherford 2006). In Mpumalanga, coal-mining has had extensive negative impacts on biodiversity, and remaining grasslands and wetlands are severely threatened by the accelerating demand for low-cost energy from coal (Tweddle *et al*. 2009). It was within this context that NSS performed the AYCP Biodiversity Assessment including the (Biodiversity) Sensitivity Assessment that is described in this report **Section F.** The Sensitivity Assessment was based on findings from the preceding floral, faunal, aquatic and wetland assessments, and takes cognisance of relevant national and provincial planning and other biodiversity conservation initiatives. Separate Sensitivity Maps were compiled for the different disciplines and combined to create an overall Sensitivity Map for Biodiversity in the study area. The sensitivity maps were used to rate the impacts and plan the mitigation measures discussed in **Section G**.

## 2. National Significance

### 2.1. National Water Act (NWA; Act 36 of 1998)

All wetlands are protected within South Africa, with their legal protection extended to include buffer zones (Ferrar & Lotter, 2007). As highlighted in **Section A**, South Africa has various pieces of legislation governing activities in and around wetlands under International, Regional and National legislation and Guidelines. The National Water Act, 1998, (Act 36 of 1998) (NWA) is the principle legal instrument relating to water resource management in South Africa. All wetlands are protected under the NWA. The NWA acknowledges:

> *"the National Government's overall responsibility for and authority over the nation's water resources and their use, including the equitable allocation of water for beneficial use, the redistribution of water, and international water matters."*

As per Chapter 3 of the NWA: Protection of Water Resources:

> *"The protection of water resources is fundamentally related to their use, development, conservation, management and control. Parts 1, 2 and 3 of this Chapter lay down a series of measures which are together intended to ensure the comprehensive protection of all water resources."*

## 2.2. Protected Areas

The AYCP borders the Kwamandhlangampisi Protected Environment to the east, and the MTPA has recently gazetted an intention to proclaim the Mabola Protected Environment, which includes several farms within and around the AYCP lease area (**Figure 2-1**). The existing Paardeplaats and Pongola Nature Reserves are both situated <15km east of the AYCP lease area.

Given this and other considerations (e.g. FEPAs and the MBSP), the MTPA has applied to the Department of Mineral Resources (DMR) to have several farms, which are situated in and around the AYCP lease area, excluded from future mining or prospecting in terms of Section 49 of the MPRDA (**Figure 2-2**).

## 2.3. Terrestrial Priority Areas & Threatened Ecosystems

During the National Spatial Biodiversity Assessment (NSBA), nine terrestrial Priority Areas were identified for conservation in South Africa (Driver *et al*. 2004). These Priority Areas were allocated where broad-scale habitat remained unprotected, or was inadequately conserved. The AYCP site is situated within the South Eastern Escarpment Priority Area (**Figure 2-3**).

A list of Threatened Ecosystems within each Priority Area was gazetted on 9 December 2011 in the NEM:BA. The identified Threatened Ecosystems occupy 9.5% of South Africa and were selected according to six criteria including:

- Irreversible habitat loss;
- Ecosystem degradation;
- Rate of habitat loss;
- Limited habitat extent and imminent threat;
- Threatened plant species associations; and
- Threatened animal species associations.

The AYCP site is situated in the MP 11 Wakkerstroom/Luneburg Grasslands Threatened Ecosystem (**Figure 2-4**), which is listed as Endangered and is only 2% conserved.

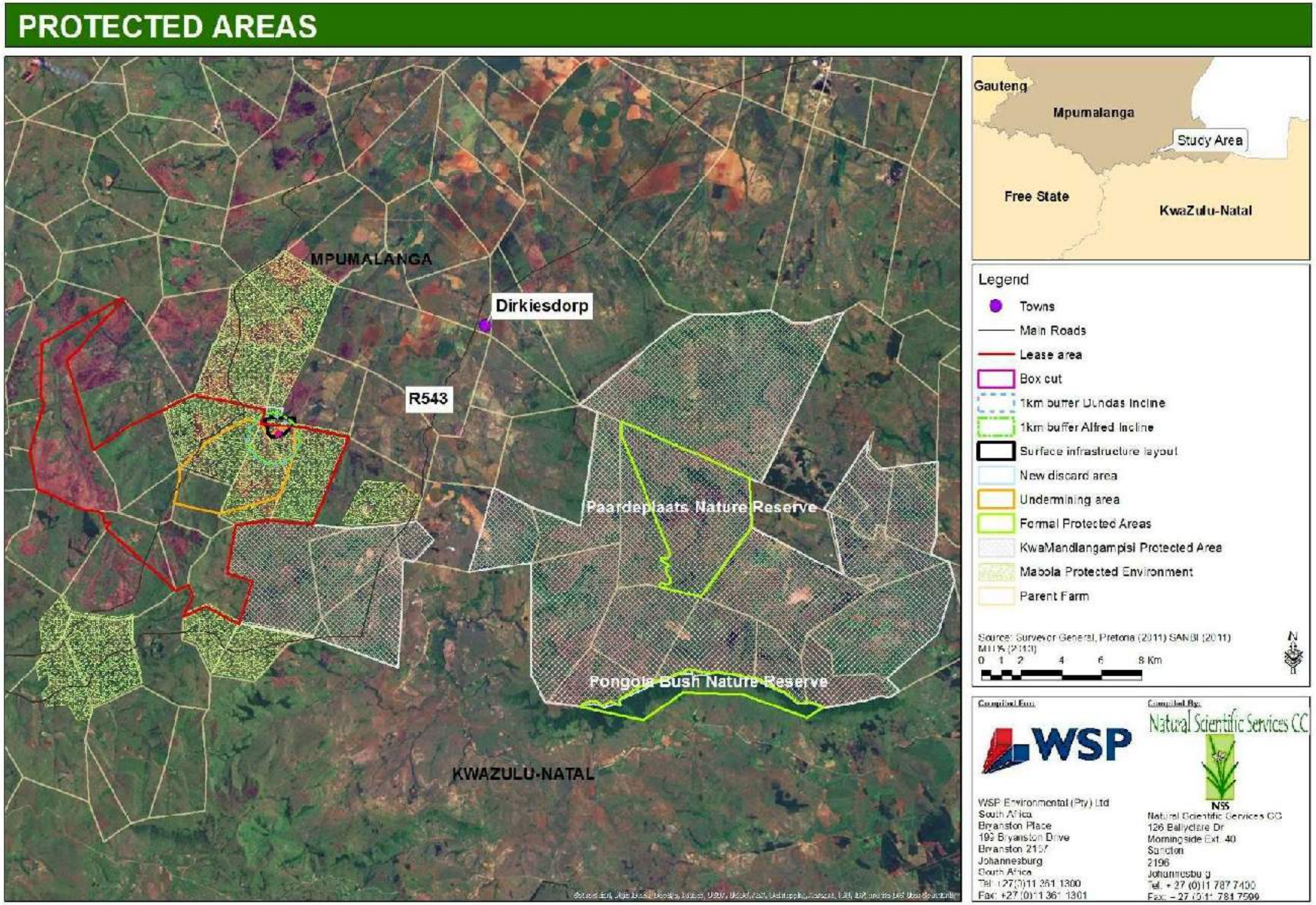



**Figure 2-1** **Existing and proposed Protected Areas in the study area**

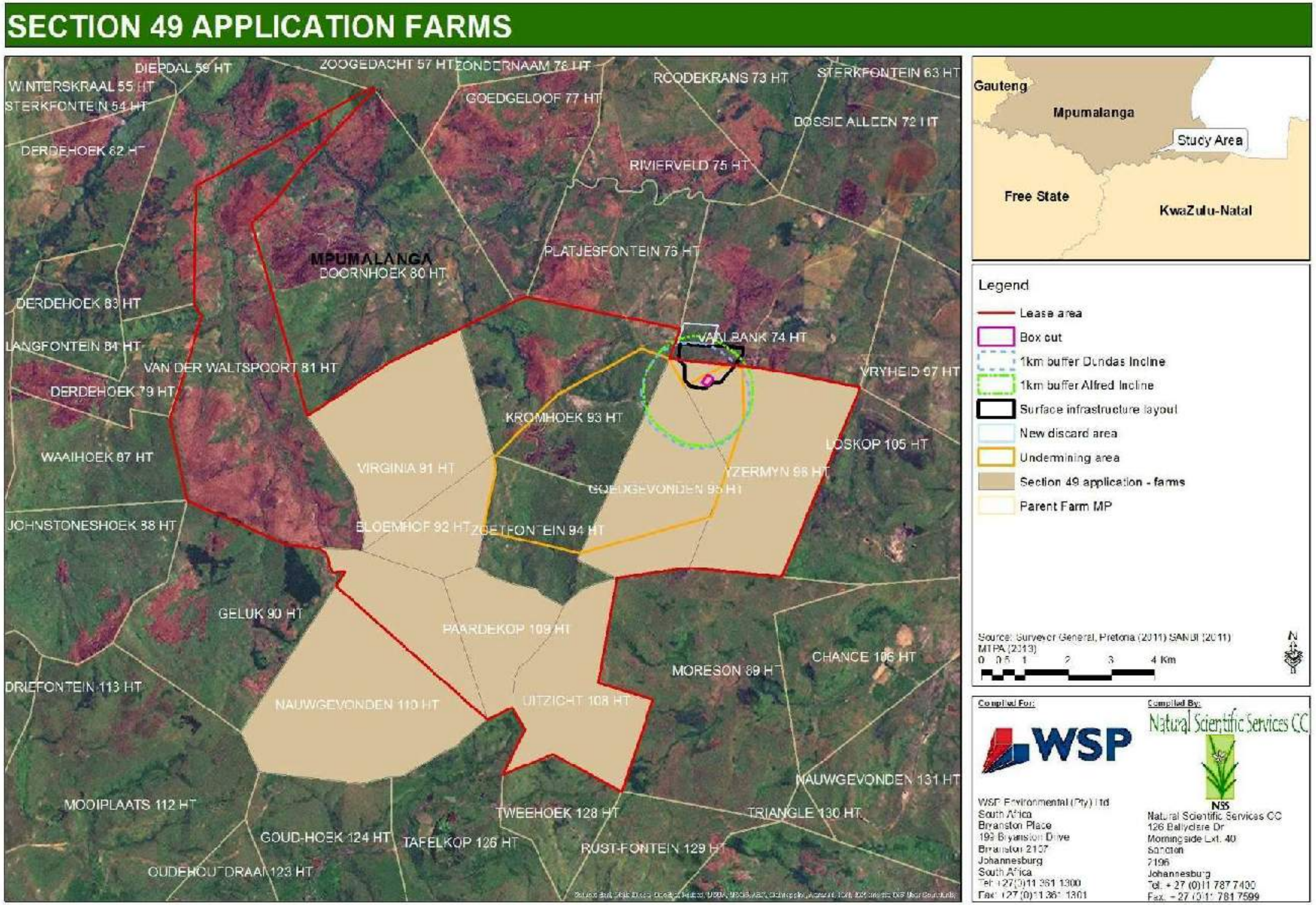



**Figure 2-2  Farms in AYCP study area that are included in the MTPA's (pers. comm. 2013) Section 49 application to the DMR**

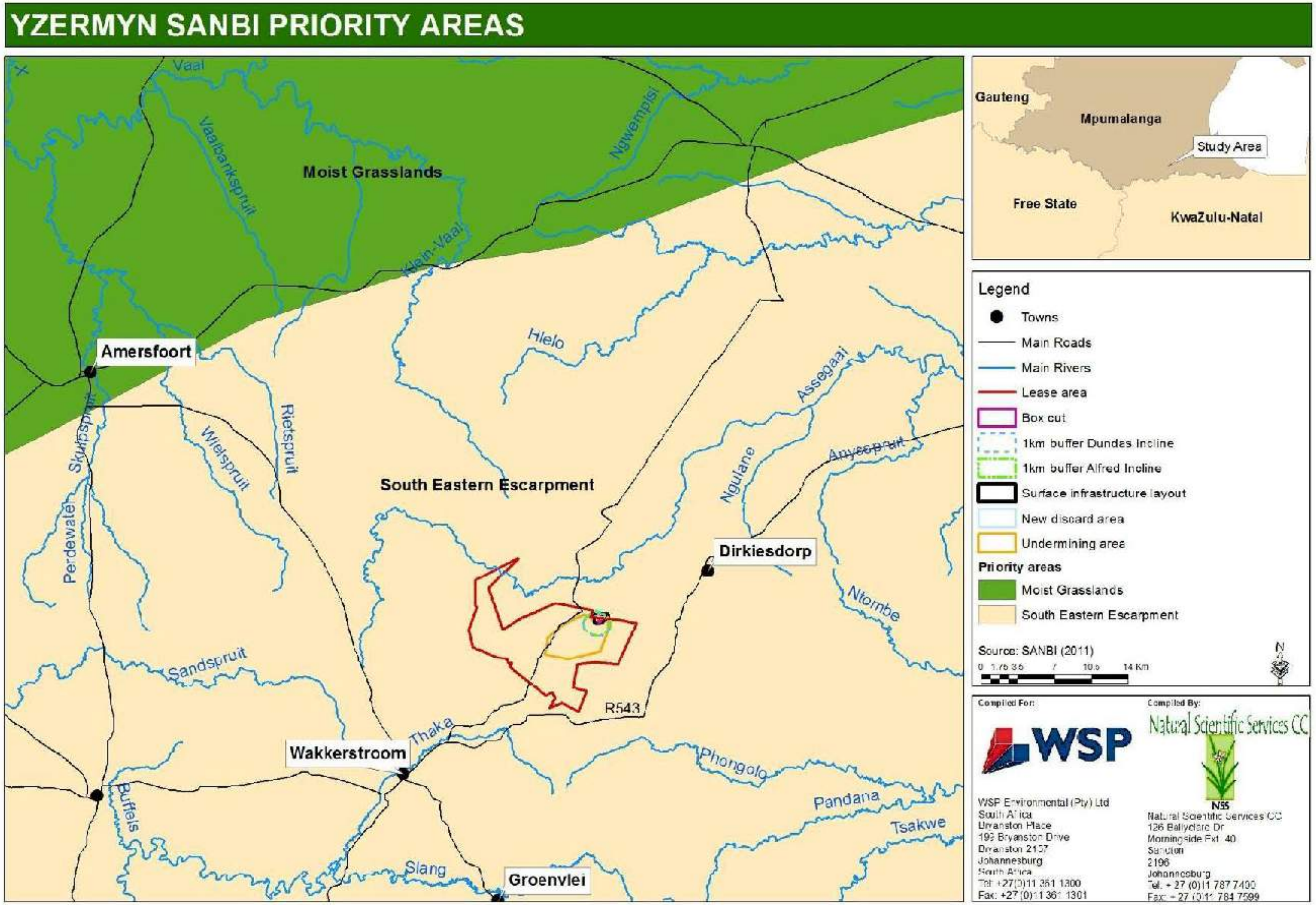



**Figure 2-3** **National Terrestrial Priority Areas in the study area**

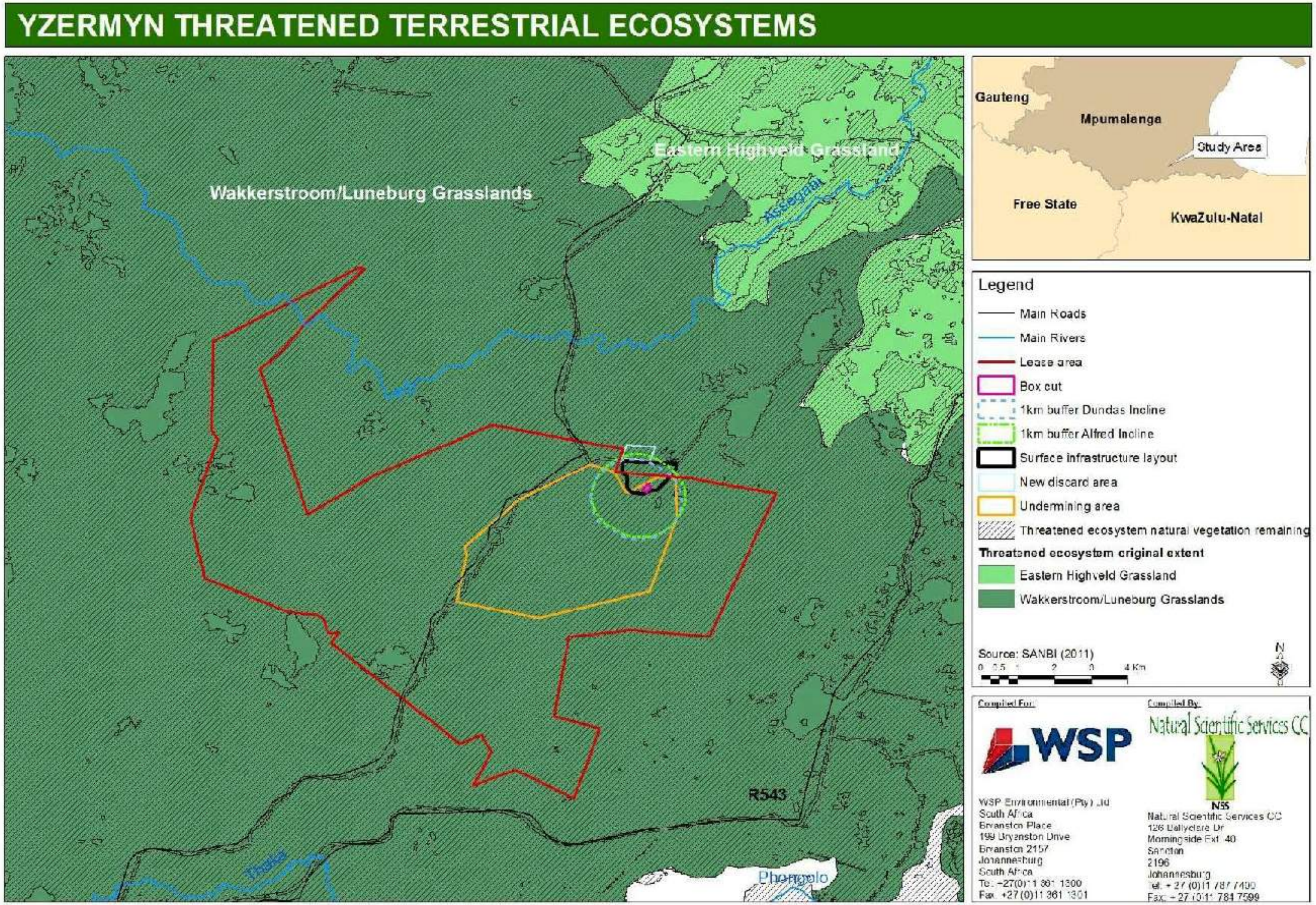



**Figure 2-4** **National Threatened Ecosystems in the study area**

## 2.4. Freshwater Ecosystem Priority Areas (FEPAs)

The National Freshwater Ecosystem Priority Area (NFEPA) project (Driver *et al.* 2011) was a three-year partnership between SANBI, CSIR, WRC, DEA, DWA, WWF, the South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). "Freshwater ecosystems" refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters and estuaries. Consistent with global trends, high levels of threat have been reported for South African freshwater ecosystems, with over half of the country's river and wetland ecosystem types considered threatened. The NFEPA provides strategic spatial priorities for conserving freshwater ecosystems and supporting sustainable use of water resources in South Africa.

Freshwater Ecosystem Priority Areas (FEPAs) were determined through a process of systematic biodiversity planning and involved collaboration of over 100 freshwater researchers and practitioners. FEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries. The AYCP lease area is situated in a FEPA river catchment, and includes several Category 1 Wetland FEPAs. Two FEPA Wetland Clusters are also situated near the eastern boundary of the lease area (**Figure 2-5**). The catchment supports the Near Threatened Incomati Chiselmouth (*Varicorhinus nelspruitensis*), Shortfin Barb (*Barbus brevipinnis*) and Phongolo Rock Catlet (*Chiloglanis emarginatus*) (Kleynhans, 1997; Engelbrecht *et al*. 2007).

The NFEPA guidelines indicate that FEPAs should be regarded as ecologically important and as generally sensitive to changes in water quality and quantity, owing to their role in protecting freshwater ecosystems and supporting sustainable use of water resources. FEPAs that are in a good condition, such as those identified within the study area, should remain so, and FEPAs that are not in a good condition should be rehabilitated to their best attainable ecological condition. Land-use practices or activities that will lead to deterioration in the current condition of a FEPA are considered unacceptable, and land-use practices or activities that will make rehabilitation of a FEPA difficult or impossible are also considered unacceptable.

"*Applications for mining and prospecting in FEPAs and associated sub-quaternary catchments should be subject to rigorous environmental and water assessment and authorisation processes, as mining has a widespread and major negative impact on freshwater ecosystems"* (Driver *et al.* 2011). Furthermore: Mining in any form should not be permitted in wetland FEPAs, or within 1km of a wetland/riverine FEPA buffer. No prospecting should occur in wetland FEPAs or within 1km of a wetland/riverine FEPA buffer. Care should be taken to reduce the risks of aquifer penetration when drilling, wherever this occurs. Although the planned surface infrastructure is >1.3km from the nearest FEPA, underground mining would infringe upon the 1km FEPA buffers. The greatest concern regarding the FEPA's is the potential impact of the mine on the water resources as a result of underground water reduction due to de-watering activities and groundwater contamination due to sulphate seepage from the mine workings and discard facility (WSP, 2013). Both the cone of depression and the groundwater contamination plume, extend to the wetland FEPA's in the near vicinity.

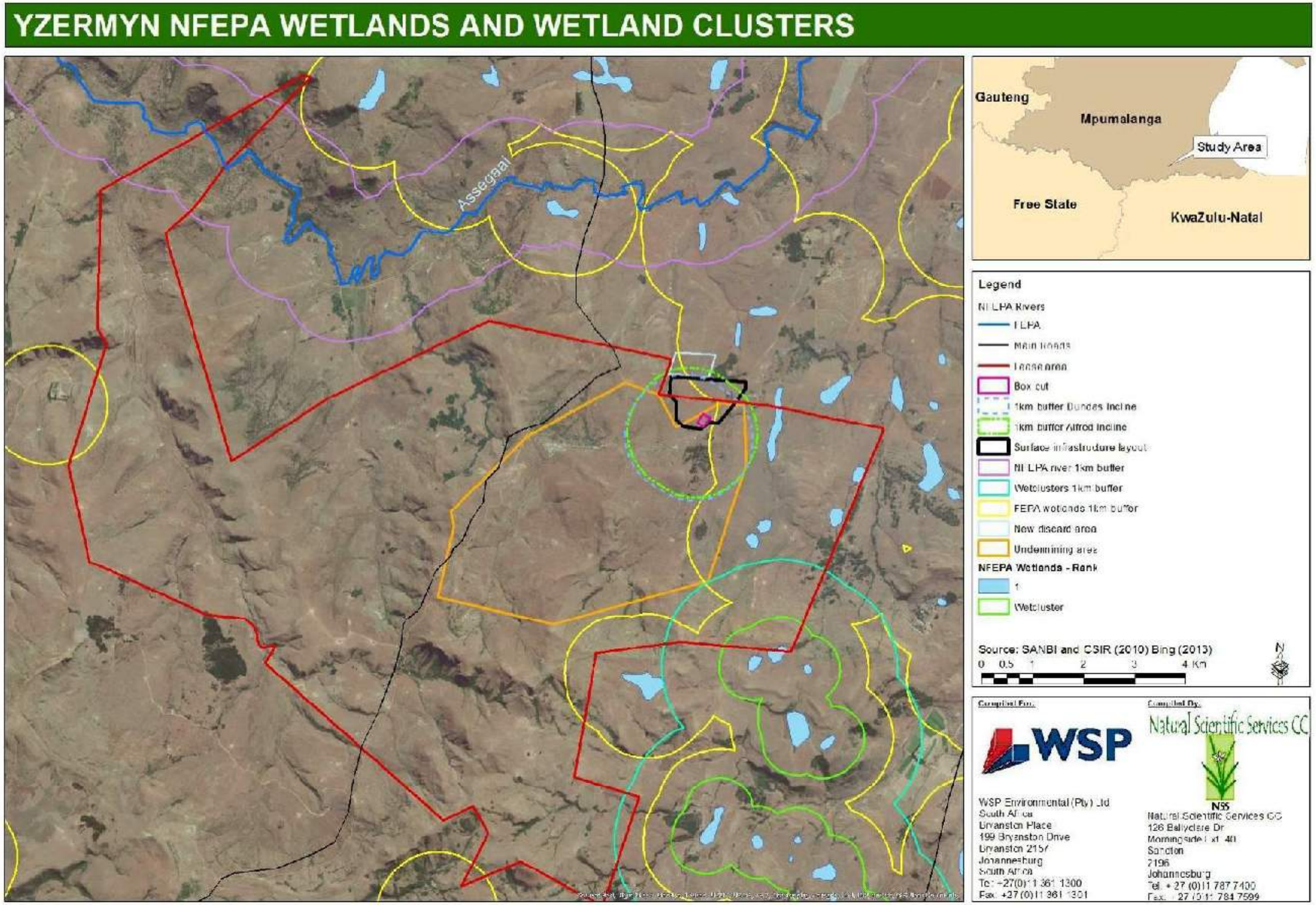



**Figure 2-5** **National Freshwater Ecosystem Priority Areas in the study area, with 1km buffers**

## 2.5. SANBI Grasslands Programme

The South African National Biodiversity Institute (SANBI) established the Grasslands Programme as a partnerships-based approach to securing the biodiversity and ecosystem services of the Biome. The Programme has been implemented in part by the World Wildlife Fund (WWF) South Africa, through the Grasslands Steering Committee and the Wakkerstroom Agriculture and Conservation Demonstration Project. The initial phase of the Programme aims to ensure that major production sectors, including mining, are directly contributing to the achievement of Biodiversity conservation priorities in the Grassland Biome.

In the mining sector, the Programme and its partners are:

- Piloting biodiversity stewardship with mining companies.
- Developing tools for mainstreaming biodiversity into the mining sector, including the national Mining and Biodiversity Guideline and Atlas of Sensitive Areas for Mining, and Wetland Offset Guidelines.
- Enabling the use of biodiversity information by the DMR, DWA, DEA and mining companies in the assessment and decision-making processes for the prospecting or mining of coal, and for the authorisation of associated activities.

## 2.6. Mining & Biodiversity Guideline

Virtually the entire AYCP lease area comprises habitat that has been zoned by the national Mining and Biodiversity Guideline (DEA *et al.* 2013) as having the Highest Importance for Biodiversity and thus the Highest Risk for mining (**Figure 2-6**). Only small, isolated patches of habitat in the lease area have a non-important rating. As mentioned earlier, the lease area also borders a Legally Protected area, where "Mining is Prohibited."

The Mining and Biodiversity Guidelines stipulate that in areas of Highest Importance for Biodiversity:

> *"Environmental screening, EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision-making for mining, water use licences, and environmental authorisations."*
>
> *If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services. These areas are viewed as necessary to ensure protection of biodiversity, environmental sustainability, and human well-being. Authorisations may well not be granted. If granted, the authorisation may set limits on allowed activities and impacts, and may specify biodiversity offsets that would be written into licence agreements and/or authorisations."*

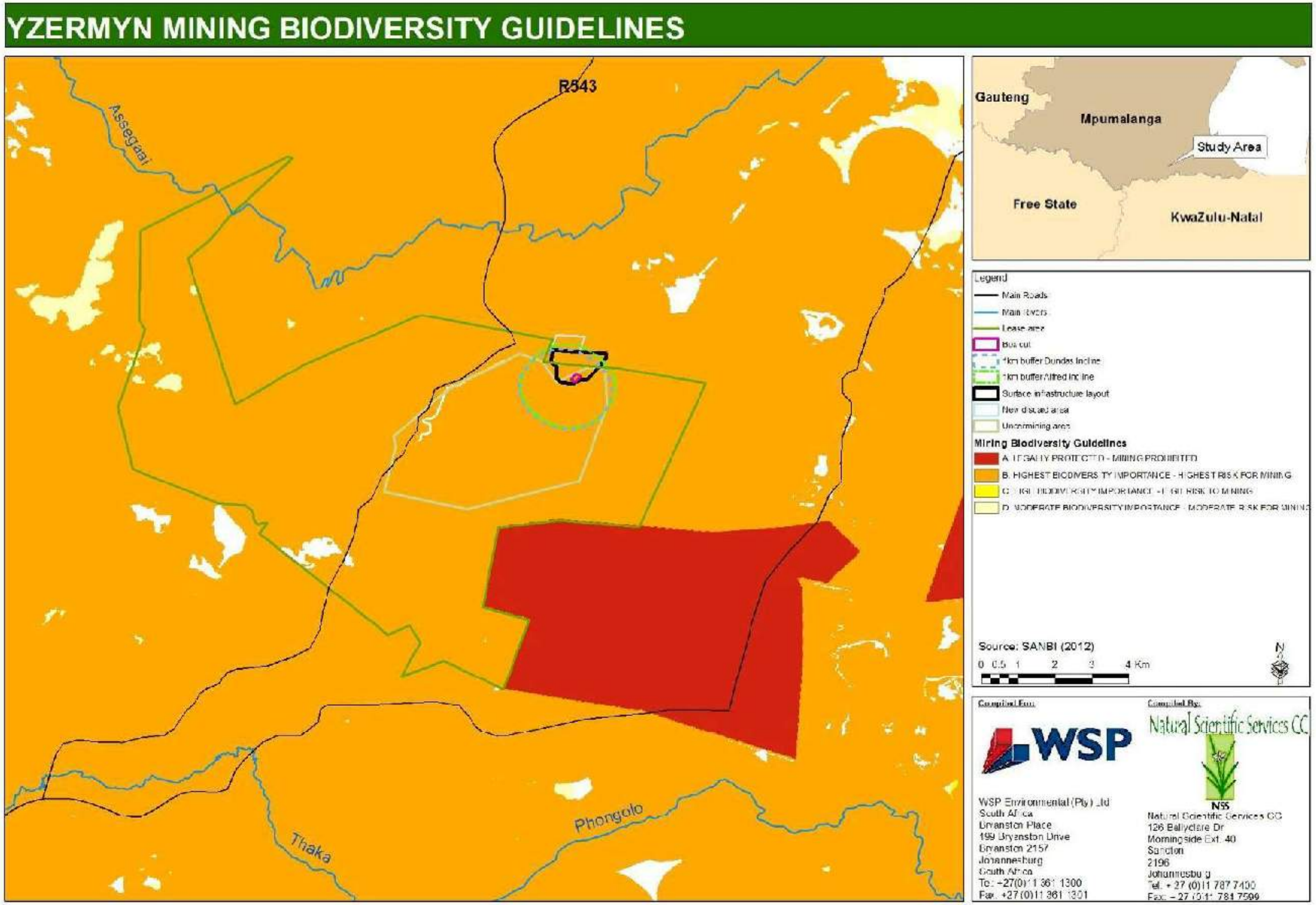



**Figure 2-6 Map showing that the AYCP study area has the Highest Biodiversity importance and Highest risk for mining according to the Mining and Biodiversity Guideline (DEA *et al.* 2013)**

## 2.7. Enkangala Grasslands Project & IBA

WWF has been supporting the Enkangala Grasslands Project for several years in partnership with the Botanical Society of South Africa. The Project is focussed on protecting biodiversity and water in the remote catchment areas of the Vaal, Pongola and Thugela Rivers from threats, including poorly planned mining. Initially, the Project was focused on piloting biodiversity stewardship approaches with private and communal / land reform landowners. Through a new partnership with BHP Billiton, WWF is also undertaking ecosystem services studies to determine, in more detail, the water and carbon value of high altitude moist grasslands. The long-term project vision is to secure the biodiversity and ecosystem services of this critical grasslands area, in partnership with the various landowners and the relevant conservation, agricultural and water authorities.

Over one hundred partner organisations of BirdLife International have used standard assessment criteria to identify global priority areas for bird conservation, called Important Bird Areas (IBAs). IBA status does not offer formal protection to an area, but any proposed changes to established land-use patterns within an IBA will be closely scrutinised by BirdLife South Africa and other conservation NGOs. The AYCP falls in the Enkangala Grassland Biosphere Reserve (EGBR) and Important Bird Area (IBA ZA016; **Figure 2-7**), which spans >800 farms, several conservancies and state-owned land. It is described by Barnes (1998) as one of the most important IBAs in Africa and is considered vital for the conservation of a number locally-, and globally-threatened bird species, as well as for the conservation of other fauna and flora. Conservation Important (CI) bird species that are known to occur in the Enkangala Grassland IBA are listed in **Table 2-1.**

**Table 2-1 Threatened bird species in the Enkangala Grassland Important Bird Area**

| COMMON NAME | COMMON NAME | COMMON NAME |
|---|---|---|
| Little Bittern (LC) | Black Stork (NT) | Southern Bald Ibis (VU) |
| Greater Flamingo (NT) | Secretarybird (NT) | Cape Vulture (VU) |
| Peregrine falcon (NT) | Lanner Falcon (NT) | White-backed Vulture (VU) |
| Martial Eagle (VU) | Bearded Vulture (EN) | Lesser Kestrel (VU) |
| Pallid Harrier (NT) | Black Harrier (NT) | African Marsh-harrier (VU) |
| White-winged Flufftail (CR) | Striped Flufftail (VU) | Corn Crake (VU) |
| Wattled Crane (CR) | Blue Crane (VU) | Grey Crowned Crane (VU) |
| White-bellied Korhaan (VU) | Blue Korhaan (NT) | Denham's Bustard (VU) |
| Chestnut-banded Plover (NT) | Black-winged Lapwing (NT) | Greater Painted-snipe (NT) |
| Caspian Tern (NT) | African Grass-owl (VU) | Black-winged Pratincole (NT) |
| Botha's Lark (EN) | Rudd's Lark (CR) | Ground Woodpecker (LC) |
| Buff-streaked Chat (LC) | Broad-tailed Warbler (NT) | Bush Blackcap (NT) |
| Yellow-breasted Pipit (VU) | Blue Swallow (CR) | Short-tailed Pipit (VU) |

Conservation status: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened

Source: Barnes (1998)

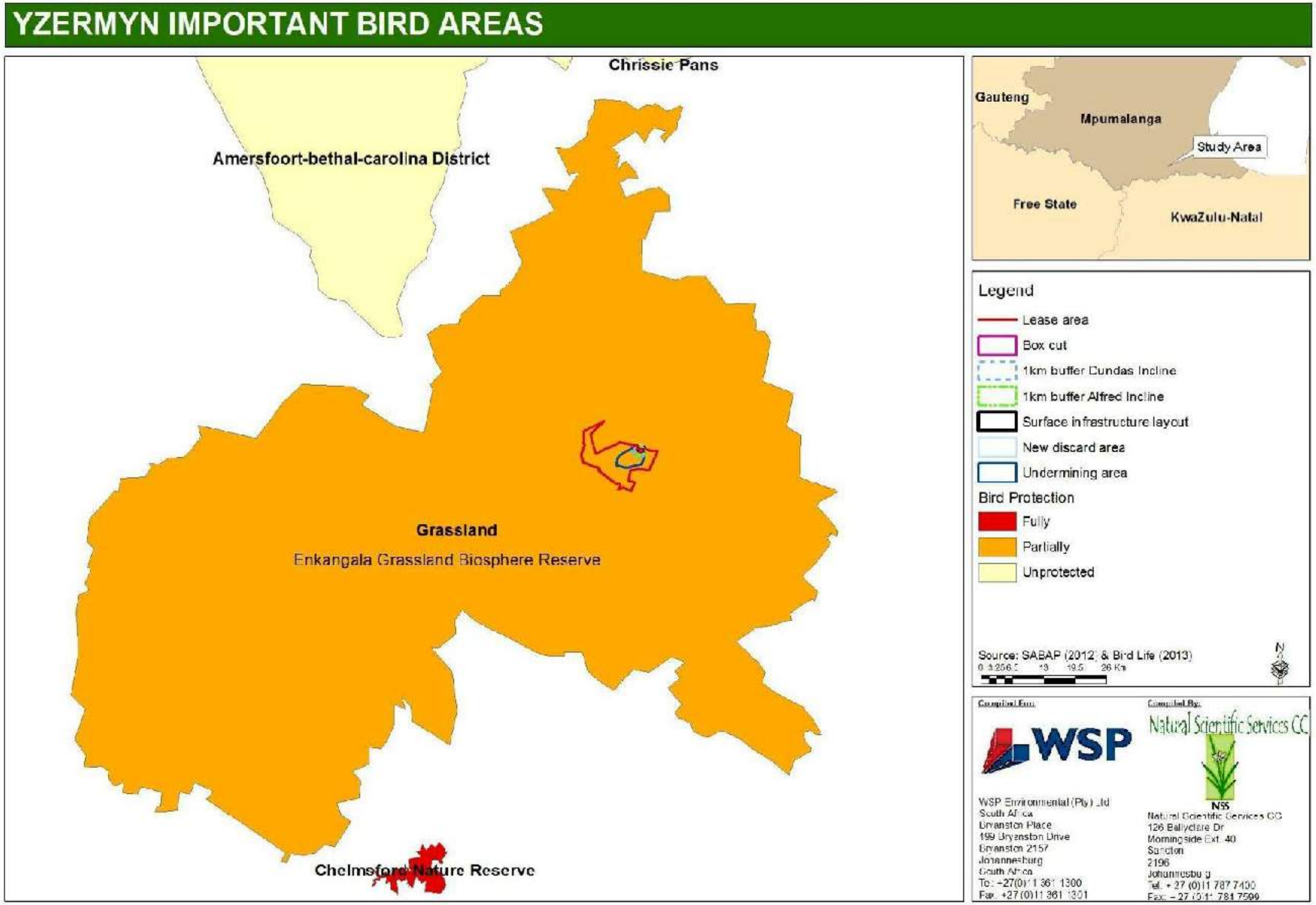



**Figure 2-7** **Enkangala Grassland Biosphere Reserve and Important Bird Area**

### 2.8. Threatened Grassland Species & Other EWT Programmes

The Endangered Wildlife Trust's (EWT's) Threatened Grassland Species Programme is focussed on highly-threatened grassland faunal species as indicators of grassland health and conservation. These species include e.g. the Critically Endangered Blue Swallow (*Hirundo atrocaerulea*), Endangered Oribi (*Ourebia ourebi*), Vulnerable Giant Sungazer (*Cordylus giganteus*), Vulnerable Yellow-breasted Pipit (*Anthus chloris*), Near Threatened Giant Bullfrog and highly-threatened Golden Moles. The African Crane Conservation Programme is a collaborative programme between the International Crane Foundation and the EWT, which aims to improve the conservation of the Critically Endangered Wattled Crane (*Bugeranus carunculatus*), and the Vulnerable Blue Crane (*Anthropoides paradiseus*) and Grey-crowned Crane (*Balearica regulorum*). The EWT Birds of Prey Programme is focussed on the conservation of diurnal and nocturnal raptors, vultures and their habitats in southern Africa. EWT Field Workers for these programmes visit the AYCP study region on a regular basis.

# 3. Provincial Significance

### 3.1. Mpumalanga Biodiversity Sector Plan (MBSP)

The Mpumalanga Biodiversity Sector Plan (MBSP) is the outcome of recent systematic conservation planning by the Mpumalanga Tourism and Parks Agency (MTPA 2013) for improved conservation of biodiversity in this province. Significant portions of the AYCP lease area are recognized in the MBSP as Irreplaceable and Optimal Critical Biodiversity Areas (CBAs). Most remaining habitat has been ear-marked for Landscape Corridors, Local Corridors and Species Specific Ecological Support Areas (ESAs). Small, scattered patches of Modified Habitat in the lease area include mainly old agricultural lands (**Figure 3-1**).

"*CBAs are areas of high biodiversity value which are usually at risk of being lost and usually identified as important in meeting biodiversity targets*." Irreplaceable CBAs are "*considered critical for meeting biodiversity targets and threshold... which are required to ensure the persistence of species and the functioning of ecosystems.*" Optimal CBAs have an irreplaceability of less than 80%, but collectively these areas incorporate the most biodiversity in the smallest area and, therefore, provide the most cost-effective options for biodiversity conservation.

ESAs "*are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of CBAs and/or in delivering ecosystem services.*" Landscape Corridors provide the best landscape connectivity to support and enable biodiversity to adapt to the impacts of climate change. Local corridors represent "*fine scale connectivity pathways that contribute to connectivity between climate change focal areas*." Species-specific ESAs are "*required for the persistence of specific species*" (MTPA 2013).

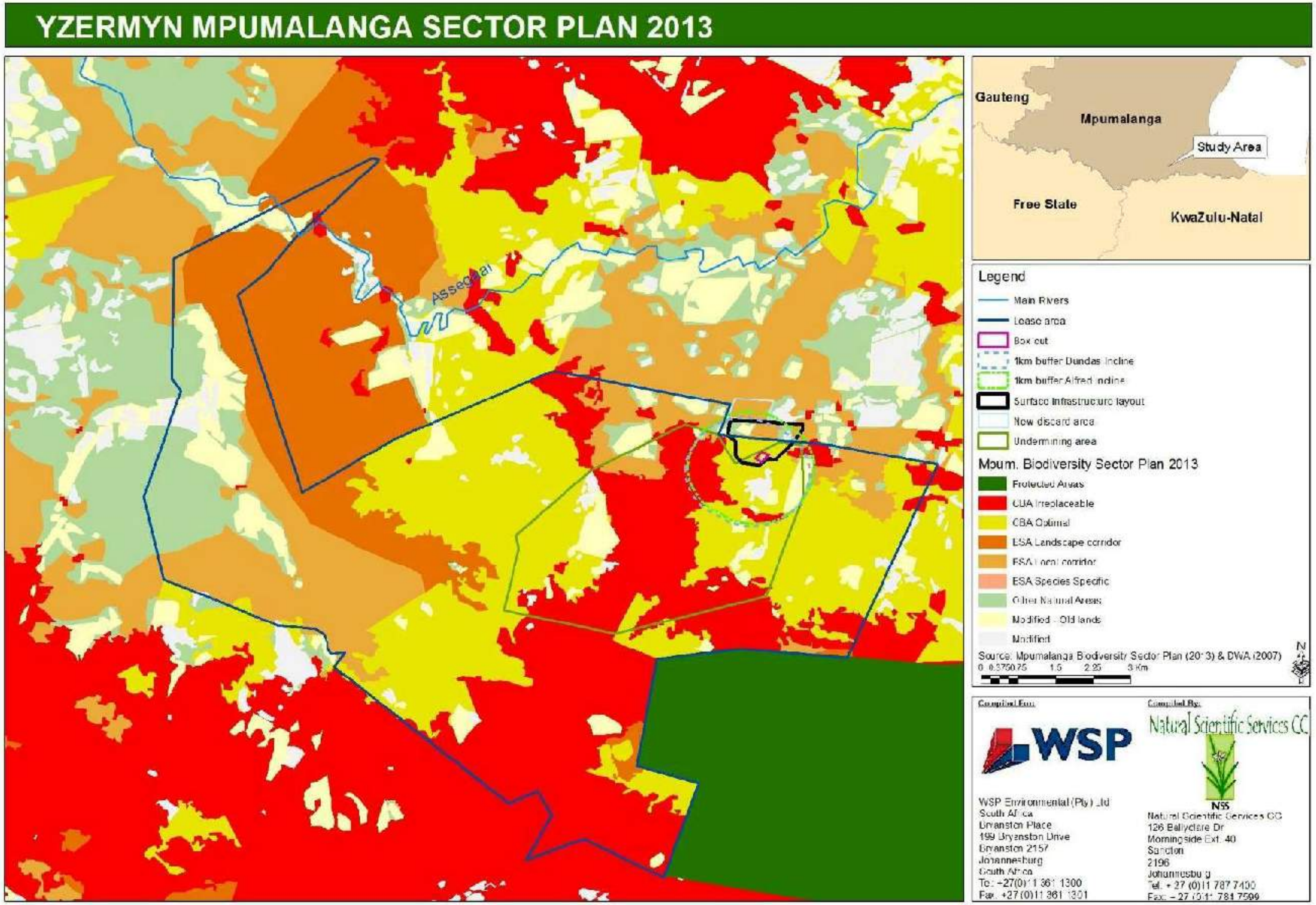



**Figure 3-1** **Mpumalanga Biodiversity Sector Plan for the study area**

# 4. Local Habitat Sensitivity

Results from the desktop and field-based investigations of flora, fauna, aquatic ecology, and wetlands for the AYCP were used to designate the following sensitivity ratings to habitat within the current proposed AYCP underground mining and surface infrastructure areas. The sensitivity ratings of different floral communities are presented in **Section B: Table 4-1**. Since the floral, faunal, aquatic and wetland assessments focussed on the current proposed surface infrastructure area, the sensitivity rating of habitat in remaining parts of the underground mining area was performed at a courser resolution.

## 4.1. VERY HIGH Sensitive Habitat

Floral communities which are considered to have a Very High importance include the:

- *Leucosidea – Merxmuellera* Riverine Community
- *Searsia – Diospyros – Athrixia* Protected Outcrops & Kloof Community
- *Andropogon* **–** *Helichrysum- Bulbostylis* seasonal seeps

These are restricted intact habitats, diverse in floral species and contain a number of CI plant species including the Near Threatened *Merwilla plumbea*. This is a highly sought after species that has been exploited over most of its range for medicinal use. The seasonal seep vegetation communities ties in with discussions above on the sensitivity and protection of wetlands. These areas provide habitat for a number of Declining TSP-listed species as well as a broad range of Protected species under the provincial legislation.

All wetlands on site, including the Rivers, Channelled Valley Bottom systems and Seeps, are protected under the NWA, and are regarded as having Very High sensitivity. The assessed wetlands represented Natural to Largely Natural systems, and their main ecosystem service is Maintenance of Biodiversity (**Section E**). Wetlands on site are largely fed by groundwater from the perched, shallow weathered and deeper, fractured aquifers, and are, therefore, sensitive to changes in groundwater levels and water quality.

From a faunal perspective all wetlands and patches of Scarp Forest were assigned Very High conservation importance. Wetlands on site support many CI faunal species such as the Vulnerable African Grass-owl, Near Threatened Half-collared Kingfisher and Serval, and the potentially occurring Critically Endangered Rough-haired Golden Mole and Vulnerable Marsh Sylph butterfly. Patches of Scarp Forest provide important habitat for foraging bats, and several CI species such as the Near Threatened Rusty Pipistrelle, and Bush Blackcap, and the potentially occurring Near Threatened Plain Stream Frog and provincially Vulnerable Natal Cascade Frog.

In addition, two large adits from previous mining in the area have Very High conservation importance. This is because these adits provide roosting habitat for at least four CI bat species including the Endangered Swinny's Horseshoe Bat (*Rhinolophus swinnyi*), and the Near Threatened Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*), Temminck's Hairy Bat (*Myotis tricolor*) and the Natal Clinging (or Long-fingered) Bat (*Miniopterus natalensis*). Moreover, the Geoffroy's Horseshoe Bat population comprised >270 individual bats.

### 4.2. HIGH Sensitive Habitat

*Andropogon* – *Hyparrhenia* temporary seeps were assigned a High sensitivity. This is because this habitat remained mostly in a relatively natural state, and supported TSP- and MTPA-listed floral species and several Vulnerable and Near Threatened CI faunal species.

Smaller adits from previous mining in the area have a High conservation importance. This is because these adits provide roosting habitat for small numbers of at least three CI bat species including the Near Threatened Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*), Temminck's Hairy Bat (*Myotis tricolor*) and the Natal Clinging (or Long-fingered) Bat (*Miniopterus natalensis*).

### 4.3. MEDIUM-HIGH Sensitive Habitat

The *Hyparrhenia* – *Cymbopogon* – *Monocymbium* Slope Community was regarded as having Medium-High conservation importance. This community remains in a relatively natural state and supports a number of CI floral and faunal species. E.g. rocky patches within this community provided habitat for the Vulnerable White-bellied Korhaan and Near Threatened Cape Grass Lizard.

### 4.4. MEDIUM Sensitive Habitat

The *Hyparrhenia* – *Microchloa* – *Helichrysum* Plateau grassland was regarded as having a Medium sensitivity, as this community was characterized by comparatively less floral and faunal diversity and fewer CI species.

Savanna patches (such as the *Acacia* - *Ziziphus* Savanna community) were also assigned Medium conservation importance. This was because Savanna is widespread and well-conserved relative to other biomes in South Africa, and local patches of this habitat supported intermediate levels of Biodiversity including comparatively few CI species.

### 4.5. LOW Sensitive Habitat

Clumps of alien, invasive trees were considered to have Low sensitivity. Despite that some CI faunal species (e.g. Serval and African Crowned Eagle) may frequent alien bushclumps, these habitat patches have limited indigenous floral species in the undergrowth, and low overall faunal diversity.

# 5. Buffer Zones

A buffer is a strip of land surrounding a sensitive area in which activities are controlled or restricted to reduce the impact of adjacent land uses on the sensitive area. Although well intended for conservation purposes, the issue of placing a standardised buffer on Conservation Important (CI) habitats, plant or animal localities is a controversial one. The controversy is sparked by the following challenges:

- Buffer distances are often based on educated guesses, and limited scientific research.
- The success of a buffer is dependent on the ecological requirements of various species and ecosystem functioning, but different species and ecosystems have different requirements.
- Buffers may be relaxed where there is high pressure for development.
- Radial buffers are generally prescribed for non-linear Conservation Important (CI) habitats even though these may not be uniformly suitable for selected species.
- The legal requirement, from a national and provincial perspective, for buffer zones is unclear, as demonstrated in the following discussion on wetland buffers:
    - The Mpumalanga Biodiversity Conservation Handbook (Ferrar & Lötter, 2007) requires a 20m buffer of natural vegetation to be left in an undisturbed state around the perimeter of all wetlands.
    - The Gauteng Department of Agriculture and Rural Development (GDARD) have produced their "Guidelines on the Requirements for Biodiversity Assessments" (GDARD, 2012). These guidelines are more specific in terms of buffer requirements:
      "*The wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive. Rules for buffer zone widths are as follows:*
        - *30m for wetlands occurring inside the urban edge; and*
        - *50m for wetlands occurring outside the urban edge.*

      *Note that these buffer zones are essential to ensure healthy functioning and maintenance of wetland ecosystems. Larger buffer zones may be required for wetlands supporting sensitive species.*
      *In addition, the catchment of all pan wetlands must be designated as sensitive."*
    - The draft Institute of Natural Resources' national wetland delineation guidelines (2010) stipulate that the aquatic impact buffers and biodiversity buffers and corridors are all to be taken into consideration when determining the buffer requirements for a specific wetland.
    - The KZN / Ezemvelo Wildlife Department have issued draft guidelines (EKZN, 2010) for buffer determination for wetland systems, which state that all wetlands are to be designated sensitive and associated with a buffer. A minimum buffer of 30m must be

defined, but is to be increased at the discretion of an appropriately qualified specialist under the following circumstances:

- Steep slopes justify wider buffers.
- Wider buffers are required around high impact developments.
- Wider buffers are required where there is a greater pollution potential.
- Wetlands of high conservation value deserve wider buffers.
- Justification for wider buffers can be made by appropriate specialists.
- A minimum 20m buffer must be designated above the 1 in 100 year flood line of rivers and streams.
- A minimum 30m buffer must be designated beyond the edge of riparian zones.

- NEMA (1998) requires 32m from the edge of the wetland.
- National Freshwater Ecosystem Priority Areas (NFEPA) Buffers. In addition to the above mentioned guidelines the NFEPA require that "Mining in any form should not be permitted in wetland FEPAs, or within 1km of a wetland FEPA buffer" (Driver *et al*. 2011). A number of NFEPA wetlands were identified within the immediate vicinity of the study area (north and north-east) and these 1km buffers must be applied to these wetland systems.

Given these circumstances, it remains up to qualified Biodiversity specialists to prescribe site-specific buffers for CI habitats and species using the best available information.

### 5.1. Buffer Zones for Wetlands & Other Aquatic Habitat

The wetland buffers applied are not uniform across the study area, with the following buffers required:

- A 1km buffer on all FEPA wetlands, wetland clusters and rivers. As specified by the NFEPA (Driver *et al.* 2011), mining in any form (including prospecting) should not be permitted in wetland FEPAs, or within 1km of a wetland/riverine FEPA buffer (including wetland clusters).
- The River and associated Channelled Valley Bottom wetland in System 1 (**Section E**) should be protected by a minimum 200m buffer measured from the outer edge of the wetland temporary zone or the outer edge of the riparian fringe. This 200m buffer is based on the **Vulnerable** Grass-owl breeding and foraging habitat identified within this system.
- A minimum 100m buffer should be retained around the River and Channelled Valley Bottom Wetland in System 2 and all Seeps identified within the study area. These systems were Natural to Largely Natural systems supporting a wide variety of CI floral and faunal species and have a Very High Ecological Importance and Sensitivity.

**NOTE**: The buffer zones for wetlands unfortunately only apply to the surface loss of wetland habitat. As discussed in detail in **Section G**, the loss of wetlands will be due to the decline in water input in these systems. A buffer cannot be placed to protect the wetland habitat from this impact as it relates to the dewatering of the shallow and fractured deep aquifers. The mitigation measures relating to this impact are discussed in **Section G**.

## 5.2. Buffer Zones for Fauna

### *4.2.1. Mammals*

Currently, the South African Bat Assessment Advisory Panel (SABAAP) recommends a minimum 200m buffer around all potentially important bat features including e.g., rocky ridges and outcrops, delineated watercourses, woody vegetation (aloes and trees including alien bush clumps) and built structures (e.g., mine adits, farm buildings, bridges and water towers). For confirmed or suspected (permanent or seasonal) bat roosts the following buffers apply:

- 1 – 50 Least Concern bats – 500m
- 50 – 500 Least Concern bats – 1km
- >500 High Risk Least Concern bats – 2.5km
- 1 – 50 Low Risk Conservation Important bats – 500m
- 1 – 50 Med-High Risk Conservation Important bats – 1km
- 50 - 500 Low Risk Conservation Important bats – 1km
- 50 - 500 Med-High Risk Conservation Important bats – 2.5km
- 500 - 2000 Low Risk Conservation Important bats – 2.5km
- 500 - 2000 Med-High Risk Conservation Important bats – 10km
- >2000 Bats of any status or risk level – 20km

These are minimum values and they do not exempt developers from implementing additional mitigation measures outside of these buffer zones where necessary.

For the large adits where four CI bat species were detected (including the Endangered Swinny's Horseshoe Bat, and >200 Near Threatened Geoffroy's Horseshoe Bats), a 1km aboveground and a 500m underground radial buffer are prescribed. For the smaller adits where much lower densities of CI bats were found, a 500m aboveground buffer is prescribed, which corresponds with the 500m cave buffer recommendation of GDARD (2012).

In addition, a 50m buffer around all forest patches is prescribed to protect the Near Threatened Rusty Pipistrelle, which roosts in tree crevices, and all five recorded CI bat species, which are expected to frequent local forest patches when foraging. This 50m buffer recommendation was based on international bat impact mitigation guidelines including the EUROBATS (http://www.eurobats.org) and Natural England (Mitchell-Jones & Carlin 2009) bat impact mitigation guidelines.

Based on the 50m riparian buffer recommendation of GDARD (2012), a minimum 50m buffer is recommended around all wetlands for the Data Deficient Swamp Musk Shrew and Reddish-Grey Musk Shrew. This recommendation would hopefully also protect small, potentially occurring CI wetland mammal species such as the Critically Endangered White-tailed Mouse and Near Threatened African Marsh Rat.

For the comparatively mobile Near Threatened Serval, buffer zones do not seem appropriate and emphasis is instead placed on maintaining connectivity between wetlands and undisturbed grassland areas.

#### *4.2.1. Birds*

GDARD (2012) recommends a minimum 170m buffer and DEC (pers. comm. 2013) recommends a minimum 200m buffer on any linear wetland system supporting the foraging and breeding habitat of the Vulnerable African Grass-owl.

For the Vulnerable White-bellied Korhaan, GDARD (2012) recommends the protection of contiguous habitat patches >100ha. Three patches of habitat in the vicinity of the current proposed surface infrastructure area were accordingly delineated for the protection of this species. These patches are separated by approximately 400m-1km and collectively exceed 100ha.

Patches of Scarp Forest should be preserved for forest-specialist CI bird species such as the Bush Blackcap. For wider-ranging, grassland-dependent CI bird species such as the Near Threatened Secretarybird and Black-bellied Bustard, the maintenance of connected grassland areas is most appropriate.

#### *4.2.1. Reptiles*

Observed and potentially occurring CI reptile species are mostly grassland specialists, such as the provincially Near Threatened Cape Grass Lizard (*Chamaesaura anguina*), and during field surveys the highest diversity of reptiles was recorded in Rocky Grasslands. Therefore, it would be most appropriate to conserve grassland habitat in the absence of information on specific buffer zones for these species.

#### *4.2.1. Frogs*

Protection of wetland, grassland and forest habitat would, respectively, benefit the potentially occurring Vulnerable Spotted Shovel-nosed Frog, provincially Vulnerable Karoo Toad and Giant Bullfrog, and the provincially Vulnerable Natal Cascade Frog.

# 6. Sensitivity Maps

Based on the afore-mentioned habitat sensitivity ratings and buffer zones, separate Sensitivity Maps were compiled for flora, fauna, wetland and other aquatic habitat, which are respectively shown in **Figure 6-1**, **Figure 6-2** and **Figure 6-3**. These were subsequently combined (overlaid) to create an overall Sensitivity Map for Biodiversity in the study area, shown in **Figure 6-4**, where:

- Very High sensitive areas include:
    - The *Leucosidea* – *Merxmuellera* Riverine floral community.
    - The *Searsia* – *Diospyros* – *Athrixia* Protected Outcrops & Kloof communities.
    - The *Andropogon* – *Helichrysum- Bulbostylis* seasonal seeps.
    - All wetlands (Rivers, Channelled Valley Bottom systems and Seeps) and the buffers around these.
    - The two large, abandoned adits and the buffers around these.
- High sensitive areas include:
    - The *Andropogon* – *Hyparrhenia* temporary seeps.
    - Smaller, abandoned adits and the buffers around these.
- Medium-High sensitive areas include:
    - The *Hyparrhenia* – *Cymbopogon* – *Monocymbium* Slope community.
- Medium sensitive areas include:
    - The *Hyparrhenia* – *Microchloa* – *Helichrysum* Plateau community.
    - The *Acacia - Ziziphus* floral community and other savanna patches.
- Low sensitive areas include:
    - Alien bushclumps.

All four Sensitivity Maps indicate that the AYCP is situated in an extremely sensitive and conservation important area, and correspond with the MTPA's (2013) Mpumalanga Biodiversity Sector Plan (**Figure 3-1**), and the DEA *et al's* (2013) Atlas of Sensitive Areas for Mining (**Figure 2-6**). These combined findings suggest that the AYCP is fatally flawed.

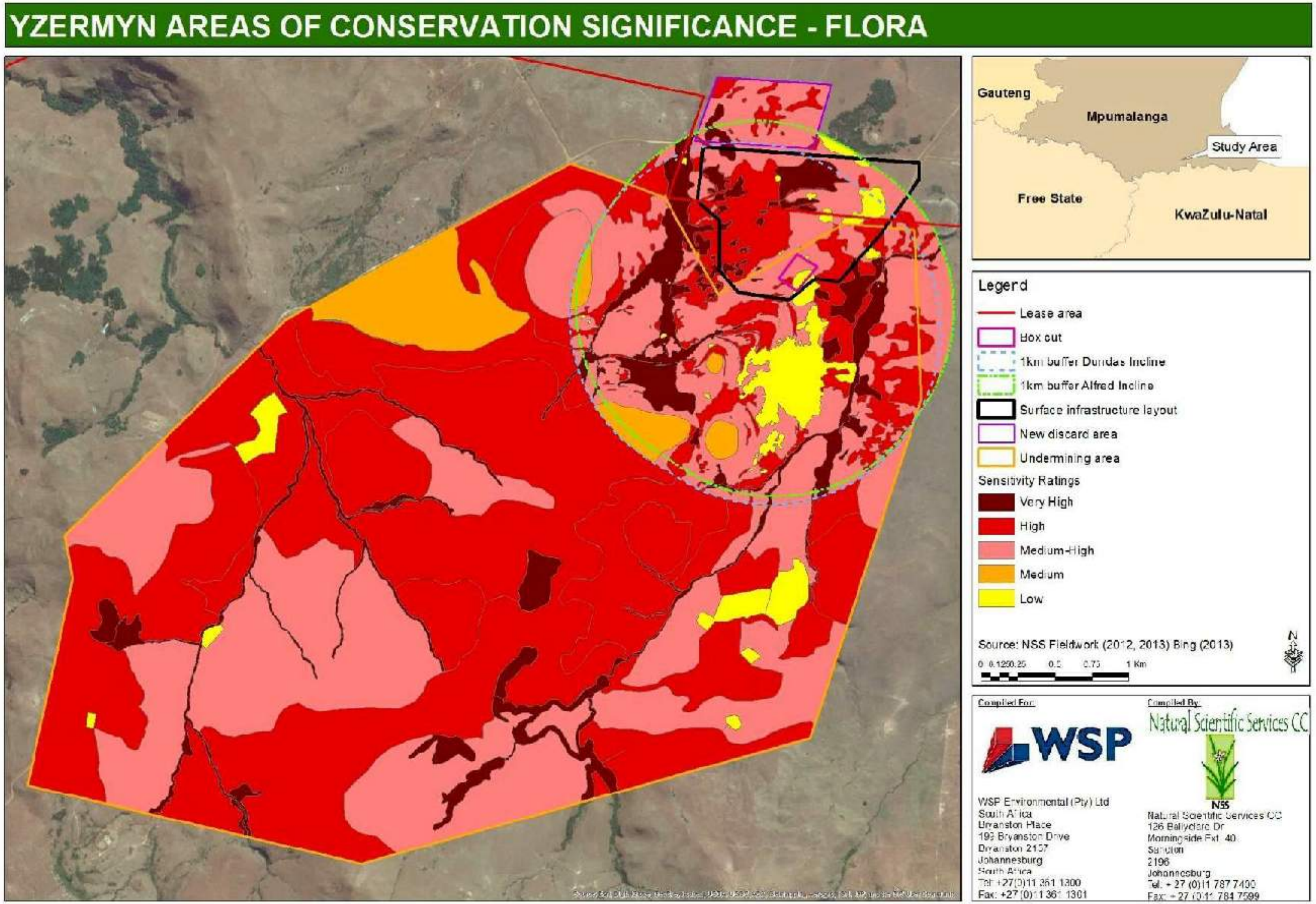



**Figure 6-1 Floral Sensitivity Map**

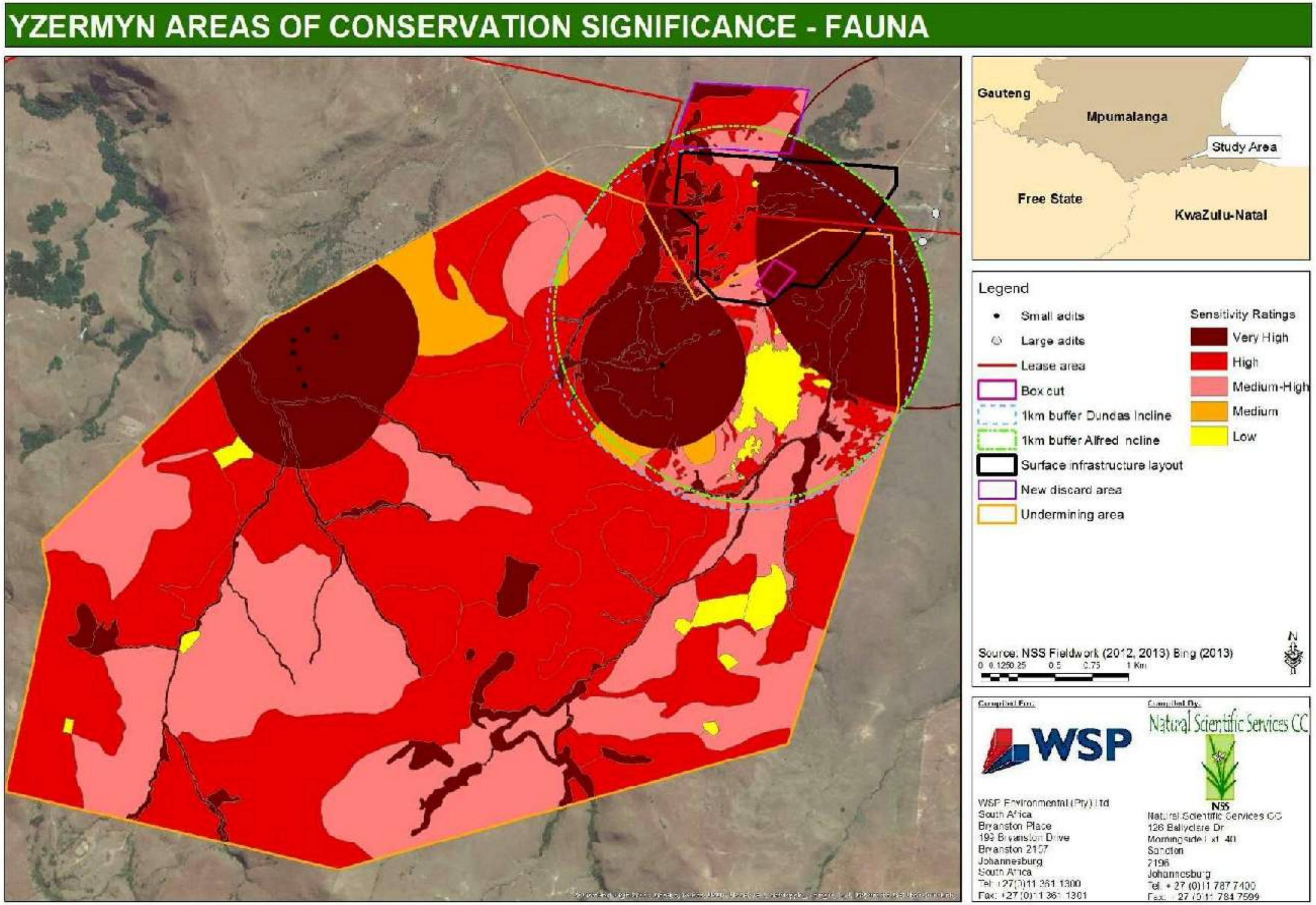



**Figure 6-2** **Faunal Sensitivity Map**

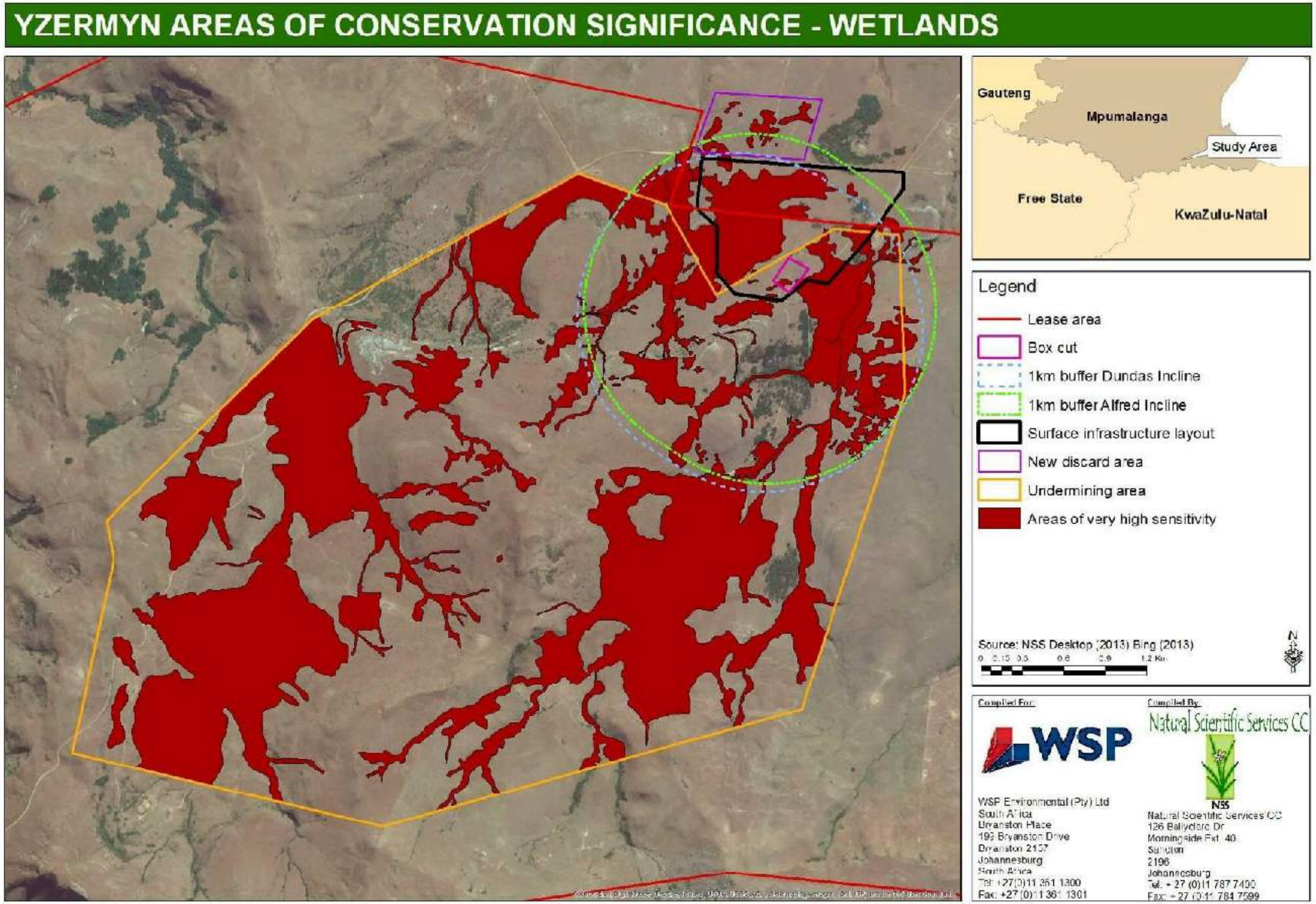



**Figure 6-3 Aquatic & Wetland Sensitivity Map**

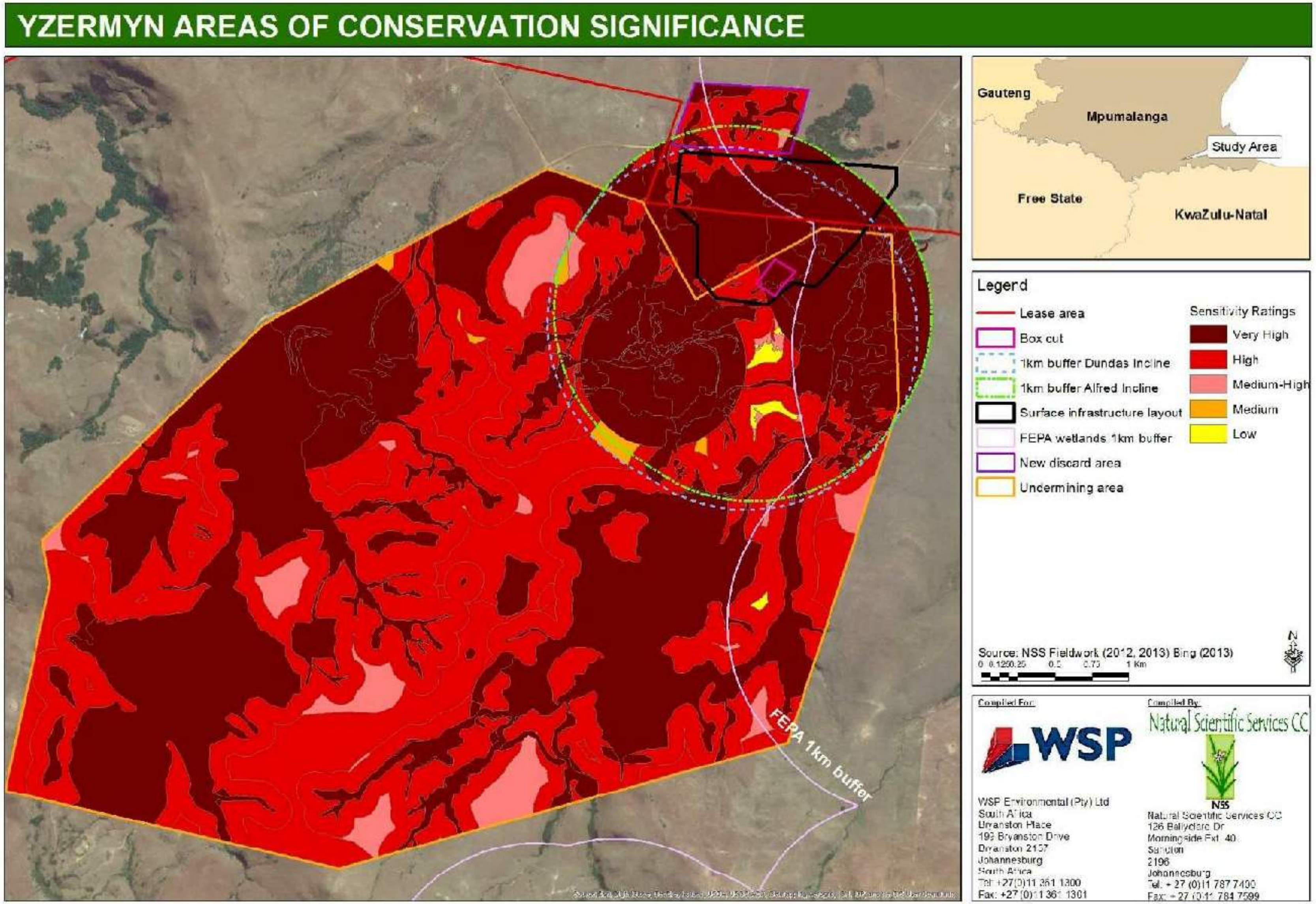



**Figure 6-4** **Overall Biodiversity Sensitivity Map for the AYCP**

# 7. Application of Sensitivity Results

The Sensitivity Maps should guide the development of the AYCP, where:

- Disturbances should preferentially occur in Low sensitive areas.
- Very High sensitive areas must remain undisturbed.
- High sensitive areas should be subject to limited disturbance and rigorous mitigation.
- Medium sensitive areas may be disturbed if mitigation measures are implemented.
- Low sensitive areas may be disturbed with minimal mitigation.

A full Impact Assessment with recommended mitigation measures is presented in **Section G**.

# Section G: Impact Assessment

NATURAL SCIENTIFIC SERVICES

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# SECTION G: IMPACT ASSESSMENT

## 1. Introduction

This **Section G** presents the Phase 3 (Biodiversity) Impact Assessment for the proposed underground mining, surface infrastructure and discard areas (shown in **Section A: Figure 2-1**).

The Impact Assessment (IA) was completed (with recommended mitigation measures) in the context of:

- Relevant international, national and provincial legislation, policies and guidelines mentioned in **Section A**.
- Results from the desktop- and field-based investigations of flora, fauna, aquatic ecology and wetlands, including local observations of CI species, as described in **Sections B, C, D** and **E**, respectively.
- The national and provincial significance of local Biodiversity, and relevant national, provincial and local conservation initiatives mentioned in **Section F**.
- The habitat sensitivity ratings, buffer zones and Sensitivity Maps presented in **Section F**.

## 2. Methodology

Current impacts on Biodiversity in the study area are briefly mentioned. Future potential impacts of the proposed project, and recommended measures to mitigate these, were rated, and are discussed in detail. Cumulative impacts have also been considered.

### 2.1. Impact Rating

Using WSP's Impact Rating Methodology, the Severity, Duration, Extent, Consequence, Frequency, Probability and Likelihood of each potential impact was assessed, and used to calculate each impact's overall Significance (with and without mitigation), as shown in **Table 2-1** to **Table 2-8**.

**Table 2-1 Rating of impact Severity (as stipulated by WSP)**

| Rating | Description |
|---|---|
| 1 | Negligible/ non-harmful/ minimal deterioration (0 – 20%) |
| 2 | Minor/ potentially harmful/ measurable deterioration (20 – 40%) |
| 3 | Moderate/ harmful/ moderate deterioration (40 – 60%) |
| 4 | Significant/ very harmful/ substantial deterioration (60 – 80%) |
| 5 | Irreversible/ permanent/ death (80 – 100%) |

**Table 2-2 Rating of impact Duration (as stipulated by WSP)**

| Rating | Description |
|---|---|
| 1 | Less than 1 month/ quickly reversible |
| 2 | Less than 1 year/ quickly reversible |
| 3 | More than 1 year/ reversible over time |
| 4 | More than 10 years/ reversible over time/ life of project or facility |
| 5 | Beyond life of project of facility/ permanent |

**Table 2-3 Rating of impact Extent (as stipulated by WSP)**

| Rating | Description |
|---|---|
| 1 | Within immediate area of activity |
| 2 | Surrounding area within project boundary |
| 3 | Beyond project boundary |
| 4 | Regional/ provincial |
| 5 | National/ international |

**Table 2-4 Determination of impact Consequence (as stipulated by WSP)**

| Determination of Consequence (C) | (Severity + Duration + Extent) / 3 |
|---|---|

**Table 2-5 Rating of impact frequency (as stipulated by WSP)**

| Rating | Description |
|---|---|
| 1 | Less than once a year |
| 2 | Once in a year |
| 3 | Quarterly |
| 4 | Weekly |
| 5 | Daily |

Table 2-6 Rating of impact Frequency (as stipulated by WSP)

| Rating | Description |
|---|---|
| 1 | Almost impossible |
| 2 | Unlikely |
| 3 | Probable |
| 4 | Highly likely |
| 5 | Definite |

Table 2-7 Determination of impact Likelihood (as stipulated by WSP)

| Determination of Likelihood (L) = | (Frequency + Probability) / 2 |
|---|---|

Table 2-8 Determination of impact Significance (as stipulated by WSP)

| Environmental Significance (Impact) = C × L | Description |
|---|---|
| L (1 – 4.9) | Low environmental significance |
| LM (5 – 9.9) | Low to medium environmental significance |
| M (10 – 14.99) | Medium environmental significance |
| MH (15 – 19.9) | Medium to high environmental significance |
| H (20 – 25) | High environmental significance. Likely to be a fatal flaw. |

## 2.2. Assumptions, Limitations & Caveats

The IA was based on the following main assumptions and limitations:

- If approved, the proposed surface infrastructure will be located within the footprint shown in **Figure 2-1** (which was supplied to NSS after field work was performed).
- Proposed mining areas beyond the assessed 15 years of mining, have not been assessed (**Section A: Figure 2-2**)
- Potential impacts associated with access roads, conveyor routes, pipelines, electricity supply routes etc have not been assessed as part of this assessment.
- The source of water for the wetlands identified within the study area and within the greater cone of depression is unknown (WSP, 2013a). A conservative approach has therefore been taken, assuming the following:
    - The shallow and deep aquifers are hydraulically connected. Recharge of the deeper aquifers is expected to occur along the few fracture systems which connect the deeper aquifer to shallow groundwater bodies or directly to the surface.
    - The wetlands may be fed by one or more of the following sources:

    - the perched aquifer. Perched on low permeability material in the weathered zone or in colluviums;
    - the shallow aquifer. Perched on hard rock at the base of the weathered zone; and
    - the deeper aquifer in terms of springs. Groundwater on horizontal and semi-horizontal contacts between different rock types
- Based on the above uncertainties on the source of water for the wetlands in the study area, it has been assumed that the mine de-watering will impact all wetlands in the proposed underground mining and surface infrastructure areas, based on the de-watering cones supplied by WSP (2013a) for both the shallow and deep aquifers. The impact will also extend into and beyond the greater mine lease area.
- Groundwater will be used to augment water supply to the washing plant. Boreholes CBH2D, CBH3S and CBH7S will be pumped 12 hours a day.
- A cut-off trench will be constructed around the surface infrastructure footprint and the clean water collected in the cut-off trench will be returned to the receiving environment.
- The discard dump will not be lined, however, the base of the discard dump will be compacted to reduce infiltration.
- The coal stockpile area will not be lined, however, the base of the coal stock pile swill be compacted to reduce infiltration.
- The Pollution Control Dams (PCDs) will be lined.
- It is estimated that groundwater levels will recover within 20-50 years after mining stops.
- The plant area will be paved, which will limit seepage to the underlying aquifers.
- It is uncertain whether the drawdown cone extends into the quaternary catchments V31A and W42A (as the groundwater model did not extend into these catchments). For this assessment it has been assumed that it is unlikely. However, further investigations should be undertaken due to the sensitive nature of these catchments and associated watercourses (FEPA rivers and wetlands).
- Conventional board and pillar underground mining methods will be used. This will involve drill and blast, and continuous miner operations. The pillars will be 6m wide and to the mining height. No high extraction is planned. The dolerite sill intruded into the area is furthermore expected to increase the strength of the overburden material. The risk of subsidence is, therefore, considered to be low (WSP, 2013a).
- A modular sewage treatment plant will be constructed, which is contained. It is therefore assumed that no soak-aways or french drains will be implemented. A reputable contractor will empty septic tanks. For this reason, the sewage plant is not expected to pose a threat to groundwater contamination. Chemical toilets will be used during the construction phase of the project.

- In addition to the above, all the assumptions made in the groundwater report apply to this assessment as the results of the groundwater model are dependent on these (WSP, 2013a).

In terms of Offsets, no national or Mpumalanga provincial guidelines (MTPA pers. comm., 2013) currently exist for wetland offset projects. The MTPA does not readily entertain offsets as an option unless the long-term security of a site can be guaranteed. This project will impact on wetlands, fed by the shallow aquifer, within an area of approximately 5,398ha and wetlands, fed by springs sourced in the deeper aquifer, within an area of approximately 7,977ha. The possibilities for offsets, of this extent within the same catchment, are unlikely. As this proposed project is at the head of catchment W51A and will impact on water resources downstream and may also impact on catchments V31A and W42A, no wetland could be offset to the same value and ecological state (Natural to Largely Natural) as those that would be lost.

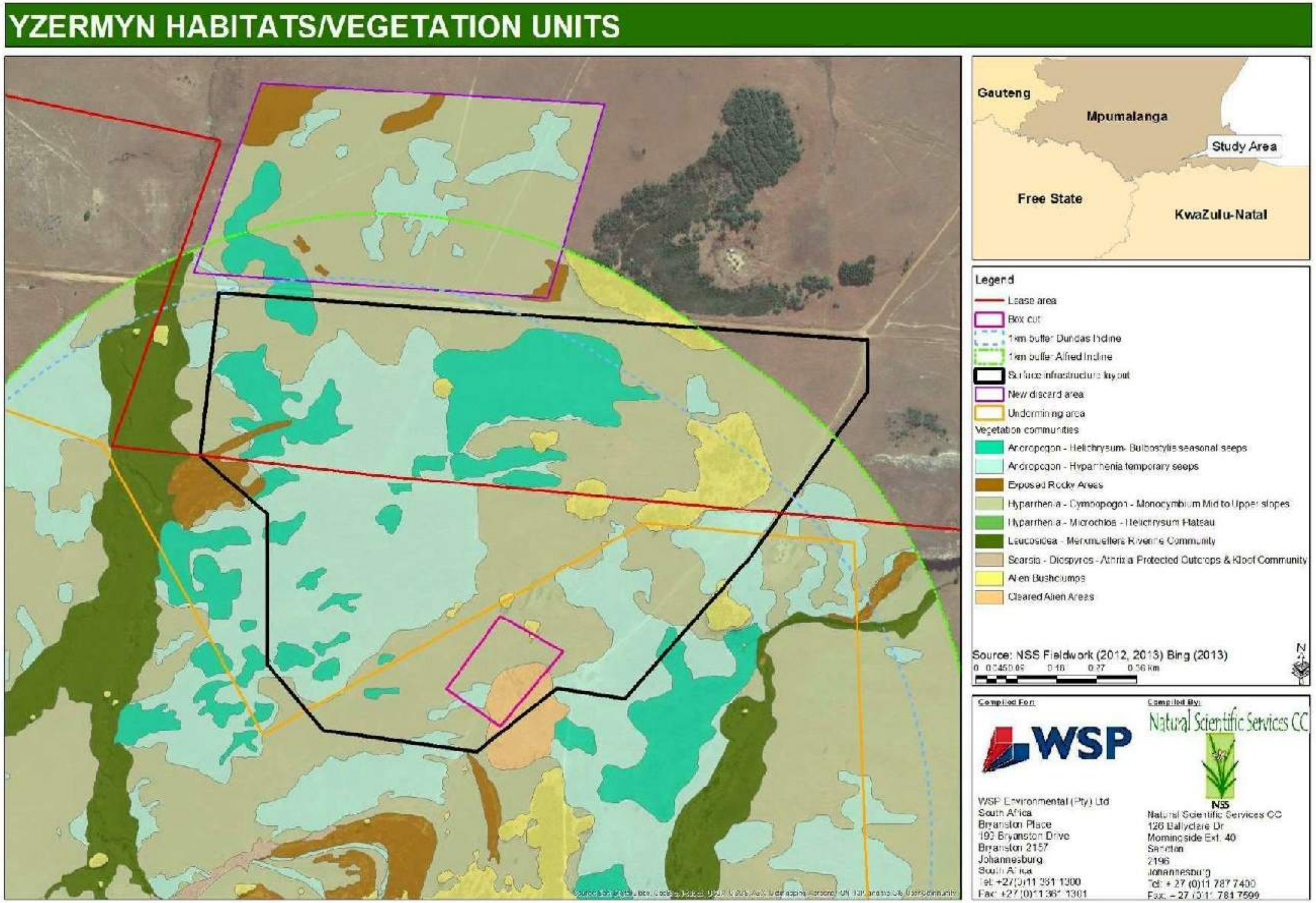


**Figure 2-1** **The planned surface infrastructure footprint**

# 3. Current Impacts

Photographs of current impacts on Biodiversity in the study area are presented in **Figure 3-1**.

## 3.1. Drilling for the AYCP

Contractors appointed by WSP to drill groundwater (NOT exploration) boreholes, have had a recent, localized impact on site. New roads/tracks have been made and sediment/silt has been left on the ground surface in the wake of borehole run-off. WSP has reportedly discussed this issue with the appointed contractor, and requested that in future, all run-off must be contained.

## 3.2. Livestock Grazing, Trampling & Eutrophication

African grass species are adapted to thrive under conditions of periodic defoliation caused by grazing or fire. The grass sward even requires periodic defoliation to remain healthy. Excessive levels of defoliation, however, can cause the grass sward to degenerate, allowing unpalatable grass species to dominate, which are referred to as Increaser 2 species (Van Wyk & Van Oudtshoorn, 2002). Cattle-grazing is widespread across the AYCP lease area, and in some areas the floral communities were dominated by Increaser 2 species. Cattle grazing and trampling were concentrated in a few small cattle camps. Trampled areas and paths are susceptible to erosion. At some aquatic sampling sites (**Section D**), slightly elevated measurements of ammonium (NH3), alkalinity, and Chemical Oxygen Demand (COD) were possibly due to eutrophication from cattle manure. Although not directly associated with the proposed mining operation, grazing activities in the lease area would need to be addressed as part of the Mine's social and environmental responsibility.

## 3.3. Crop Cultivation

Crop cultivation eliminates species from the land, fragments natural habitat, and provides refuge for numerous weedy and alien species (such as the Category 1 species *Datura stramonium*) to establish. Ephemeral and other wetlands are also susceptible to damage by cultivation because habitat integrity and water flow paths, flow rates and quality may be affected (Walters & Koopman, 2003). In eastern South Africa ~50% of wetlands/watercourses have been lost or degraded, most commonly as a result of commercial or subsistence crop cultivation and other forms of agriculture (Kotze *et al*., 1995). Less than 2% of the total footprint area has been transformed by recent crop cultivation, mostly around homesteads. Some additional areas are fallow and may be re-worked. Some other areas show signs of historical cultivation.

## 3.4. Alien Plant Invasion

Alien plant species out-compete indigenous flora, reduce water inputs into wetland and riverine systems and, thereby, transform faunal habitat and impinge on local eco-system services.

Although alien bushclumps in the study area provide refuge for some large mammals and birds, bushclumps may reduce water inputs into systems especially seeps. Within the study area alien flora occur in isolated patches including weedy infestations in fallow and active crop fields, and bushclumps comprising *Acacia mearnsii*, *Eucalyptus* spp. and *Populus x canescens* (**Section B**). Scattered woody alien species exist in riparian areas and are generally dominated by the Category 1b species *Acacia melanoxylon*. If the AYCP is approved, the Mine will need to implement an Alien Invasive Management and Action Plan.

### 3.5. Harvesting of Fauna & Flora

Certain animals in the study area are hunted or otherwise persecuted by people, especially cattle herdsmen and their dogs. Plants of medicinal or cultural significance may also be harvested by local communities. A dead snake was found hooked to a fence near a local settlement, for example, and potential harvesting of *Hyparhennia* Thatching Grass was observed in some areas (**Section B**). These practices may be problematic if they are unsustainable or if CI species are targeted. If the AYCP is approved, the influx of labourers to the Mine may result in increased (and possibly unsustainable) harvesting of local flora and fauna, which would be difficult to control. If the AYCP is approved, the Mine will need to implement rigorous monitoring, management and enforcement systems to control unsustainable harvesting of biodiversity, especially CI taxa.

Silt from groundwater borehole run-off

Cattle camp

Alien invasive plants

Potential harvesting of Thatching Grass

**Figure 3-1 Photographs of current impacts in the study area**

# 4. Future Potential Impacts

The rating of each potential impact to determine its overall Significance, with and without mitigation, is shown in **Table 4-1**.

**Table 4-1 The potential impacts rated with and without mitigation (as stipulated by WSP)**

| Ref. | Phase | Impact Description | Mitigation Measure | A<br>Severity | B<br>Duration | C<br>Extent | D<br>Consequence (A+B+C)/3 | E<br>Frequency | F<br>Probability | G<br>Likelihood (E+F)/2 | (DxG)<br>Environmental Significance (Without Mitigation) | (DxG)<br>Environmental Significance (With Mitigation) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Biodiversity** | | | | | | | | | |
| 1 | Pre-construction<br>Construction<br>Operation<br>De-commission<br>Post-closure | **Construction of Infrastructure & Resultant Loss of Habitat & Species** | Obtain permits to translocate CI taxa; Locate, transplate & monitor CI plants; Translocate certain CI fauna; Include Biodiversity conservation in staff training & inductions; Prohibit disturbance of Biodiversity beyond the construction & operation footprints; Prohibit driving off the main access road & develop a fining system; Avoid all Very High & High Sensitive areas; Shift the infrastructure layout to impact only one catchment; Rehabilitate existing alien-invaded wetlands; Fence-off the construction area; Purify trench water & carefully return to the environment; Control storm water & erosion along roads; Remove all waste post-construction; Install bridges & culverts over wetland crossings; Stockpile soil in small mounds for brief periods | 5.0 | 5.0 | 2.0 | 4.0 | 5.0 | 5.0 | 5.0 | 20.0 | |
| | | | | 5.0 | 4.0 | 2.0 | 3.7 | 5.0 | 5.0 | 5.0 | | 18.3 |
| 2 | Pre-construction<br>Construction<br>Operation<br>De-commission<br>Post-closure | **Decline in Water Inputs & Resultant Deterioration in PES & Functionality** | Assess the flow rates of fountains pre-construction; Complete a Rapid III Reserve Determination prior to obtaining abstraction permits; Do not abstract water from boreholes CBH2D, CBH3S & CBH7S; **Return abstracted water to the environment as per the RQO or TWQR**; Investigate groundwater in other catchments; Monitor the PES & ecosystem services of all impacted water resources; Monitor & rehabilitate water flow & vegetation along the Assegaai River; Seal water-bearing geological structures as they are intersected underground; | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 25.0 | |
| | | | | 4.0 | 5.0 | 4.0 | 4.3 | 5.0 | 5.0 | 5.0 | | 21.7* |
| 3 | Pre-construction<br>Construction<br>Operation<br>De-commission<br>Post-closure | **Decline in Water Quality & Resultant Deterioration in PES & Functionality** | Obtain authorization to impact water resources & their buffers; **Construct an ENGINEERED lining for the base of the discard dump & coal stockpile**; Install efficient toe drains to remove seepage from entering aquifers; Do not dump waste in or near water resources; Regularly check vehicles & machinery for leaks & spills; Only release sufficiently-purified water into the environment; Prevent dirty run-off; Pave the plant area; Adits must be sealed during decommissioning; Perform bio-monitoring of surface and groundwater | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 25.0 | |
| | | | | 4.0 | 5.0 | 4.0 | 4.3 | 5.0 | 5.0 | 5.0 | | 21.7* |
| 4 | Pre-construction<br>Construction<br>Operation<br>De-commission<br>Post-closure | **Alien Species Invasion & Resultant Impacts on Biodiversity** | Prohibit introductions of alien & domestic species; Only use indigenous flora & rehabilitation material certified to exclude potential weeds; Train the EO & staff to identify & remove alien taxa; | 5.0 | 5.0 | 3.0 | 4.3 | 5.0 | 4.0 | 4.5 | 19.5 | |
| | | | | 2.0 | 3.0 | 2.0 | 2.3 | 5.0 | 3.0 | 4.0 | | 9.3 |
| 5 | Pre-construction<br>Construction<br>Operation<br>De-commission<br>Post-closure | **Increased Erosion & Sedimentation & Resultant Impacts on Biodiversity** | Compile & implement a Soil Management Plan; Implement appropriate dust control strategies; Vegetate exposed areas a.s.a.p. with indigenous flora | 4.0 | 5.0 | 3.0 | 4.0 | 5.0 | 4.0 | 4.5 | 18.0 | |
| | | | | 2.0 | 3.0 | 2.0 | 2.3 | 5.0 | 3.0 | 4.0 | | 9.3 |
| 6 | Construction<br>Operation | **Sensory Disturbance of Fauna** | Maintain a minimum 500m underground buffer around the large bat roosts; Screen the infrastructure area with indigenous hedging; Minimize noise & lighting as far as possible | 3.0 | 4.0 | 3.0 | 3.3 | 5.0 | 4.0 | 4.5 | 15.0 | |
| | | | | 2.0 | 3.0 | 2.0 | 2.3 | 5.0 | 3.0 | 4.0 | | 9.3 |

***NOTE: The Significance of these impacts would ONLY be reduced if the recommended mitigation measures in BOLD are EFFECTIVELY implemented!**

## 4.1. Construction of Infrastructure & Resultant Loss of Habitat & Species

Significance without mitigation: HIGH; Significance with mitigation: MEDIUM-HIGH.

### *4.1.1 Impact Assessment*

Construction of the proposed surface infrastructure will result in complete removal of vegetation and levelling of the area. The plant area will be paved, a cut-off trench will be constructed around the surface infrastructure footprint, and shafts will be created through blasting. The impact will be long-term as it will continue from the construction phase until de-commissioning.

Flora

The proposed surface infrastructure footprint will result in direct loss of the following vegetation communities (**Figure 2-1**):

- Exposed Rocky Areas (0.65ha)
- *Andropogon* – *Helichrysum* – *Bulbostylis* seasonal seeps (12.36ha)
- *Andropogon* – *Hyparrhenia* temporary seeps (28ha)
- *Hyparrhenia* – *Cymbopogon* – *Monocymbium* Mid- to Upper slopes (34.3ha)
- Alien bushclumps (4.62ha)
- Cleared Alien bushclumps (1.25ha)

A vegetation community represents a relatively uniform collection of plant species in a designated geographical area, which is distinguishable from other neighbouring communities. The components of each plant community are influenced by soil type, topography, climate and human disturbance. Of the vegetation communities listed above, the most significant include the Exposed Rocky areas; *Andropogon* – *Helichrysum* – *Bulbostylis* seasonal seeps; *Andropogon* – *Hyparrhenia* temporary seeps; and to a lesser extent the *Hyparrhenia* – *Cymbopogon* – *Monocymbium* slopes.

The loss of these communities will also result in a loss of CI plant specimens and small populations. Seventeen CI plant species were recorded within the vegetation communities to be directly lost by the surface infrastructure. Two of these are listed by the TSP as Declining due mainly to habitat destruction: *Boophone disticha* (Tumbleweed/Gifbol) and *Crinum bulbispermum* (Orange River Lily). Endangered, Vulnerable, Rare and other Declining plant species, which have been recorded on nearby farms (**Section B**), may also occur in the footprint and would increase the overall Significance of this impact. Some of the species are rarely recorded mainly because they are inconspicuous in nature, unless in flower. Flowering seasons are either very short or in times when NSS was not in the field.

Fauna

Removal of vegetation for proposed surface infrastructure will cause direct mortality of small, fossorial, and other, less mobile animals and, more importantly, loss of breeding and foraging habitat for various fauna including several CI species, in particular:

- Resident breeding pairs of the Vulnerable White-bellied Korhaan (*Eupodotis senegalensis*), Vulnerable African Grass-owl (*Tyto capensis*) and Near Threatened Secretary Bird (*Sagittarius serpentarius*). Adult birds could fly away from the surface infrastructure area, but chicks would be abandoned, and because of increasing habitat loss, displaced birds might not find suitable habitat that is unoccupied by conspecifics.
- The provincially Near Threatened Cape Grass Lizard (*Chamaesaura anguina anguina*), which was found on multiple occasions in the footprint area, and which is unable to move across cleared, compacted surfaces (Alexander, 2009). These present a significant barrier to individual lizards and, consequently, development of surface infrastructure will fragment the local population. Lizards, which are not killed when vegetation is cleared, would most likely be confined to remaining fragments of suitable rocky grassland habitat because of this species' poor movement capacity. Some displaced or dispersing individuals might not find suitable habitat that is unoccupied by conspecifics.

Wetlands & Aquatic Ecology

The direct loss of wetland seeps and paving of the plant area will cause:

- A change in the water distribution and retention patterns of downstream wetlands. A cut-off trench will be installed around the plant area. The cut-off trench will collect clean water, which will then be returned to the receiving environment. This collection and release of clean water will result in a change in the water distribution and retention patterns of the wetlands. The release of water into the catchment could result in an increase in flood peaks and potential erosion.
- A decline in water inputs into the adjacent river and associated channelled valley bottom wetlands. Presumably, water collected in the surface infrastructure footprint will be dirty, and not returned to the receiving environment. Major impacts associated with the decline in water inputs are discussed further on.
- A loss in the eco-system services provided by these seep wetlands, which include the maintenance of biodiversity, erosion control, and the provision of natural resources.
- An encroachment into the required 1km buffer around adjacent wetland FEPAs. In accordance with the FEPA guideline documents, no mining is to take place within a 1km buffer of any wetland/riverine FEPA (Driver *et al*. 2011).

#### *4.1.2 Recommended Mitigation*

The main recommended mitigation measure is to avoid all areas of Very High and High sensitivity. This would make the project a No Go as almost the entire undermining area is rated as having a Very High or High sensitivity. Should the project go ahead, the following mitigation measures regarding the layout of the surface infrastructure should be implemented:

- Protected floral and faunal species will require permits for destruction/translocation.
- The footprint area should be re-investigated by a qualified botanist with appropriate field experience so that the locations of all CI and transplantable plant species (e.g. *Eucomis autumnalis*) can be recorded and visually marked. The designated mine Environmental Officer (EO) should be included in the search. Transplanted specimens should be monitored to assess their success of establishment during the operational phase.
- A qualified zoologist with appropriate expertise should assess the success of translocating resident CI faunal species such as the Cape Grass Lizard.
- Biodiversity and conservation awareness should be incorporated into the training and induction programmes. Education of the EO on site through photographic references of species can be supplied.
- The current surface infrastructure layout impacts on the catchments of both System 1 and 2 as defined in the wetland assessment (**Section E**). The layout of the surface infrastructure should be re-aligned to impact on only one of these systems.
- Any topsoil that is to be stockpiled for future use must be stored at a minimum height to retain the viability of the seed bank.
    - Remove the top 100mm of topsoil and stockpile in small mounds, where possible. The recommended depth of removal is between 100–200 mm of topsoil as this contains the indigenous seed bank. Stockpiling should occur for the shortest possible time to minimize propagule death.
    - A study by Harris *et al*. (1989) states stockpiled soil exceeding a meter deep, results in chemical effects such as accumulation of ammonium and anaerobic conditions at the base of the pile. The suggested height of the stock pile is below 2m (1-1.5m preferably), (ARC pers. comm., 2006). Although this is highly recommended for successful rehabilitation, the trade-off between this, and the increase in footprint and impact of a greater area, needs to be considered.
    - The introduction of top soil supports the opportunity to support a higher diversity of plants than would have been the case had the top soil not been introduced.
- For the wetland systems lost by the surface infrastructure footprint, a Hectare Equivalent approach taking into consideration wetland integrity/functionality of the wetland lost should be conducted. Based on the outcome of what hectare equivalents are required, wetland areas identified for rehabilitation should therefore be secured in the same catchment. Due to the Natural to Largely Natural status of the wetlands in the region,

these rehabilitation options will be limited, and will mainly include the removal of alien and invasive bushclumps (specifically within System 2).

- Water collected in the cut-off trench should remain clean, and be returned to the receiving environment. The release of water into the receiving environment should be dissipated to prevent erosion, and to mimic the fluctuation in flow of the receiving environment.
- Roads passing along steep gradients (≥1 in 10) should include erosion control measures, as deemed appropriate by registered civil engineers. Effective storm water management measures should be implemented and maintained along these roads.
- The footprint area and construction lay down areas should be clearly demarcated and no entry in the surrounding areas should be allowed. Temporary barriers should be erected to protect surrounding habitats from construction activities and dumping of rubble and waste. Only the access road to each of the sites should be used. Off-road driving should be prohibited, and a fining system should be enforced. All surplus and waste materials should be removed from the site at the end of construction.
- Although the impact of linear infrastructure was not included in this assessment, crossings of any water resources should include effective implementation of drainage control, such as the building of bridges, placement of culverts or drifts, as deemed appropriate by registered civil engineers.

## 4.2. Decline in Water Inputs & Resultant Deterioration in PES & Functionality

Significance without mitigation: HIGH; Significance with mitigation: HIGH.

### *4.2.1 Impact Assessment*

This impact was largely assessed using the findings of the groundwater assessment (WSP, 2013a). The decline in water inputs will be as a result of mine dewatering and the proposed abstraction of water from boreholes CBH2D, CBH3S and CBH7S to supplement the water supply needed for the washing plant. De-watering activities will take place during the construction and operational phases of the proposed mine, with the impacts associated with de-watering still occurring into the closure phase (until the underground mine voids have filled – 20-50 years). During the construction phase local de-watering of the aquifer will occur around the adit. The cone of depression is expected to be steep around the adit and will not extend more than 500m away. Limited groundwater will seep into the shaft and boreholes, but this flow will most probably be sealed off during construction of the adit walls. The construction phase is expected to be short-term and the impact is, therefore, assessed as moderate in comparison to the operational impact.

The main impact associated with the decline in water inputs will be due to the dewatering activities and will occur during the operational phase (approximately 15 years) and post-closure (20-50 years after mining ceases and the groundwater levels recover).

Wetlands

The groundwater model has indicated that during the operational phase the extent of the cone of depression on both the shallow weathered and deeper fractured rock aquifers will probably have a significant impact in the immediate vicinity of the mining operations, mainly due to the depth of mining. Groundwater levels in the shallow aquifer may be lowered by up to 10m in the southern section of the underground workings where mining will be deepest (**Figure 4-1**), whilst the deeper aquifer will be lowered up to 55m during years 11-16 of mining (WSP, 2013a) (**Figure 4-2**) . This lowering in groundwater level will have a negative impact on all wetlands fed by the shallow aquifer and the springs within the cone of depression. These springs are one of the main sources of water for the wetlands in the area, supplying water during the drier winter months when the wetlands are not fed by rainfall. As the source of water supplying the wetlands is unknown, and the fact that the groundwater levels will be lowered in the shallow and deeper aquifers, one must assume that the wetlands within the cone of depression will be impacted upon and may possibly dry out. This impact will be seasonal, with the most significant effect on wetlands occurring during the dry season.

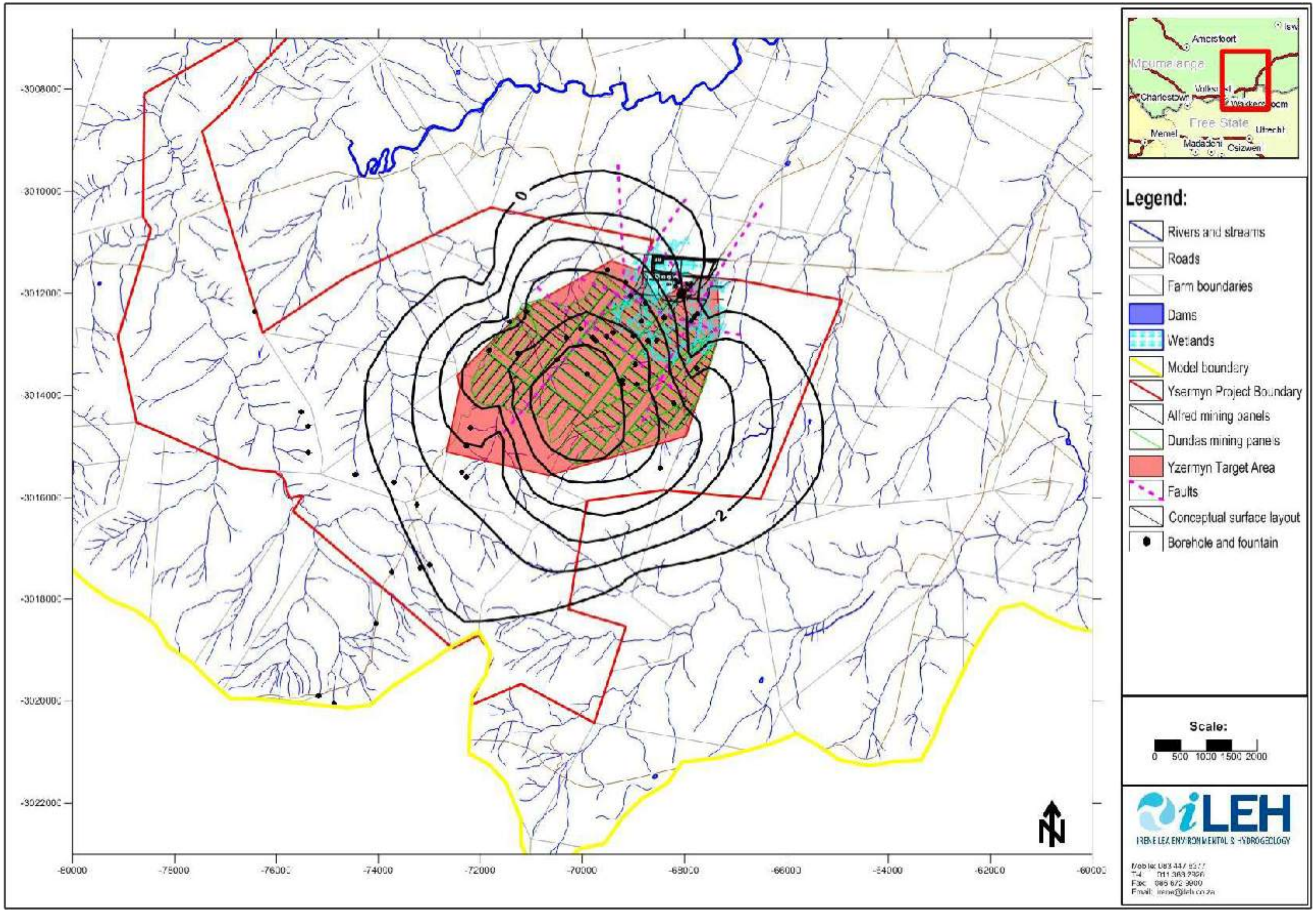


**Figure 4-1** **Simulated drawdown in the shallow aquifer: 11-16 years (WSP, 2013a)**

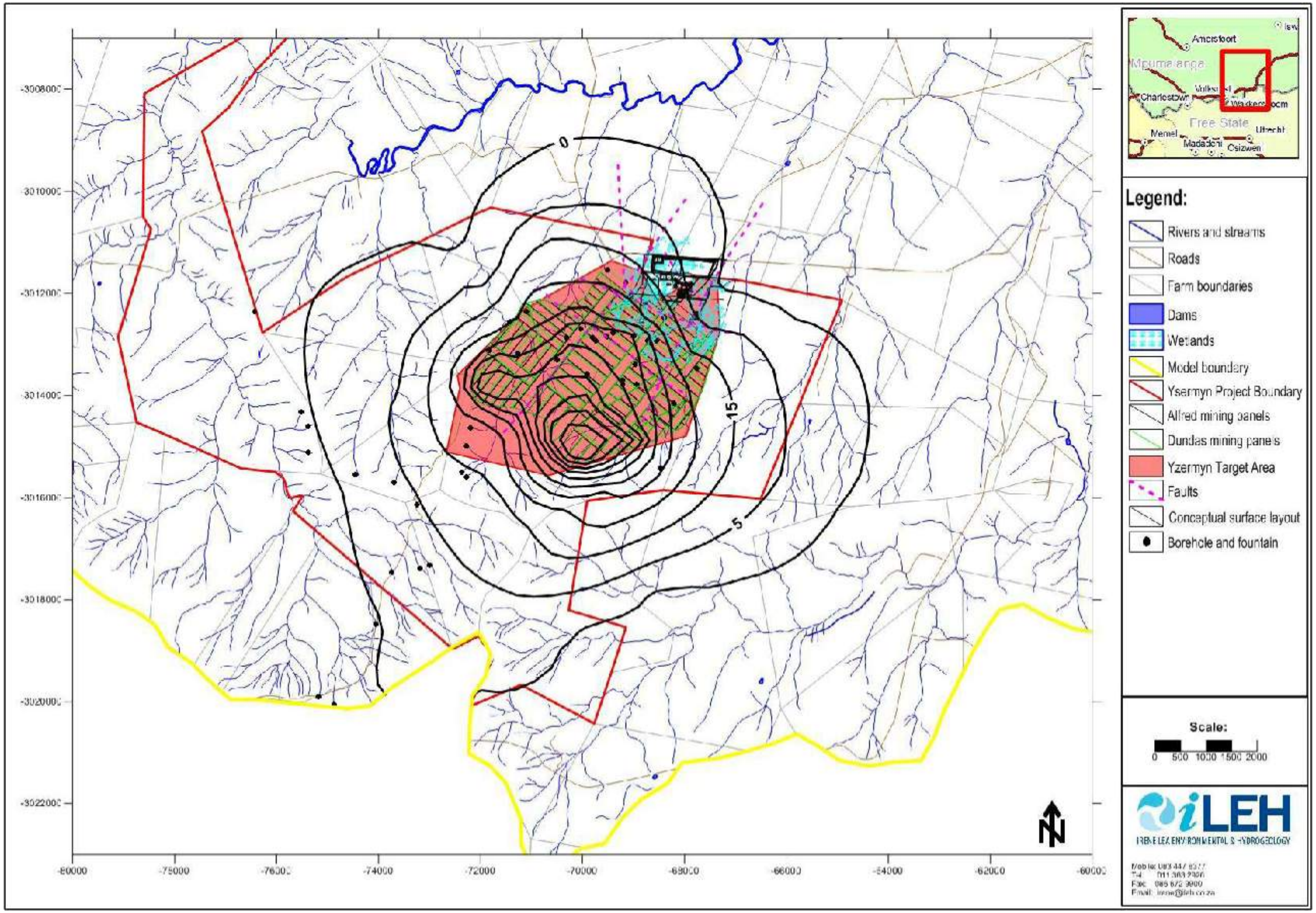


**Figure 4-2** **Simulated drawdown in deep aquifer: 11-16 years (WSP, 2013a)**

The decrease in water input to the wetlands within the study area and surrounds, and the resultant reduction in flow, and potential drying up of wetlands will have a HIGH significance on Biodiversity as a minimum of 40% of the underground mining area and surface infrastructure footprint area constitutes wetland habitat. The impact will also extend into and beyond the greater mine lease area. If one uses the same approach of approximately 40% of the area being wetland, this will equate to the loss or deterioration of between 2,000 and 3,000 ha of wetland habitat. It is uncertain whether the drawdown cone also extends into the quaternary catchments V31A and W42A (as the groundwater model did not extend into these catchments). Further investigations should be undertaken to determine the groundwater impacts within these catchments. From a national and provincial perspective, this is HIGHLY significant as it will result in:

- The loss or deterioration of wetlands in areas that are formally Protected and of Highest Biodiversity Importance according to the Mining and Biodiversity Guideline (**Figure 4-3**).
- The loss or deterioration of the wetlands will extend beyond the study area and will extend into the wetland FEPAs within the mine lease area and the wetland FEPAs and Wetland Clusters in the immediate surrounds (**Figure 4-4).** These systems are also the start of the catchment that feeds the Assegaai River FEPA, and a decline in water input will, therefore, result in a decrease in flow of this river system.
- The drawdown cone will result in the loss or deterioration of wetlands within the Irreplaceable habitat (Mpumalanga Biodiversity Sector Plan) to the south of the underground mining and lease areas (**Figure 4-5**).
- The drawdown cone will result in the loss of fountains and the resultant decline in water input for wetlands in the Kwamandhlangampisi Protected Environment to the east, and the proposed Mabola Protected Environment (**Figure 4-5**).

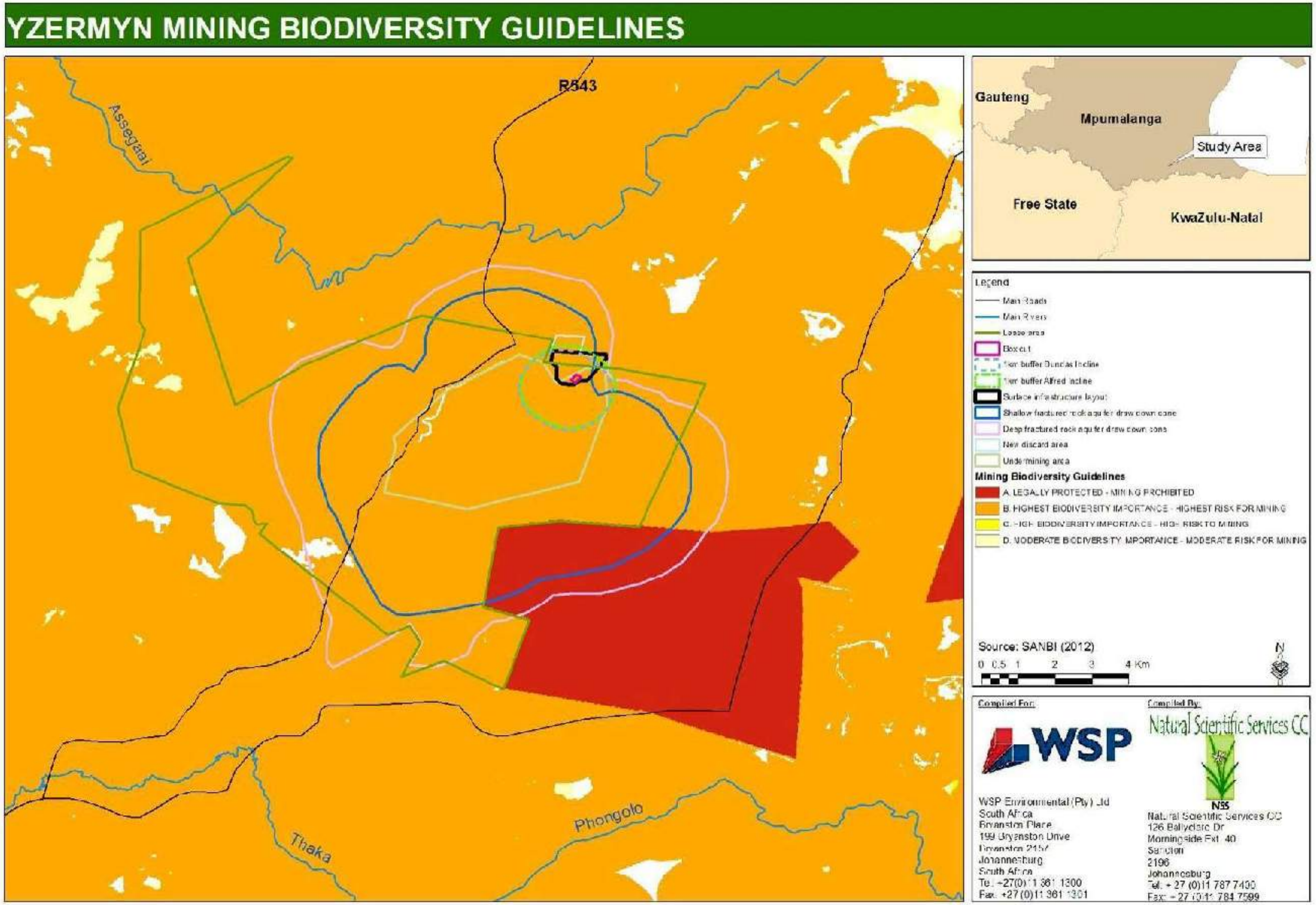


**Figure 4-3** **Shallow and deep aquifer drawdown cones (at 11-16 years), and the national Mining and Biodiversity Guideline**

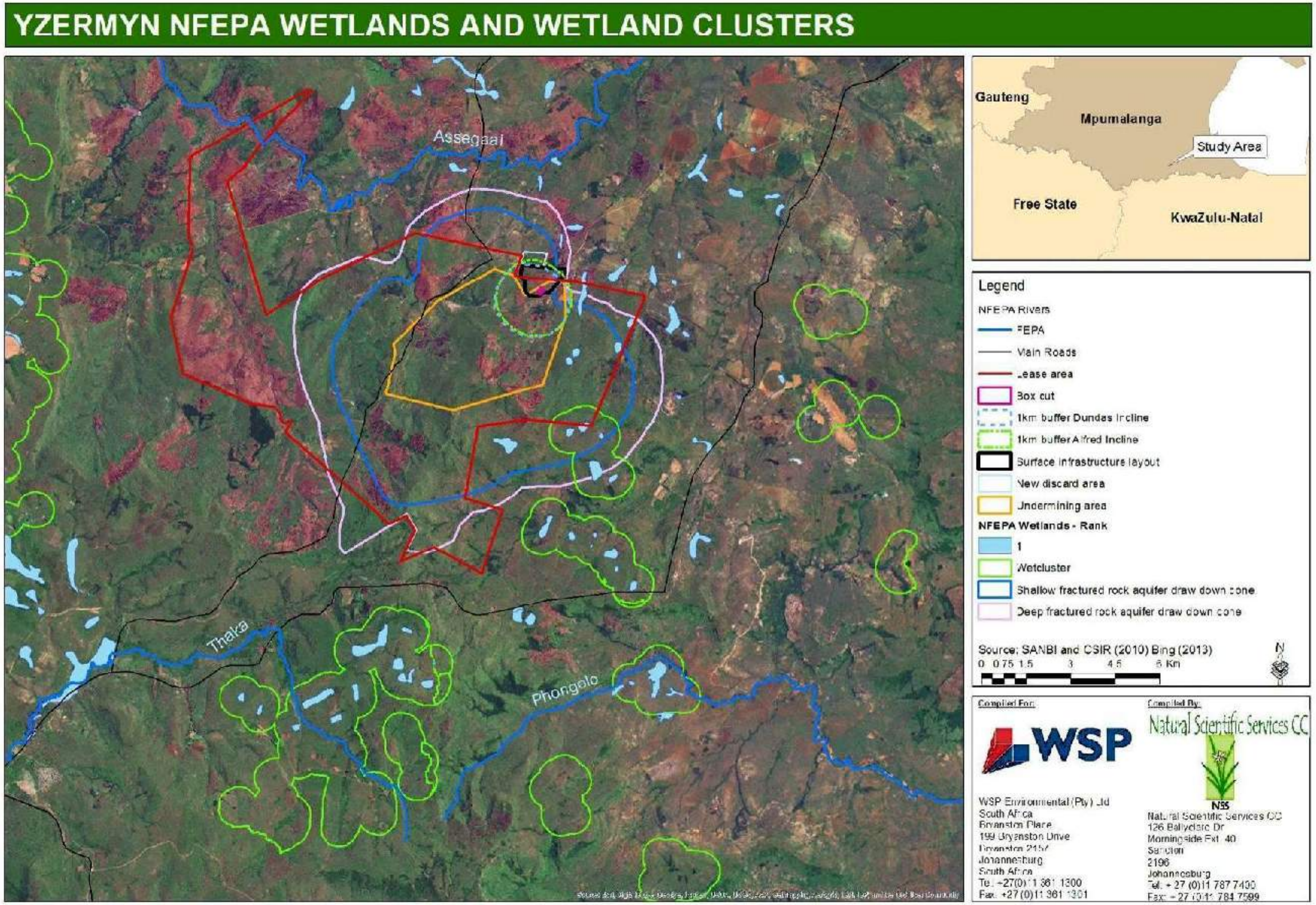


**Figure 4-4** **Shallow and deep aquifer drawdown cones (at 11-16 years), and the National Freshwater Ecosystem Priority Areas**

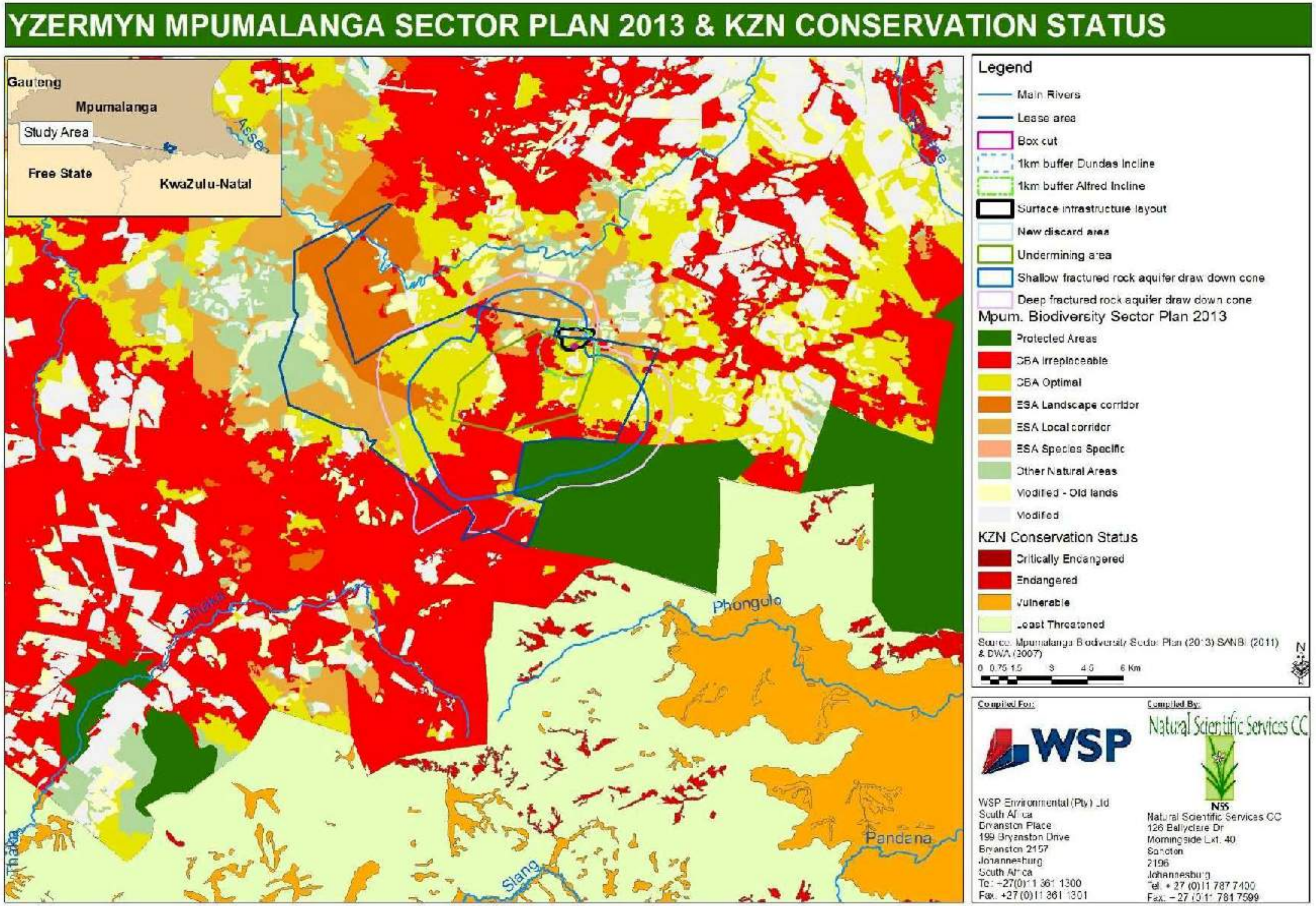


**Figure 4-5** Shallow and deep aquifer drawdown cones (at 11-16 years), and the Mpumalanga Biodiversity Sector Plan

Aquatic Ecology

Flow regime is regarded as a key driver of aquatic ecosystems, and change in flow regimes is the most serious and continuing threat to the ecological sustainability of rivers. Firstly, flow determines the physical habitat in stream, which in turn determines the biotic composition. The shape and size of river channels, the distribution of riffle and pool habitats, and the stability of the substrate are all largely determined by the interaction between the flow regime and local geology and landform. Therefore, the flow and physical habitat is a major determinant of the distribution, abundance and diversity of aquatic plants, macro-invertebrates and fish.

Secondly, aquatic species have developed life history approaches in direct response to their natural flow regimes. Change in flow can lead to recruitment failure and loss of biodiversity.

Thirdly, preservation of the natural patterns of longitudinal and lateral connectivity is essential to the viability of populations of many riverine species. Loss of connectivity can lead to isolation of populations, failed recruitment and local extinction.

Finally, the invasion and success of exotic species in rivers is made easier by the change of flow regimes. The impacts of flow change are manifest across broad taxonomic groups including riverine plants, invertebrates and fish (Bunn & Arthington, 2002).

Even though local aquatic systems may be perennial in nature, water abstraction for the proposed mining operation has the potential to change the flow of these resources during the construction, operation and de-commissioning phases, with the impacts extending into the closure phase. If the flow rates of local water resources are lowered, this will lead to changes in channel shape, sedimentation, water quality (discussed further on), aquatic habitat integrity, and faunal communities. Reduced flow rates will also hinder fish migration.

Potentially the worst-affected macro-invertebrate taxa would be those that require moderate to fast-flowing water such as the Heptageniidae (flatheaded mayflies), Hydropsychidae (caseless caddisflies), Psephenidae (water pennies), Tricorythidae (stout crawlers) and Elmidae (riffle beetles). Six of the fish species, namely *A. uranoscopus*, *B. brevipinnis, B. argenteus, C. emarginatus*, *L. polylepis* and *V. nelspruitensis,* have preferences to clear fast-flowing shallow and deep water in rocky habitats. Four of these species, *A. uranoscopus*, *B. brevipinnis, B. argenteus* and *C. emarginatus*, are intolerant to no-flow conditions. While two of these species i.e. *L. polylepis* and *V. nelspruitensis* are moderately intolerant to no-flow conditions (**Table 4-2**). Therefore, if the flows in these systems change – these species will be lost in these rivers. This is a concern since three of these species are Near Threatened and the Mpumalanga Conservation authorities have indicated these species are of conservation importance in the area.

**Table 4-2 The sensitivity to flow of the present and expected fish species (Kleynhans *et al*. 2007)**

| | INTOLERANT TO NO-FLOW | MODERATELY INTOLERANT TO NO-FLOW | MODERATELY TOLERANT TO NO-FLOW | TOLERANT TO NO-FLOW |
|---|---|---|---|---|
| **Present fish species** | | | | |
| *A. uranoscopus*<br>Stargazer Mountain Catfish | √ | | | |
| *L. polylepis*<br>Smallscale Yellowfish | | √ | | |
| *Barbus anoplus*<br>Chubbyhead Barb | | | √ | |
| **Expected fish species** | | | | |
| *C. emarginatus**<br>Phongolo Suckermouth | √ | | | |
| *B. brevipinnis**<br>Shortfin Barb | √ | | | |
| *V. nelspruitensis**<br>Incomati Chiselmouth | | √ | | |
| *B. argenteus*<br>Rosefin Barb | √ | | | |
| *T. sparmanii*<br>Banded Tilapia | | | | √ |
| *P. philander*<br>Southern Mouthbrooder | | | | √ |
| *A. mossambica*<br>Longfin Eel | | | √ | |
| *__Conservation Important fish species__ | | | | |

<u>Flora</u>

Approximately 42% of the vegetation communities identified within the surface infrastructure footprint and 40% within the mine lease area are moisture dependant (**Sections B** and **E**). If the dewatering activities have a major effect on the wetland systems identified, these vegetation communities and the potential CI species found within these habitats will be affected and may change in structure in the long term.

Along with the large number of Protected CI species, TSP-listed species that would be affected include:

- *Gladiolus appendiculatus* (Vulnerable)
- *Alepidea peduncularis* (DDT) – located on site
- *Bowkeria citrina* (Rare)

- *Eucomis montana* (Declining)
- *Gunnera perpensa* (Declining) – located on site
- *Sandersonia aurantiaca* (Declining)

The decline in water input may also result in the loss of riparian vegetation. Riparian vegetation is a source of energy and nutrients which provides the organic matter needed to drive the stream food web and it provides cover for macro-invertebrates and fish populations (Tabacchi *et al*. 1998). The four fish species that have a high preference for overhanging vegetation include *B. anoplus, B. brevipinnis, P. philander* and *T. sparmanii* (Kleynhans et al. 2007). For the aquatic sampling sites assessed, the main impacts associated with the removal of riparian vegetation will be that of increased risk of erosion, habitat loss of aquatic species, and an increase in alien and invasive plant species.

<u>Fauna</u>

Deterioration or loss of wetland, stream and hydromorphic grassland habitat will lead to changes in the species composition of terrestrial fauna and potential loss of wetland-dependant fauna species. Four CI animal species were observed on site, which would be significantly negatively affected by the predicted drop in ground water and resulting loss of wetland, stream and/or hydromorphic grassland habitat. These species include the Vulnerable African Grass Owl (*Tyto capensis*), the Near Threatened Half-collared Kingfisher (*Alcedo semitorquata*) and Serval (*Leptailurus serval*), and the Data Deficient Swamp Musk Shrew. Desktop research indicated that a large number of potentially occurring CI faunal species may be adversely affected by local loss of these habitats.

The Critically Endangered Rough-haired Golden Mole (*Chrysospalax villosus*) is found in four restricted localities in South Africa: three in Kwa-Zulu Natal and one in Mpumalanga (Bronner 2008). The mine lease area falls within the Mpumalanga population's known area of occurrence. This species, therefore, is highly likely to occur on site, and would be severely compromised by loss of its peripheral wetland habitat (Bronner, 2008). The Vulnerable Sclater's Golden Mole (*Chlorotalpa sclateri*) would be similarly threatened. The Endangered Oribi antelope (*Ourebia ourebi*) has been recorded on nearby farms (MTPA pers. comm. 2013), and is likely to occur near larger wetlands with suitable cover on site. The potentially occurring Near Threatened Highveld Golden Mole (*Amblysomus septentrionalis*), African Marsh Rat (*Dasymys incomtus*) and Data Deficient Sloggett's Vlei Rat (*Otomys sloggetti*) could also be adversely affected by local loss or deterioration of wetlands.

The Vulnerable Grey-crowned Crane (*Balearica regulorum*) has been recorded within the pentad to the south-west of the AYCP, and is likely to make temporary foraging bouts into the study area. The potentially occurring Vulnerable Spotted Shovel-nosed Frog (*Hemisus* *guttatus*), the provincially Vulnerable Natal Cascade Frog (*Hadromophryne natalensis*), the Near Threatened Karoo Toad (*Vandijkophrynus gariepensis*), and the Rare Aurora House Snake (*Lamprophis aurora*) would also suffer from loss or deterioration of local wetlands, streams or hydromorphic grassland.

#### *4.2.2 Recommended Mitigation*

Due to the HIGH and long-term (if not irreversible) status of this impact in an area far exceeding the study area, the project should be a NO GO. Should the project go ahead, the following minimal mitigation measures are recommended:

- No water should be abstracted from boreholes CBH2D, CBH3S and CBH7S, or any other boreholes, for supplementing the water requirements of the washing plant. Dirty water collected from the plant area or from the de-watering activities should be treated and used for the water requirements of the washing plant.
- Water abstracted for de-watering should be returned to the receiving environment under the requirements of the Resource Quality Objectives or if these have not been set then the Target Water Quality Range for the protection of the receiving environment (Driver *et al.* 2011). The requirements of the Reserve Determination must also be taken into consideration in terms of volume and timing of releases. NOTE that although this recommended measure would reduce the impact of the dewatering activities on the Assegaai River, it is unlikely to reduce the impact of the de-watering activities on affected wetlands. Should it not be possible to discharge the water to the receiving environment it must be re-used in the underground workings.
- Annual monitoring of the PES and Eco-system services of the water resources on site and within all systems impacted on by the drawdown cone.
- Seal off water-bearing geological structures like faults and dykes as they are intersected in the underground workings to minimise groundwater seepage to the workings and to limit the impact of mine dewatering (WSP, 2013a).
- The guidelines for FEPAs state that FEPAs should be considered as priorities for reserve determination (Driver *et al.* 2011). It is recommended that a Rapid III Reserve Determination should be completed prior to new abstraction permits being considered for river FEPAs (Driver *et al.* 2011). A reserve determination is currently underway for the Mhlatuze River, which the Assegaai flows into. A reserve determination should therefore be undertaken for the main systems impacted on by the drawdown cone.
- It is uncertain whether the drawdown cone extends into the quaternary catchments V31A and W42A. Further investigations should be undertaken to determine the groundwater impacts within these catchments.
- The flow within the Assegaai and associated tributaries should be monitored prior to construction and during the operational phase of the mine (until the mine voids have

been filled). The minimum flow requirements, as per the above reserve determination, must be met.

- There is currently no information available on the flow rate of the fountains. It is recommended that the fountains are re-visited before mining commences to measure and record flow rates. This information is vital to determine the impact of mining on fountains in future.
- Riparian integrity of the Assegaai River and associated tributaries should be monitored by a vegetation ecologist to assess the health of the riparian vegetation and the survival of threatened and protected CI species.

## 4.3. Decline in Water Quality & Resultant Deterioration in PES & Functionality

Significance without mitigation: HIGH; Significance with mitigation: HIGH.

### *4.3.1 Impact Assessment*

The main impact on water quality is associated with the groundwater contamination due the the underground workings and seepage from the discard dump. The information on water quality and potential contamination thereof has, therefore, been largely based on the iLEH (2013) and WSP (2013a) groundwater reports, and professional experience.

The contamination of water will occur during the construction, operation, decommissioning and closure phases of the mine and will occur due to both surface and groundwater contamination. Based on the assumptions listed at the start of the IA, the main source of surface water quality contamination is:

- The unlined discard dump and coal stockpile area;
- The occasional spill or leak from machinery used during construction (minor);
- Increase in sedimentation due to erosion and dust caused by the clearing of vegetation, increased traffic on the sand roads, etc.

Impacts on groundwater quality include:

- The occasional spill or leak from machinery used during construction (minor).
- Seepage from the discard dump during the operational phase of mining. The groundwater model indicates that the plume will move in a northerly and north easterly direction with some contamination moving in a southerly and westerly direction due to dispersion and the effect of increased recharge from the discard dump. During the operational phase, sulphate concentrations of up to 650mg/l may occur in the shallow weathered aquifer in the immediate vicinity of the discard dump. Sulphate concentrations are expected to increase to above 60mg/l in the vicinity of the Mawandlane River. Sulphate concentrations exceeding 100mg/l are, however, not

expected to extend more than 300m from the discard dump during the operational phase. Post-closure sulphate concentrations in baseflow to the Mawandlane River may rise to above 2,000mg/l in the long-term.

- Potential acid mine drainage (AMD) once groundwater levels have recovered (20-50 years after mining ceases). Based on the findings of the groundwater model, possible decant points for this project, include the adit and the proposed ventilation borehole. As the position of the ventilation borehole is not yet available (WSP, 2013a) this groundwater assessment was undertaken for possible decant from the adit. If the ventilation shaft is located at a lower elevation than the adit, decant may take place from the shaft rather than the adit. AMD represents the most severe impact of coal mining on water resources. Coal is either in a sulphide form or associated with sulphide bearing strata that are linked to the formation of AMD. When sulphide minerals (especially pyrite, FeS) are exposed to water and oxygen, these oxidize to form sulphuric acid and iron. This in turn leaches other metals, and the process can lead to a high increase in salt concentrations and a decline in pH values. Oxygenated water (from rainfall or surface flow) will start the acidification process when it comes into contact with minerals, and reducing pH. This acidic water will flow in the groundwater resources and ultimately discharge into streams and rivers (Colvin *et al*. 2011). The elevated location of the mine will lead to drainage of contaminated water away from the mine. Since the proposed mine will be located in the headwaters of the Assegaai River (Usutu River Catchment) it will threaten more than one water resource and thus users located in the lower catchment. The severity of the AMD will depend on the geochemistry and mineral composition of the coal strata and the presence and abundance of sulphide-bearing materials within the location near the coal-bearing reserves. The wetter climate in the study area will also promote the mobility of the contaminants due to the fact that the water will be both the solvent and transport medium. The predicted quality of the decant is highlighted in **Table 4-3**.

**Table 4-3 Expected decant quality (iLEH, 2013)**

| PARAMETER | MOST LIKELY LONG-TERM SCENARIO | WORST CASE LONG-TERM SCENARIO |
|---|---|---|
| pH | >7 | 6 - 7 |
| $SO_4$ | < 450 mg/l | < 2,500 mg/l |

In terms of biodiversity, both fauna and flora are exposed to ground and surface water contamination as the wetlands may be fed by both the shallow weathered aquifers and the deep fractured aquifers. Any contamination within these aquifers will therefore impact on the surface water quality downstream. This contamination will impact on the PES of the wetlands and the eco-services the wetland can provide, the main one of which is the maintenance of Biodiversity.

Aquatic Ecology

According to Dallas & Day (2004) great changes in water quality (WQ) will gradually change the constituent species of aquatic biotic communities until these are no longer recognisable. The changes include:

- A shift in the physical position of a community of aquatic organisms.
- The introduction or loss of key species.
- Reduction in diversity as a result of increases in the concentration of toxins.
- Reduced ecosystem functioning.

Severe deterioration in WQ can lead to a dramatic decrease in aquatic biota and ceased aquatic ecosystem functionality.

The macro-invertebrates families that are sensitive to WQ changes are Heptageniidae, Baetidae (>2sp), Athericidae, Psephenidae, Chlorocyphidae, Leptophlebiidae Tricorythidae, Chlorolestidae and Elmidae (Thirion, 2007). If WQ changes, there will be a decrease in these macro-invertebrate families which will lead to a decrease in food supply for the fish species in these rivers. In addition, four of the fish species, namely *A. uranoscopus*, *B. argenteus, B. brevipinnis, C. emarginatus*, prefer good WQ and are intolerant to modified WQ conditions. While *V. nelspruitensis* are moderately intolerant to modified WQ (Kleynhans *et al*. 2007). Therefore, if the WQ conditions in these systems are modified – these species will be lost in these rivers.

The impacts, of increased diesel, petrol and oil leaks from machinery used on site, on the aquatic environment are summarised in **Table 4-4**. The mining activities during the operational phase will also affect the WQ in terms of AMD, low pH and elevated levels of EC, TDS, salts and coal associated metals. The impact of these constituents on the aquatic environment are summarised in **Table 4-5**. According to iLEH (2013), the sulphate concentrations in baseflow to the Mawandlane River may rise to above 2,000mg/l in the long-term. First order groundwater baseflow calculations suggest a volume of around 27m$^3$/d in the affected area. This will result in an annual salt load of approximately 20t/a to the Mawandlane River. Potentially contaminated baseflow may also enter the tributary of the Assegaai River to the north of the discard dump. The average sulphate concentration along the affected area is expected to be above 1,500mg/l in this river. Baseflow to the tributary is estimated to be around 19m$^3$/d, which could result in a salt load of some 10t/a to the tributary of the Assegaai River (iLEH, 2013). According to Kotze (2001) the ideal sulphate concentration for aquatic organisms is below 80mg/l. When sulphate concentrations are higher than 200mg/l water becomes unacceptable for human consumption (DWAF, 1996). Therefore, if the concentrations increase to 1,500mg/l in the tributary of the Assegaai and 2,000mg/l in the Mawandlane River, water will become completely inhospitable and toxic for any aquatic organisms living in these rivers.

**Table 4-4 Impacts of hydrocarbons on aquatic systems**

| WQ CONSTITUENT | DESCRIPTION & IMPACT | SIGNIFICANCE WITHOUT MITIGATION |
|---|---|---|
| Hydrocarbons | Hydrocarbons are organic compounds that are present within the oil and grease. They can cause major toxic effects on the receiving environment at relatively low concentrations (Phillips & Rainbow, 1993). Due to its lipophilic nature, they concentrate in the sediment and bioaccumulate in high concentrations in aquatic organisms. The aquatic organisms are particularly susceptible to such exposure as hydrocarbons are generally difficult to metabolise. | Moderate |

**Table 4-5 Water quality constituents indicative of coal mining, and their impacts on aquatic systems**

| WQ CONSTITUENT | DESCRIPTION & IMPACT | SIGNIFICANCE WITHOUT MITIGATION |
|---|---|---|
| Acid Mine Drainage (AMD) | The host material for coal contains pyrite (FeS) and when this is uncovered and exposed to the oxidising action of air, water and chemosynthetic bacteria it will convert the inorganic sulphur to sulphate and sulphuric acid. The ferrous iron will be oxidized and when mine the discharges it will result in acid conditions in rivers. When pH rises again, ferric hydroxide will precipitate and cause "yellow boy" on stream bottoms and any structures in the rivers. Iron can also precipitate as iron oxide and oxyhydroxides. All of these precipitates can discolour water and smother plant and animal life on the river bed. This will severely disrupt the river ecosystem and can also completely annihilate the aquatic communities (Dallas & Day, 2004; Colvin *et al*. 2011; Hedin, 2002). | Major |
| Low pH | AMD will cause a reduction in pH. Direct effects of pH changes consist of changes in the ionic and osmotic balance of individual organisms, especially in the rate and type of ion exchange across body surfaces. This will result in slow growth and reduced fecundity. Impacts of indirect pH changes include changes in the availability of toxic substances such as aluminium and ammonia (Dallas & Day, 2004; DWAF, 1996). | Major |
| Sulphate ($SO_4$) | Sulphates are not toxic. However, in excess sulphates form sulphuric acid which reduces pH and affect the aquatic ecosystems negatively. $SO_4$ are reduced to hydrogen sulphide in anoxic (oxygen-free) conditions. Hydrogen sulphide ("bad egg gas") is an indicator of reducing conditions. It is toxic and inhibits a number of enzymes important in cellular metabolism. The effects of hydrogen sulphide have been proven toxic in the laboratory but could not be quantified in the field (Dallas & Day, 2004). In addition, the high sulphate content in the water has the capacity to leach heavy metals should they come into contact with any of the minerals or rock formations (Colvin *et al*. 2011) causing increased metal concentrations. | Major |
| EC, TDS and | These increased sulphates caused by coal mining will lead to salinisation | Major |

| WQ CONSTITUENT | DESCRIPTION & IMPACT | SIGNIFICANCE WITHOUT MITIGATION |
|---|---|---|
| salinity | due to increased concentrations of the ions (Dallas & Day, 2004; Colvin *et al*. 2011; Rikard & Kunkle, 1990). Increased EC, TDS and salinity concentrations will be due to the increased concentrations of the ions and salts, namely $Ca^{2+}$, $Mg^{2+}$, $Na^{+}$, $NO_3^{-}$ and $Cl^{-}$. Each species have a specific tolerance to these constituents and elevated levels will lead to a loss of sensitive species (Dallas & Day, 2004; James *et al*. 2003). | |
| Iron (Fe) | Fe is associated with AMD. Fe is toxic at high concentrations and inhibits various enzymes. Fe compounds are easily oxidizes and high concentrations can result in acidic conditions and oxygen depletion in the rivers and streams (DWAF, 1996). | Major |
| Aluminium (Al) | Al is one of the more toxic metals within a water ecosystem and is associated with numerous biochemical effects on aquatic biota. Al is toxic and interferes with the ionic and osmotic balance in fish. This results in respiratory problems due to the coagulation of mucus on the gills. Al also hinder Ca metabolism and change the functioning of the Ca regulating protein, calmodulin. In addition, Al interferes with ion exchange sites, especially those involved with sodium homeostasis. This in turn may lead to neuromuscular dysfunction in fish (Colvin *et al*. 2011; Dallas & Day, 2004; DWAF, 1996). | Major |
| Cadmium (Cd) | Cd normally accumulates in the plants and soil. Therefore, macroinvertebrates that live in and are associated with the sediment biotope i.e. earthworms and bivalves will be heavily affected. Cd can influence the whole soil process and may be a threat to the whole soil ecosystems. Cd can also accumulate in mussels, shrimps and fish (Lenntech, 2012). In addition, Cd inhibits aquatic plant growth which affects the whole will affect the whole food chain. Cd can also lead to skeletal deformities and impair function of kidneys in fish. In crustaceans, Cd causes cellular damage and affects both the digestive and metabolic functions (Solomon, 2008). | Moderate |
| Chromium (Cr) | In natural water, Cr occurs in three oxidation states of which $Cr^{6+}$ are the most toxic. Macroinvertebrates are usually more sensitive to Cr than fish. For example, Cr only temporary reduces growth in juvenile fish. In addition, water hardness and pH affects the toxicity of Cr. Therefore, when water hardness and pH increase the toxicity of Cr will decrease (DWAF, 1996; Dallas & Day, 2004). | Minor |
| Cobalt (Co) | Co is toxic in small quantities. The insoluble inorganic compounds are carcinogenic and the soluble compounds are toxic, inhibiting and stimulating different enzymes (Dallas & Day, 2004). | Moderate |
| Copper (Cu) | Cu is a micronutrient, forming an essential part of cytochrome oxidase and various other enzymes involved in redox reactions in the cell. It is toxic at low doses, but its toxicity is reduced in the presence of Zn, molybdenum and sulphate ($SO_4$). It is mobile and soluble at low pH, but precipitates in alkaline conditions becoming non-toxic (DWAF 1996; Dallas and Day 2004). | Moderate |

| WQ CONSTITUENT | DESCRIPTION & IMPACT | SIGNIFICANCE WITHOUT MITIGATION |
|---|---|---|
| Manganese (Mn) | Mn is toxic in high concentrations that may lead to disturbances in various metabolic pathways, in particular disturbances of the central nervous system caused by the inhibition of the formation of the neurotransmitter dopamine (DWAF, 1996). | Major |
| Nickel (Ni) | Ni is toxic in small quantities. It inhibits cytochrome oxidase and various enzymes and can be carcinogenic in mammals (Dallas & Day, 2004). | Moderate |
| Lead (Pb) | Pb is a trace metal that accumulates in living tissues and bone. Pb interferes with haeme synthesis, an essential portion of the haemoglobin molecule (blood). It affects membrane permeability, displacing Ca and inhibits enzymes involve in energy metabolism. In addition, it reduces immune responses (DWAF, 1996; Dallas & Day, 2004). | Moderate |
| Zinc (Zn) | Zn is a trace metal which is also an essential micronutrient in all organisms. In aquatic ecosystems the $Zn^{2+}$ ion is dangerous to aquatic organisms and fish at relative low concentrations. Death can be caused by severe imbalances, while marginal imbalances contribute to reduced fitness. Sub-lethal concentrations at which toxic effects are evident depend on the concentration ratio of zinc to copper, because zinc interferes with copper absorption. Observed symptoms include depressed white blood cell-thrombocyte counts. The observed effects of prolonged exposure to sub-lethal concentrations of zinc in fish fry caused oedema and liver necrosis. The lethal effect of zinc on fish is considered to be from the formation of insoluble compounds in the mucus covering the gills (DWAF, 1996). | Moderate |

**Flora**

A decline in water quality in the downstream water resources, including wetlands, may result in a change in vegetation structure and composition, as described for the previous impact.

**Fauna**

Terrestrial fauna may be exposed to contaminated surface water resources due to the unconfined nature of the deep fractured aquifer. Impacts of this contamination on faunal species can include aspects such as a decline in general health, reduction in fecundity rates and birth defects.

Two potentially occurring CI species in particular may be adversely affected by changes in water quality: the provincially Vulnerable Natal Cascade Frog (*Hadromophryne natalensis*) and the nationally Near Threatened Plain Stream Frog (*Strongylopus wageri*). Although the presence of either species could not be confirmed on site, suitable habitat exists and both have been recorded within the QDSs wherein the AYCP is situated. Both frog species are highly dependent on cool, clear, fast-flowing, rocky mountain streams.

The predicted increased sulphate and heavy metal concentrations as well as the increase in turbidity and sedimentation will adversely affect these and other frog species. Increased sulphate concentrations will result in the waters becoming more acidic while high metal concentrations often associated with coal mining are known to damage amphibian DNA resulting in deformations (Zocche *et al*. 2013). Increased TDS (a measure of turbidity) would decrease the clarity of water. These alterations in water quality would affect not only the two potentially occurring CI frog species, but a much wider spectrum of faunal taxa that utilize streams and wetlands, as described for the previous impact.

#### *4.3.2 Recommended Mitigation*

The current groundwater and surface quality within the region of the study area is good (iLEH, 2013). Based on the predicted groundwater plume, and the surface water resources, the receiving environment for any surface or groundwater contamination is the Assegaai River. This river is a FEPA river. The NFEPA guidelines state that water quality must support keeping wetland FEPAs in good condition (equivalent to an A or B ecological category) for those currently in a good condition, or best attainable ecological category for those not in good condition (equivalent to C or lower; Driver *et al.* 2011). Assuming the assumptions made at the start of the IA are correct, the following mitigation measures must be implemented as a minimum:

- Any activity impacting on a watercourse, or associated buffer, should only occur after authorisation by the relevant authorities.
- Construct an ENGINEERED lining for the base of the discard dump and coal stockpile to prohibit infiltration of contaminated water to the underlying aquifers during the operational phase. A less preferable alternative option would be to compact the base of the discard facility to minimize infiltration of poor quality water to the underlying aquifers during the operational phase. Toe drains should be installed to remove discard seepage and reduce the volume available for infiltration to the aquifers. Do not dump waste of any nature, or any foreign material into any watercourse or associated buffer.
- Regularly check vehicles, machinery and equipment operating on site to ensure that none have leaks or cause spills of oil, diesel, grease or hydraulic fluid.
- No untreated water should enter the receiving environment. Water released into the receiving environment must comply to the Resource Quality Objectives or if these have not been set then the Target Water Quality Range for the protection of the receiving environment (Driver *et al.* 2011).
- Prevent dirty water runoff from leaving the general mining area. This will be achieved with a cut-off trench around the adit, plant and discard facility.
- The plant area must be paved to prevent contaminated seepage from the stockpiles and coal washing areas to the underlying aquifers.

- The adit must be sealed during the decommissioning phase using sound engineering principles to prevent decant.
- A number of limitations were placed on the number of aquatic sampling points allocated for the baseline assessment. Additional sampling points for the future long-term monitoring of the area are therefore recommended. These monitoring points are highlighted in **Figure 4-6,** and have been based on the expected groundwater contamination plume as highlighted by WSP (2013). The following bio-monitoring programmes are recommended:
  - Water quality should be monitored monthly at the sampling sites highlighted in **Figure 4-6** . This ensures that water monitoring takes place downstream of any potential point of contamination. These water quality results should be compared against the baseline data and TWQR, annually incorporated and interpreted in order to determine trends and identify possible sources of acute and chronic contamination. It is highly recommended that the following water quality constituents should be monitored:
    - pH, EC, TDS, DO;
    - salts (SO4, Mg, Na and Cl);
    - As, Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn (coal mining associated constituents); and
    - SS, turbidity, nutrients, organic enrichment, algal presence and eutrophication should be monitored.
  - If significant changes occur in water quality, the cause must be investigated and rectified immediately.
  - Diatoms are also a good indicator of water quality conditions and could be used in addition to water quality.
  - The bio-monitoring of the habitat, macro-invertebrate and fish communities should be determined bi-annually.
  - The habitat, diatoms and biodiversity of the macro-invertebrate and fish communities should be determined bi-annually at any non-flowing sites.
- Additional monitoring includes surface and groundwater monitoring. Refer to the specific specialist studies for these monitoring programmes.

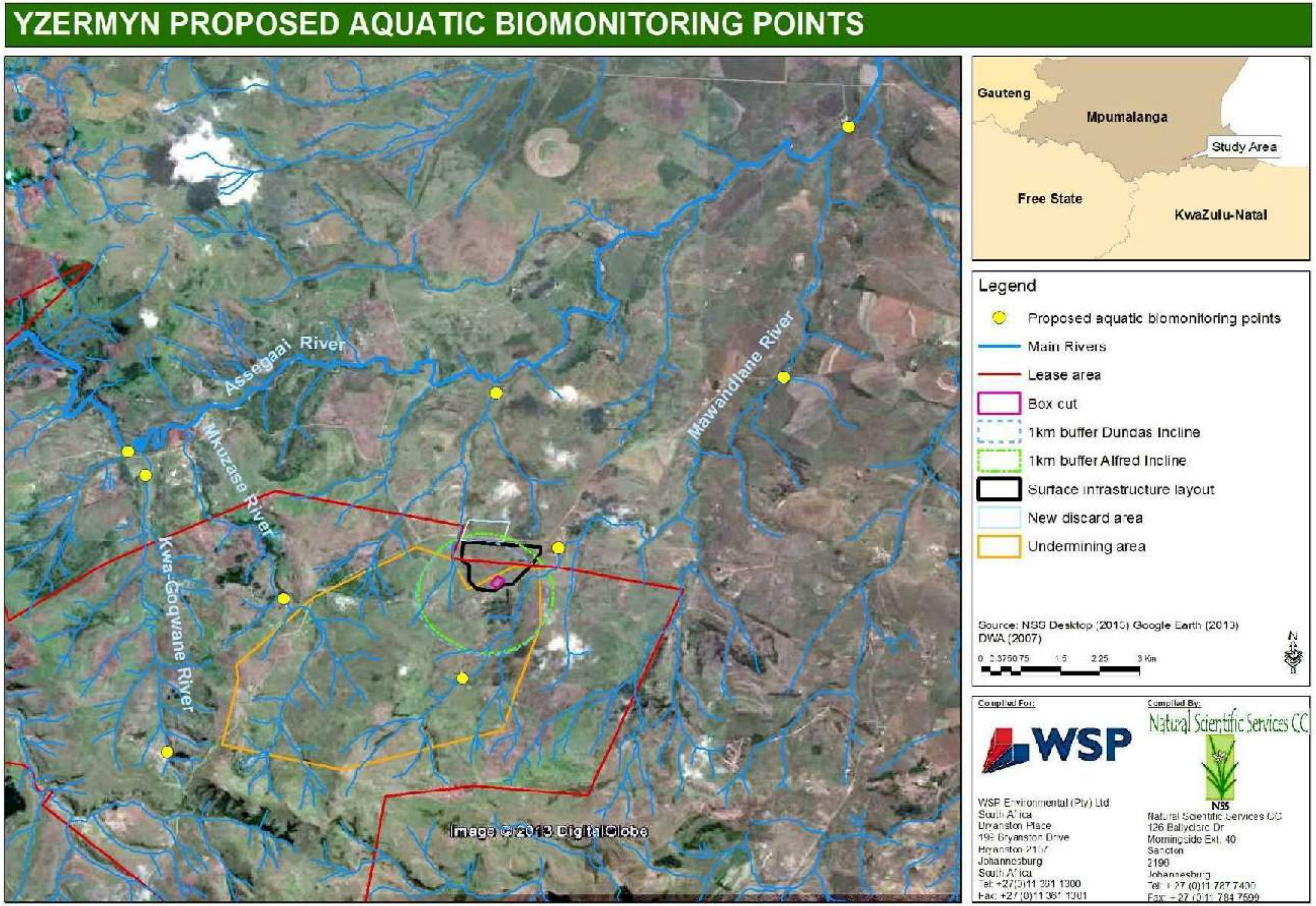


**Figure 4-6** Proposed aquatic bio-monitoring points

## 4.4. Alien Species Invasion & Resultant Impacts on Biodiversity

Significance without mitigation: MEDIUM-HIGH; Significance with mitigation: LOW-MEDIUM.

### *4.4.1 Impact Assessment*

Alien plant species were found in varying degrees within the proposed surface infrastructure area, and included *Acacia mearnsii* (Black Wattle), *Acacia melanoxylon*, *Eucalyptus* and *Populus* species. There was a predominance of alien flora in the seeps associated with System 2. It is possible that these clumps were intentionally planted to provide a source of fuel wood for local communities. The remainder of the site, however, is relatively free from alien invasive plants. No alien animal species such as the Common Myna (*Acridotheres tristis*) and House Sparrow (*Passer domesticus*), were detected within the AYCP study area

New and existing alien species invasions are likely to be facilitated, especially during the construction of infrastructure, when people, vehicles, and building materials are brought onto site, and vegetation and soils are disturbed. Increased vehicle traffic on the local road network will also contribute to the introduction and spread of alien invasive taxa. Invasive species can negatively impact Biodiversity by:

- Spreading disease and parasites (e.g. the Black Rat, *Rattus rattus*).
- Displacing indigenous, including CI, species.
- Transforming (i.e. degrading and fragmenting) terrestrial and aquatic habitat.
- Altering eco-system functioning and services.

### *4.4.2 Recommended Mitigation*

An Alien and Invasive Management Plan should be developed for the proposed mining project. A detailed 'on-the-ground' assessment of alien species within the greater study area, their density and distributions should form the baseline. Furthermore, stakeholder engagement strategies should be included into the planning phase of the programme. By ensuring that effective consultation takes place with local communities and all affected parties, any potential misunderstandings (if communities are utilising species such as *Acacia mearnsii* for firewood etc.) and disagreements can be resolved or accommodated in advance.

Preventing the introduction of alien invasive species is the cheapest, most effective and most preferred option and warrants the highest priority. Furthermore the following is recommended:

- Rehabilitation materials should be sourced from reliable suppliers that can certify the absence of weed specimens in their materials.
- The EO and staff in general should be made aware of existing and potentially occurring alien species on site. If any alien species are seen emerging, the EO on site must be able to identify and remove these.

- The intentional introduction of an alien plant species should not be considered for any screening effects, landscaping etc. Indigenous alternatives should be considered suitable for the purposes for which the introduction is required.
- No alien plant species or domestic animals such as dogs and cats should be allowed into the construction camps.

## 4.5. Increased Erosion & Sedimentation & Resultant Impacts on Biodiversity

Significance without mitigation: MEDIUM-HIGH; Significance with mitigation: LOW-MEDIUM.

### *4.5.1 Impact Assessment*

Erosion in the study area is currently limited to roads, cattle paths and some alien-infested areas (**Section E**), but sediment loads were low within the sampled aquatic systems. Increased traffic for the proposed mining project, especially at watercourse crossings on the dirt roads, is likely to cause significant erosion and increased sedimentation of aquatic systems. Dust, erosion and sedimentation are likely to be most severe during the construction phase when there is clearing of vegetation, sudden increased traffic on the roads, storage of topsoil, digging of foundations, blasting of shafts, etc.

Flora

Increased erosion will ultimately result in a change in plant species composition with a reduced water input into the wetland areas.

Fauna

Increased erosion could impact on terrestrial faunal communities through transformation (degradation) of grassland, wetland and riverine habitat.

Aquatic Ecology

According to Long *et al.* (1998), increased suspended sediment concentrations have the ability to impact on river size, flow volume, bed material and sedimentation rate. These can cause changes in in-stream conditions, loss of available habitat types downstream, and fragmentation of the general system. This in turn may result in population isolation, failed migration during flow events, increased crowding in available pools, increased competition, and local extinction of aquatic species. The impacts of increased sedimentation on aquatic systems are summarised in **Table 4-6**. Fish species that require clear water such as *A. uranoscopus*, *B. argenteus*, *B. brevipinnis*, *C. emarginatus* and *V. nelspruitensis*, would be severely negatively affected by increased sedimentation in local systems.

**Table 4-6 Impacts of sedimentation on aquatic systems**

| WQ CONSTITUENT | DESCRIPTION & IMPACT |
|---|---|
| Suspended Solids (SS) and Turbidity | The light penetration is affected by the increase in SS. When the light penetration is reduced it will lead to decreases in primary production and food availability will diminish for organisms in the food chain. Benthic invertebrates will be affected because it changes the suitability of the substrate for some taxa, increase drift, affects respiration and feeding activities. Fish can be affected by having physiological effects (impairment of gill function or reduced resistance to disease), reduction in spawning habitat development hindering, change in migration patterns, reduction in food and intervention with hunting (Dallas & Day, 2004). |

### *4.5.2 Recommended Mitigation*

- Compile and implement a Soil Management Plan. The Plan should address the identification of high-risk erosion areas, the rehabilitation of areas (should erosion occur), and the monitoring of erosion throughout the life of the project. The Plan must also incorporate the use of indigenous vegetation suitable to the area for rehabilitation purposes.
- Adequate dust control strategies should be implemented to minimise dust, erosion, deposition and sedimentation. Measures include road-wetting, and vegetating exposed areas as soon as possible, etc.

## 4.6. Sensory Disturbance of Fauna

Significance without mitigation: MEDIUM-HIGH; Significance with mitigation: LOW-MEDIUM.

### *4.6.1 Impact Assessment*

Increased traffic, human activity, noise, vibration and lighting from mining operations will disturb a wide spectrum of fauna and may eliminate certain CI animal species from the area. This is because animals generally have well-developed senses. Highly-sensitive animals may be frightened or disorientated by loud noises, bright lights, etc., and many animals feel threatened by humans. Some species may struggle to communicate if their calls or other behavioural displays cannot be seen or heard by conspecifics.

Of particular concern is the potential impact of noise and vibrations from surface and underground activities (such as blasting) on bats in the old mine adits. The two largest adits are situated 315-335m outside the proposed surface infrastructure layout, and 180-300m outside the proposed underground mining area. The old adits provide significant roosting habitat for the Endangered Swinny's Horseshoe Bat (*Rhinolophus swinnyi*), a large population of the Near Threatened Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*), and the Near Threatened Temminck's Hairy Bat (*Myotis tricolor*) and Natal Clinging Bat (*Miniopterus natalensis*).

In the absence of information that might suggest otherwise, this should be treated as a valid concern given that:

- Bats have exceptionally well-developed sensory systems, and cave-dwelling species are usually highly sensitive to disturbance of their normally dark and quiet roosting habitat (Monadjem *et al.* 2010).
- The Noise Assessment for the AYCP (Collett 2013) indicated that blasting will occur on a daily basis (Collett 2013), and certain operations will continue on a 24 hour basis. During construction and operation, "The highest noise levels are predicted at FH 04," which is 315-415m from the two largest old mine adits. Moreover, during operation, cumulative noise levels are predicted to exceed the SANS (South African National Standards) daytime and nightime guidelines at FH 04 and other locations in the study area.
- The old mine adits could cause vibrations and noise from surface and underground activities to resonate or amplify.

Several CI bird species, which have been recorded in the study area, are known to be intolerant of human and vehicle activity (DEC pers. comm., 2013). Due to noise and dust from the proposed mining surface activities and traffic, in particular, these species would likely avoid a wide radius of otherwise suitable habitat around the surface infrastructure footprint and road network for the life of the Mine. Confirmed species most likely to be impacted include the Vulnerable White-bellied Korhaan (*Eupodotis senegalensis*), and the Near Threatened Black-bellied Bustard (*Lissotis melanogaster*) and Secretary Bird (*Sagittarius serpentarius*). Other species not detected on site that could be affected include the Vulnerable Blue- and Grey-crowned Cranes (*Anthropoides paradiseus* and *Balearica regulorum*).

Lighting at night could negatively affect sensitive nocturnal fauna. Some species may return to the area after the mine has closed, but this is likely to be a slow process that may not see a return of the full spectrum of species once present.

#### *4.6.2 Recommended Mitigation*

- A minimum No Go 500m underground buffer must be maintained around the two large, old adits where at least four CI bat species are roosting.
- The site could be screened using indigenous plants to create hedging. Alien and invasive plants must not be used.
- Noise and lighting on site should be minimized as far as possible.

# 5. Cumulative Impacts

Within the greater southern Mpumalanga study region there are currently numerous applications for mining (**Figure 5-1**; MTPA pers. comm. 2013). If a significant portion of these applications are approved, the combined impacts of mining, afforestation and agriculture will have a massive deleterious impact on Biodiversity at provincial and national levels. Potential cumulative impacts of anthropogenic land use in the region would include:

- Water, air, noise and light pollution.
- Reduction and deterioration of regional groundwater.
- Deterioration and loss of wetland habitat, species, ecosystem functioning and services.
- Deterioration of aquatic habitat, species, ecosystem functioning and services.
- Increased erosion, sedimentation and invasion of alien species.
- Loss and deterioration of threatened terrestrial floral communities, vegetation types, ecosystem functioning, services and faunal habitats.
- Reduction in the richness and abundance of floral and faunal species, and extirpation of locally restricted populations or species.

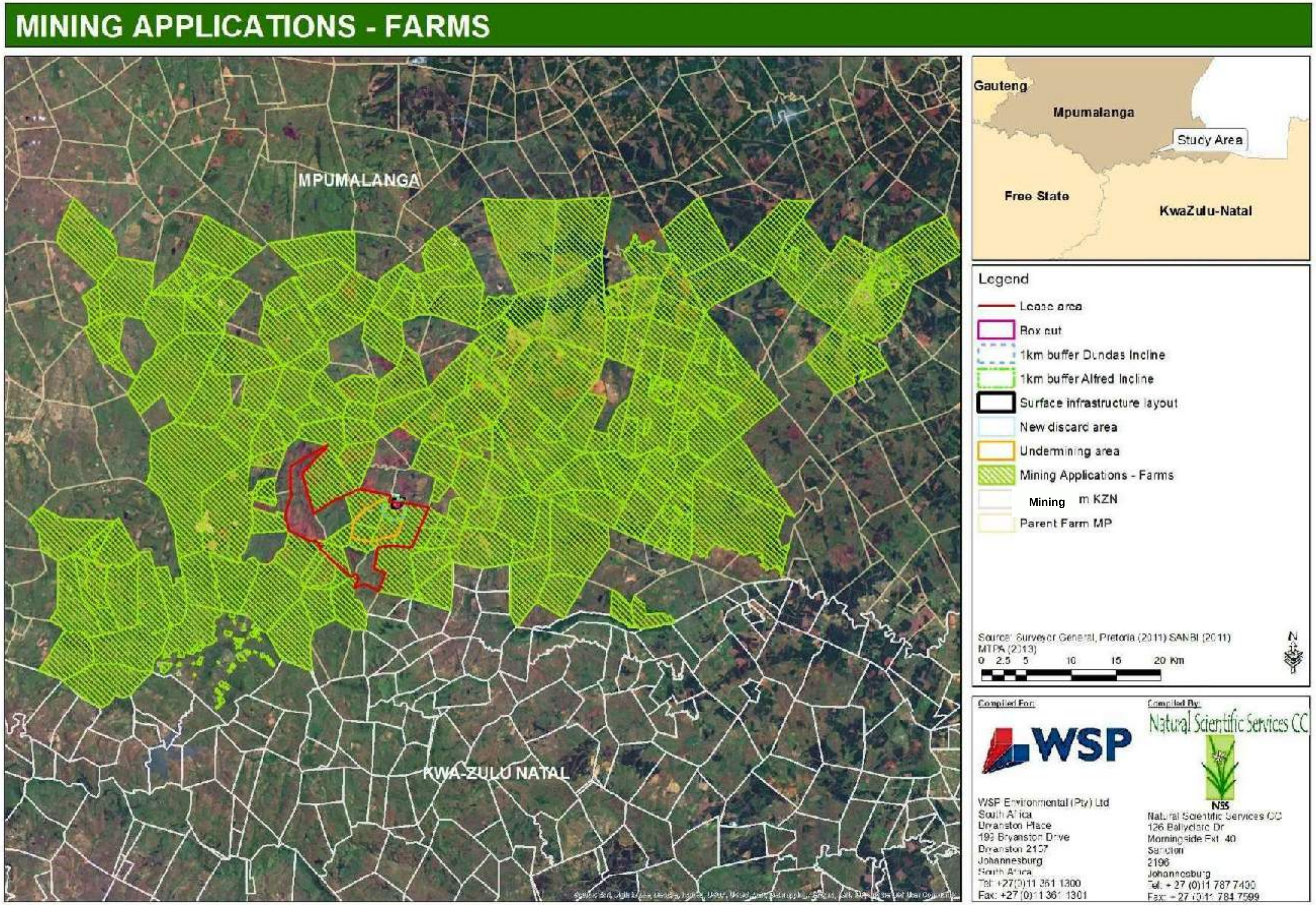


**Figure 5-1** **Farms included by mining applications in the study region**

# 6. Conclusion

The combined Baseline and Impact Assessments indicate that the AYCP is fatally flawed, and should be NO GO in terms of Biodiversity. This is largely because of the impact of the proposed underground mining on the supply of water to the surface water resources (due to the de-watering activities) and the potential groundwater contamination. These aspects will have a significant impact on aquatic and wetland ecosystem functioning and biodiversity in a far greater area than the underground mining area. These and other aspects of the mining project are in strong conflict with international, national and provincial legislation, policies and guidelines. A high number of CI species were detected, and most habitat in the proposed underground mining and surface infrastructure areas was assigned a Very High or High sensitivity. Most potential impacts of the mining operation had a HIGH overall significance rating, even with mitigation. Moreover, the cumulative impacts of numerous mining applications in the study region are of serious concern.

This is partly why large areas in the study region are currently, or are proposed to be, set aside for Biodiversity conservation under the:

- National Water Act (Act 36 of 1998);
- National Mining and Biodiversity Guideline;
- NSBA terrestrial Priority Areas and Threatened Ecosystems;
- NFEPA Freshwater Ecosystem Priority Areas;
- National Vegetation Unit Status Classifications;
- SANBI Grasslands Programme;
- Enkangala Grassland Biosphere Reserve and IBA;
- Mpumalanga Biodiversity Sector Plan;
- Wakkerstroom Section 49 application by the MTPA;
- Kwamandhlangampisi Protected Environment; and
- Proposed Mabola Protected Environment, among others.

Even though NSS recommends that the project is a NO GO from a Biodiversity perspective, mitigation measures have been discussed should the project go ahead.

# SECTION H: REFERENCES

AGIS, 2010. www.agis.agric.za. Agricultural Geo-Referenced Information System – land type data.

ALEXANDER, G., 2009. Assessment of the Herpetofauna of the Rietvlei and Bronberg areas and the Impact of the Proposed Water Pipeline.

ALEXANDER, G., & MARAIS, J., 2009. A guide to the reptiles of southern Africa. Struik Publishers, Cape Town.

BARBOUR, M.T., GERRITSEN, J., SNYDER, B.D., AND STRIBLING, J.B., 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, (Second Edition). EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington D.C.

BARNES, K.N., (Ed). 1998. The Important Bird Areas of southern Africa. Birdlife South Africa, Johannesburg.

BARNES, K.N., (Ed). 2000. The Eskom Red data Book of Birds of South Africa, Lesotho & Swaziland. Birdlife South Africa, Johannesburg.

BIRDLIFE website: www.birdlife.org Accessed: 2012 & 2013.

BRANCH, B., 1998. Field Guide to Snakes and Other Reptiles of Southern Africa. Struik Publishers, Cape Town.

BRONNER, G. 2008. *Chrysospalax villosus*. In: IUCN 2013. The IUCN Red List of Threatened Species (2013.1). www.iucnredlist.org. Accessed August 2013.

BUNN, S.E., & ARTHINGTON, A. H., 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. *Environmental Management*, 30(4):492–507.

CAMPBELL, H.W., & CHRISTMAN, S.P., 1982. Field Techniques for Herpetofaunal Community Analysis. In SCOTT, N.J., Jr. (ed). Wildlife Research Report 13, US Dept. of the Interior and Wildlife Services.

COLVIN, C., BURNS, A., SCHATSCHNEIDER, K., MAHERRY, A., CHARMIER, J., & DE WIT, M., 2011. WWF Report. www.wwf.org.za. Coal and Water Features in South Africa.

COWLING, R.M., RICHARDSON, D.M., & PIERCE, S.M., (Eds). 1997. Vegetation of Southern Africa. Cambridge University Press, Cambridge.

HILTON-TAYLOR C. 1996. Red Data List of southern African plants. Strelitzia 4. National Botanical Institute, Pretoria, South Africa.

DALLAS, H.F., & DAY, J.A., 2004. The effect of water quality variables on Aquatic Ecosystems: A Review. WRC Report No. TT 224/04. Water Research Commission. Pretoria, South Africa.

DALLAS, H.F., 2000. The derivation of ecological reference conditions for riverine macroinvertebrates. Institute for water quality studies. Department of Water Affairs and Forestry. Pretoria, South Africa.

DALLAS, H.F., 2005. River Health Programme: Site characterisation field-manual and field-data sheets. Resource quality services. Department of Water Affairs and Forestry. Pretoria, South Africa.

DALLAS, H.F., 2007. River Health Programme: South African Scoring System (SASS) Data Interpretation Guidelines. The Freshwater Consulting Group/Freshwater Research Unit. University of Cape Town. Prepared for Institute of Natural Resources and the Department of Water Affairs and Forestry.

DAVIS, S.D., DROOP, S.J.M., GREGERSON, P., HENSON, L., LEON, C.J., VILA-LOBOS, J.L., SYNGE, H., & ZANTOVSKA, J., 1986. Plants in Danger: What do we know? IUCN, Gland.

DE MOOR, I.J., DAY, J.A., & DE MOOR, F.C., 2003. Guides to the freshwater invertebrates of Southern Africa. *Insecta II*. Volume 8: WRC Report No. TT 214/03. Water Research Commission. Pretoria, South Africa.

DEA, (DEPARTMENT OF ENVIRONMENTAL AFFAIRS), DMR (DEPARTMENT OF MINERAL RESOURCES), CoM (CHAMBER OF MINES), SAMBF (SOUTH AFRICAN MINING & BIODIVERSITY FORUM) & SANBI (SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE) 2013. Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Pretoria.

DEAT, (DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM) 2005. South Africa's National Biodiversity Strategy and Action Plan. Department of Environmental Affairs and Tourism, Pretoria.

DESMET, P., GOODMAN, P., HARRIS, J., JONAS, Z., REYERS, B., SINK, K., & STRAUSS, T., 2005. National Spatial Biodiversity Assessment 2004: Priorities for Biodiversity Conservation in South Africa. *Strelitzia* 17. South African National Biodiversity Institute, Pretoria

DICKENS, C.W.S., & GRAHAM, P.M., 2002: The South African Scoring System (SASS), version 5, rapid bioassessment methods for rivers, *African Journal of Aquatic Science*, 27, 1 – 10.

DRIVER, A., MAZE, K., LOMBARD, A.T., NEL, J., ROUGET, M., TURPIE, J.K., 2004. South African National Spatial Biodiversity Assessment Summary Report.

DRIVER, A., NEL, J.L., SNADDON, K., MURRAY, K., ROUX, D.J., HILL, L., SWARTZ, E.R., MANUEL, J., & FUNKE, N., 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Water Research Commission Report. Pretoria.

DRIVER, A., NEL, J.L., SNADDON, K., MURRAY, K., ROUX, D.J., HILL, L., SWARTZ, E.R., MANUEL, J., & FUNKE, N., 2011. Implementation Manual for Freshwater Ecosystem Priority Areas, WRC.

DU PREEZ, L., & CARRUTHERS, V., 2009. A Complete Guide to the Frogs of Southern Africa. Struik Nature, Cape Town.

DWAF, (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) 1996. South African Water Quality Guidelines, Volume 7: Aquatic Ecosystems. Department of Water Affairs and Forestry. Pretoria, South Africa.

DWAF, (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) 1996b. South African Water Quality Guidelines, Volume 8: Field guide. Department of Water Affairs and Forestry. Pretoria, South Africa.

DWAF, (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) 1999. (Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0 by H. MacKay, A. Duthie, M. de Lange, Department of Water Affairs and Forestry, Pretoria.

DWAF, (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) 2005. Environmental Best Practice Guidelines: Planning. *Integrated Environmental Management Sub-Series* No. IEMS 1.6. (Third Edition). Pretoria, South Africa

EKZN, (EZEMVELO KWAZULU-NATAL WILDLIFE). 2010b. Biodiversity Impact Assessment Handbook for KwaZulu-Natal, Beach, Bush & Berg. Final Draft, July 2010.

ENGELBRECHT, J., BILLS, R., & CAMBRAY, J., 2007. *Varicorhinus nelspruitensis*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. www.iucnredlist.org. Downloaded on 01 May 2012.

EUROBATS. http://www.eurobats.org

FERRAR, T.A., & LÖTTER, M.C., 2007. Mpumalanga Biodiversity Conservation Plan. Mpumalanga Tourism and Parks Agency.

FILMER, M.R., 1995. Southern African spiders. An identification guide. Struik Publishers, Cape Town.

– Final Report. http://www.sanbi.org/. Accessed September 2006

FRIEDMANN, Y., & DALY, B., (eds). 2004. Red Data Book of the Mammals of South Africa: a conservation assessment. CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa.

GAMMETER, S., & FRUTIGER, A., 1990. Short-term toxicity of ammonia and low oxygen to benthic macroinvertebrates of running waters and conclusions for wet weather water pollution control measures. *Water Science and Technology,* 22:291–296.

GDARD, (GAUTENG DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT) 2012. Requirements for Biodiversity Assessments, Version 2. GDARD, Johannesburg.

GDARD, (GAUTENG DEPARTMENT OF AGRICULTURE AND RESOURCE DEVELOPMENT) 2012. Minimum Requirements for Biodiversity Assessments Version 2. Directorate Nature Conservation, Johannesburg

GERMISHUIZEN, G., & MEYER, N.L., (eds.). 2003. Plants of Southern Africa: An annotated checklist. Strelitzia 17, SANBI, Pretoria.

GOOGLE EARTH, 2013. www.google.com/earth. Google Earth (6.0) satellite imagery of the study area. Accessed July 2013.

GOOGLE EARTH., 2011. www.google.com/earth. Google Earth (6.0) satellite imagery of the study area. Accessed 2011.

HART, B.T., ANGEHRN-BETTINAZZI, C., CAMBELL, I.C., & JONES, M.J., 1992. Australian water quality guidelines. Australian & New Zealand Environmental & Conservation Council.

HEDIN, R.S., 2002. Recovery of marketable iron oxide from mine drainage. National Meeting of the American Society of Mining and Reclamation (ASMR). ASMR, Lexington, America. http://www.hedinenv.com/pdf/Recovery%20of%20Marketable%20Iron%20Oxide%20from%20Mine%20Drainage.pdf

HENNING, G.A., TERBLANCHE, R.F., & BALL, J.B., (eds) 2009. South African Red Data Book: Butterflies. SANBI Biodiversity Series 13. South African National Biodiversity Institute, Pretoria.

HILL, M.O. 1979. TWINSPAN. A Fortran Program for Arranging Multivariate Data in an Ordered Two-way Analysis. Cornell University, Ithaca, NY

HILTON-TAYLOR, C., 1996. Red Data List of Southern African plants. *Strelitzia 4*. National Botanical Institute, Pretoria.

HOCKEY, P.A.R., DEAN, W.R.J., RYAN, P.G., (eds.) 2005. Roberts – Birds of Southern Africa VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

HURFORD, & SCHNEIDER., 2007. Monitoring Nature Conservation in Cultural Habitats: A Practical Guide and Case Studies. Springer. Netherlands.

ILEH, 2013. Ysermyn Underground Coal Mine: Numerical Groundwater Model: Draft Report. July 2013 iLEH-WSPYSE 06-13. Accessed July 2013.

IUCN (INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES) 2012. IUCN Red List Categories and Criteria: Version 3.1. IUCN, Gland, Switzerland.

IUCN 2013. The IUCN Red List of Threatened Species (2013.1). www.iucnredlist.org. Accessed July 2013.

JAMES, K.R., CANT, B., & RYAN, T., 2003. Responses of freshwater biota to rising salinity levels and implications for saline water management: a review. Australian Journal of botany, 51:703–713.

JOHNSON, S., & STARKE, L., (eds.) 2006. ICMM, (INTERNATIONAL COUNCIL ON MINING AND METALS). Good Practice Guidance for Mining and Biodiversity. London, UK.

KARR, J.R., 1981. Assessment of biotic integrity using fish communities. Fisheries 66: 21-27

KLEYNHANS, C.J., & LOUW, M.D., 2007. Module A: EcoClassification and Ecostatus determination in River EcoClassification: Manual for ecostatus determination (Version 2). Pretoria, South Africa: Joint Water Research Commission and the Department of Water Affairs and Forestry. Pretoria, South Africa.

KLEYNHANS C. J. & LOUW M. D., 2008. Module A: EcoClassification and Ecostatus determination in River EcoClassification: Mannual for ecostatus determination (version 2). Pretoria, South Africa: Joint Water Research Commission and the Department of Water Affairs and Forestry.

KLEYNHANS, C.J., 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo system, South Africa). *Journal of Aquatic Ecosystem Health 5*: 41-54.

KLEYNHANS, C.J., 1997. Threatened fishes of the world: *Chiloglanis emarginatus* (Jubb & Le Roux, 1969) (*Mochokidae*). *Environmental Biology of Fishes,* 49:206.

KLEYNHANS, C.J., 1999. The development of a fish index to assess the biological integrity of South African rivers. *Water SA* 25: 265-278

KLEYNHANS, C.J., 2008. River Eco Classification manual for ecostatus determination (version 2) Module D: Volume 1, Fish Response Assessment Index (FRAI). Pretoria, South Africa: Water Research Commission no TT 330/08.

KLEYNHANS, C.J., LOUW, M.D., & MOOLMAN, J., 2008. Reference frequency of occurrence of fish species in South Africa. Pretoria. DWA and WRC Report no. TT 331/08. Department of Water Affairs and Forestry. Water Research Commission. Pretoria, South Africa.

KNNCS, (KWAZULU NATAL NATURE CONSERVATION SERVICES). 1999. Nomination Proposal for the Drakensberg Park alternatively known as Ukhahlamba Park to be listed as a World Heritage Site. Kwazulu-Natal Nature Conservation Service. Amafa Akwazulu Natali - Heritage Kwazulu Natal

KOTZE, P. 2001. The Ecological Integrity of the Klip River (Gauteng) and the development of a Sensitivity-Weighted Fish Index of Biotix Integrity (SIBI). PhD thesis. Rand Afrikaans University. Johannesburg. South Africa.

KOTZE, D.C., MARNEWECK, G.C, BATCHELOR, A.L., LINDLEY, D.S., & COLLINS, N.B., 2008. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08, Water Research Commission, Pretoria.

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S., & COLLINS, N.B., 2007. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08, Water Research Commission, Pretoria

KUNTONEN-VAN'T RIET., 2007. Strategic Review of the Status of Biodiversity Management in the South African Mining Industry. This report was prepared at the request of the South African Mining and Biodiversity Forum, the Chamber of Mines of South Africa and the World Conservation Union (IUCN) South African Office. Matrix+ Consulting (Pty) Ltd.

LEEMING, J., 2003. Scorpions of Southern Africa. Struik Publishers, Cape Town.

LENNTECH, 2012. (website). Technical University of Delft, Netherlands. http://www.lenntech.com/periodic/elements/cd.htm

LONG, R.F., SIMPSON, T., DING, T., *et al*. 1998. Bats feed on crop pests in Sacramento Valley. *Cal Ag 52(1)*:8–10.

LOTTER, M., 2013. Mpumalanga Biodiversity Sector Plan. Mpumalanga Tourism and Parks Agency.

LOW, A.B., & REBELO, A.G., (Eds.) 1996. Vegetation of South Africa, Lesotho and Swaziland. A Companion to the Vegetation Map of South Africa, Lesotho and Swaziland. Dept of Environmental affairs and Tourism, Pretoria.

MACFARLANE, D.M., KOTZE, D.C., ELLERY, W.N., WALTERS, D., KOOPMAN, V., GOODMAN, P., GOODMAN P. AND GOGE C. 2008. Wetland Tools Assessment. WRC Report.

MANGOLD, S. 2001. National Aquatic Ecosystem Biomonitoring Programme: An Implementation Manual for the River Health Programme - a hitch hiker's guide to putting the RHP into action. NAEBP Report Series No 15. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria.

MBSP (MPUMLANGA BIODIVERSITY SECTOR PLAN) 2013. MTPA

MCKEE, J.E., & WOLF, H.W., 1963. Water quality criteria. The Resource Agency of California (2nd edition). *State Water Quality Control Bd*., Publication 3A. 584pp.

MEADOR, M.R., CUFFNEY, T.F., & GURTZ, M.E., 1993. Methods for sampling fish communities as part of the natural-water quality assessment programme. U.S Geology survey. Open-file Report 93-104. Carolina.

MIGDOLL, I. 1994. Butterflies of Southern Africa. Struik Publishers, Cape Town.

MINTER, L., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J., & KLOEPFER, D., (Eds.) 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington, DC.

MITCHELL-JONES, T., & CARLIN, C., 2009. Bats and onshore wind turbines, Interim guidance, Natural England Technical Information Note TIN051, 9pp accessed from www.naturalengland.org.uk in April 2010.

MONADJEM, A., TAYLOR P.J., COTTERILL, F.P.D., & SCHOEMAN, M.C., 2010. Bats of southern and central Africa – A biogeographic and taxonomic synthesis. Wits University Press, Johannesburg

MTPA, (MPUMALANGA TOURISM AND PARKS AGENCY). 2013. Mpumalanga Biodiversity Sector Plan. MTPA.

MUCINA, L., & RUTHERFORD, M.C., (eds). 2006. The vegetation map of South Africa, Lesotho and Swaziland. *Strelitzia 19*, South African National Biodiversity Institute.

MUELLER-DOMBOIS, & ELLENBERG., 1974. Aims and Methods of Vegetation Ecology. New York: *John Wiley and Sons*, pp 93-120.

NEL, J., MAREE, G., ROUX, D., MOOLMAN, D., KLEYNHANS, N., SILBERBAUER, N., & DRIVER, A., 2004. South African National Spatial Biodiversity Assessment Technical Report, Volume 1. South African National Biodiversity Institute. Pretoria, South Africa.

NEMA, 1998. National Environmental Management Act, 1998 (Act No. 107 of 1998): An Act to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance and procedures for co-ordinating environmental functions exercised by organs of state; to provide for certain aspects of the administration and enforcement of other environmental management laws; and to provide for matters connected therewith.

NEMBA, 2007. National Environmental Management: Biodiversity Act, 2004 (Act No. 10, 2004): Publication of lists of Critically Endangered, Endangered, Vulnerable and Protected Species. February 2007.

NEWMAN, K., 2002. Newman's Birds of Southern Africa. Struik Publishers, Cape Town.

O'FARRELL, P., 2006. Ecosystem Services and Benefits to Farmers. Conservation Farming Project

OLLIS, D.J., SNADDON, C.D., JOB, N.M., & MBONA, N., 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African National biodiversity Institute, Pretoria. RAMSAR, 1999. People and Wetlands: The Vital Link, 7th Meeting of the Conference of the Contracting Parties to the Convention on Wetlands (Ramsar, Iran, 1971), San José, Costa Rica.

OLSON, D.M., DINERSTEIN, E., WIKRAMANAYAKE, E.D., BURGESS, N.D., POWELL, G.V.N., UNDERWOOD, E.C., D'AMICO, J.A., ITOUA, I., STRAND, H.E., MORRISON, J.C., LOUCKS, C.J., ALLNUTT, T.F., RICKETTS, T.H., KURA, Y., LAMOREUX, J.F., WETTENGEL, W.W., HEDAO, P., & KASSEM, K.R., 2001. Terrestrial Ecoregions of the World: a new map of Life on Earth. *BioScience* 51: 933-938.

PATTERSON, R. 1987. Reptiles of Southern Africa. Struik, Cape Town

PFAB, M.F., & VICTOR, J.E., 2002. Threatened plants of Gauteng, South Africa. *South African Journal of Botany* 68:370-375.

PICKER, M., GRIFFITHS, C., & WEAVING, A., 2002. Field Guide to Insects of South Africa. Struik Publishers, Cape Town.

PICKETT, S.T.A., OSTFELD, R.S., SHACHAK, M., & LICKENS, G.E., 1997. The Ecological Basis of Conservation: Heterogeneity, Ecosystems, and Biodiversity. Chapman & Hall. N.Y.

REBELO, A.G., DOLD, A.P., VAN WYK, A.E., HELME, N.A., HOLMES, P.M., FORSHAW, C.N., RICHARDSON, S.H., RAIMONDO, D., EUSTON-BROWN, D.I.W., VICTOR, J.E., FODEN, W., EBRAHIM, I., BOMHARD, B., OLIVER, E.G.H., JOHNS, A., VAN DER VENTER, J., VAN DER WALT, R., VON WITT, C., LOW, A.B., PATERSON-JONES, C., ROURKE, J.P., HITCHCOCK, A.N., POTTER, L., VLOK, J.H. & PILLAY, D. 2009. *Protea subvestita* N.E.Br. National Assessment: Red List of South African Plants version 2013.1. Accessed on 2013/08/05

RIVERS DATABASE 2007. (Version 3). The River Health Programme in conjunction with the Department of Water Affairs and Forestry and the Water Research Commission. Pretoria, South Africa.

RUTHERFORD, M.C., & WESTFALL, R.H., 1994. Biomes of southern Africa: an objective characterization. Memoirs of the Botanical Survey of South Africa.

SA EXPLORER 2013. Wakkerstroom climate http://www.saexplorer.co.za/south-africa/climate/wakkerstroom.asp. Accessed July 2013.

SABAP 2 (SECOND SOUTHERN AFRICAN BIRD ATLAS PROJECT) 2013. http://sabap2.adu.org.za/. Accessed 2013.

SABCA (SOUTHERN AFRICAN BUTTERFLY CONSERVATION ASSESSMENT) 2010. http://sabca.adu.org.za. Accessed 2010.

SARCA (SOUTH AFRICAN REPTILE CONSERVATION ASSESSMENT) 2010. http://sarca.adu.org.za/index.php. Accessed 2010.

SCOTT, L.E.P., SKELTON, P.H., BOOTH, A.J., VERHEUST, L., HARRIS, R., & DOOLEY, J., 2006. Atlas of South African Fishes. Grahamstown: SAIAB., (The South African Institute for Aquatic Biodiversity).

SKELTON, P., 2001. A complete guide to the freshwater fishes of southern Africa, (2nd edition). Halfway House: Southern Publishers. Cape Town, South Africa. 395pp.

SOIL CLASSIFICATION WORKING GROUP, 1991. Soil Classification: A taxonomic systems for South Africa (Reprinted 2006). Department of Agricultural Development, Pretoria.

SOUTH AFRICAN BIRD ATLAS PROJECT (SABAP2). http://birds.sanbi.org/sabap/sabap_select1.php. Accessed 2013.

SAWS (SOUTH AFRICAN WEATHER SERVICES) 2013. www.weathersa.co.za. Accessed 5 August 2013

SOUTHERN AFRICAN BIRD ATLAS PROJECT (SABAP2) database

STUART, C., & STUART, T., 1998. Field Guide to the Mammals of Southern Africa. Struik

TABACCHI, E., CORRELL, D.L., HAUER, R., PINAY, G., PLANTY-TABACCHI, A., & WISSMAR, R.C., 1998. Development, maintenance and role of riparian vegetation in the river landscape. *Freshwater Biology*, 40:497–516.

TAINTON, N.,1999. Veld management in South Africa. University of Natal press, Pietermaritzburg.

TARBOTON, W.R., 2001. A Guide to the Nests and Eggs of Southern African Birds. Struik Publishers (Pty) Ltd. Cape Town.

TARBOTON, W.R., KEMP, M.I., & KEMP, A.C., 1987. Birds of the Transvaal. Transvaal Museum, Pretoria

THIRION, C., 2007. Module E: Macroinvertebrate Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. Pretoria, South Africa.

THIRION, C., 2008. EcoClasification manual for ecostatus determination (version 2) Module E. Macro-invertebrate response assessment index in river eco-classification manual for ecostatus determination. Pretoria, South Africa: Water Research Commission no TT 330/08.

TICHY, L., & HOLT, J., 2006. JUICE Program for Management, Analysis and Classification of Ecological Data. Vegetation Science Group, Czech Republic. Upgraded December 2009 from: http://www.sci.muni.cz/botany/juice

TWEDDLE, D., BILLS, R., SWARTS, E., COETZER, W., DA COSTA, L., ENGELBRECHT, J., CAMBRAY, J., MARSHALL, B., IMPSON, D., SKELTON, P.H., DARWALL, W.R.T., & SMITH, K.S., 2009. The status and distribution of freshwater fishes. In: The status and distribution of freshwater biodiversity in Southern Africa. *IUCN*: 118 pp.

VAN WYK, B.E., 2002. www.sawac.co.za. Grassland: the most threatened biome in South Africa. SAWAC (South African Water Crisis).

WIKUM, D., & G., SHANHOLTZER. 1978. Application of the Braun-Blanquet cover-abundance scale for vegetation analysis in land development studies. *Environmental Management* 2:323-329.

WILLIAMS, K.A., GREEN, D.W.J., & PASCOE, D., 1986. Studies on the acute toxicity of pollutants to freshwater macro-invertebrates. *Archiv fuer Hydrobiologie*, 106:61–70.

WSP 2013a. Yzermyn Underground Coal Mine. Specialist study: Geohydrologogy Impact Assessment. WSP Environment & Energy, Johannesburg.

WSP 2013b. Proposed Yzermyn Underground Coal Mine – Land Use, Soil and Land Capability Assessment. WSP Environment & Energy, Durban/Johannesburg.

YETMAN, C.A., ROBERTSON, M., & FERGUSON, J.W.H., 2012. Conservation implications of habitat preference and geographic range of the giant bullfrog (*Pyxicephalus adspersus*) at two spatial scales. PhD thesis. University of Pretoria.

ZOCCHE, DIMER LEFFA, PAGANINI DAMIANI, CARVALHO, ÁVILA MENDONÇA, IOCHIMS DOS SANTOS, APPEL BOUFLEUR, FERRAZ DIAS, MORAES DE ANDRADE 2010. "Heavy metals & DNA damage in blood cells of insectivore bats in coal mining areas of Catarinense coal basin, Brazil"