BIODIVERSITY & WETLAND ASSESSMENT FOR THE FGD PROJECT AT MEDUPI POWER STATION - LEPHALALE, LIMPOPO

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All pictures taken on site

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LIST OF ACRONYMS

ACRONYM	DESCRIPTION
ADF	Ash Disposal Facility
APPA	Atmospheric Pollution Prevention Act
CARA	Conservation of Agricultural Resources Act
CBA	Critical Biodiversity Area
CBG4	Central Bushveld Group 4
CI	Conservation Important
CR	Critically Endangered
CIS	Conservation important species
CITES	Convention on International Trade in Endangered Species
CoPs	Conference of the Parties
DAFF	Department of Agriculture, Forestry and Fisheries
DCA	TWINSPAN Detrended Correspondence Analysis
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ECA	Environmental Conservation Act
EA	Environmental Authorisation
EI	Ecological Importance
ES	Ecological Sensitivity
ESA	Ecological Support Area
EIAs	Environmental Impact Assessments
EIS	Ecological Importance and Sensitivity
EMPRs	Environmental Management Programme Reports
EMPs	Environmental Management Plans
EN	Endangered
EO	Environmental Officer
EWT	Endangered Wildlife Trust
FEPA	Freshwater Ecosystem Priority Area
FGD	Flue Gas Desulphurisation
FRAI	Fish Response Assessment Index
GG	Government Gazette
GPS	Global Positioning System
HGM	Hydro-geomorphic
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectrophotometer
ICP-MS	Inductively Coupled Plasma – Mass Spectrophotometer
JPOI	Johannesburg Plan of Implementation
LC	Least Concern
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LCPlan	Limpopo Conservation Plan
LSB	Limpopo Sweet Bushveld
LO	Likelihood of Occurrence
LT	Least Threatened

ACRONYM	DESCRIPTION
m.a.s.l	Meters above sea level
MBG	Mining & Biodiversity Guidelines
MoP 5	5th Meeting of the Parties
MPS	Medupi Power Station
NT	Near Threatened
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environmental Management Act
NEPAD	New Partnership for Africa's Development
NWA	National Water Act
NSS	Natural Scientific Services
NSBA	National Spatial Biodiversity Assessment
PES	Present Ecological State
PS	Protected species
PT	Protected
Pr.Nat.Sci.	Professional Natural Scientist
QDS	Quarter Degree Square
SABAP	Southern African Bird Atlas Projects
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System Version 5
SQG	sediment quality guidelines
SEW	Semi-Ephemeral Washes
SMPs	Strategic Management Plans
ToR	Terms of Reference
ToPS	Threatened or Protected Species
UNFCCC	UN Framework Convention on Climate Change
VU	Vulnerable
WDBP	Waterberg District Bioregional Plan
WMA	Water Management Area
WMLA	Waste Management Licence Application
WRG	Water Research Group
WULA	Water Use Licence Application
WQ	Water quality

1. Introduction

In South Africa, the legislation affirms the national commitment to conservation. The National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) has the objective to provide for, amongst others the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998; the protection of species and ecosystems that warrant national protection; and the sustainable use of indigenous biological resources.

Biodiversity is defined as "…***the variability among living organisms from all sources including…terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems***" (The Convention of Biological Diversity, 1992). In other words, plants, animals and micro-organisms, their genes, and the ecosystems that living organisms inhabit, are all facets of biodiversity.

Further to this, 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, with all wetlands protected under the NWA. The National Water Act (Act No. 36 of 1998), (NWA) 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 in normal circumstances supports or would support vegetation typically adapted to life in saturated soils* ."

This report represents an amalgamation of work done by NSS on terrestrial biodiversity and wetlands since 2014 at Medupi Power Station (MPS) as it relates to the Flue Gas Desulphurisation (FGD) Retrofit Project. Medupi is located about 15km west of the town of Lephalale in the Limpopo Province. The project essentially involves the reduction of sulphur dioxide (SO_2) emissions from power station and the consequent disposal of its by-product, gypsum, on the proposed ash disposal facility. Medupi will be the first coal-fired power station in the Eskom fleet to deploy this supercritical abatement technology which will reduce SO_2 emissions by over 90%.

Zitholele Consulting (Pty) Ltd (Zitholele) was appointed in 2014 to undertake the environmental processes including an Environmental Impact Assessment (EIA), Water Use Licence Application (WULA) and Waste Management Licence Application (WMLA) for the MPS Flue Gas Desulphurisation (FGD) Retrofit project. In 2017, the MPS FGD project scope was extended to include the environmental authorisation process for the other FGD associated infrastructures including the railway yard and siding, limestone and gypsum handling facilities, diesel storage facilities, new access roads, a Waste Water Treatment plant, and facilities for temporary storage of salts and sludge (hazardouswaste). Additionally the project is dealing with the Water Use Licence Application (WULA) for the wetlands which

were detected by NSS during 2015 within the study area and a 500m buffer around it. Therefore NSS was requested by Zitholele to provide biodiversity and wetland input into this greater EIA process.

It must be noted that the construction of the MPS is almost complete and the ADF construction already commenced prior to 2012 (**Figure 1-1**). The majority of the site is now cleared and any depressions, washes and other wetlands that were within the footprint have now been removed. NSS therefore focused on areas within the railway yard, MPS and ADF that were not transformed as well as within the 500m buffer of the site.

Ongoing construction of the ADF

Ongoing construction of the MPS

Figure 1-1 Construction of MPS and the ADF facilities

2. Terms of Reference

Based on requests made by ESKOM at the FGD scope consolidation workshop held in December 2017, this report represents an amalgamation of NSS work conducted to date for Medupi Power Station (MPS) as it pertains to the FGD project area as a whole. The various projects for which NSS was previously appointed are summarized in **Table 2-1**.

Table 2-1 Work performed by NSS for the Medupi FGD project

WORK REQUESTED	STATUS
Eco assessment FGD railway yard -September 2014:	Submitted – March 2015
Eco & Wetland assessment (2,12 &13) - October 2014	Stopped, fieldwork completed – December 2015
Eco opinion sites 2,12 & 13	Submitted – January 2016
Screening additional ADF sites – April 2016	Cancelled
Wetland assessment Site 13 - October 2016	Submitted – December 2016 - revised 2017
Wetland offset and rehabilitation plan - May 2017	**Ongoing**
Wetland & eco assessment for FGD area – November 2017	**Ongoing**

More specifically the SoW for this report is as follows:

- Combine relevant sections of reports into one integrated biodiversity and wetland report for the FGD study area which includes the Medupi Power Station, the FGD / railway yard area and the area earmarked for the ADF (referred to as Site 13) and a 500m buffer around these areas.
- Over and above integration, address any new impacts which may be associated with the construction and operation of the FGD system within the Medupi Power Station Footprint as well as that of the railway yard, limestone and gypsum handling facilities between the Medupi Power Station and existing ADF.
- The Report includes:
    - An Introduction and Terms of Reference;
    - List of applicable legislation, guidelines, standards and criteria;
    - A broad description of the biophysical environment wherein Medupi is situated;
    - The terrestrial assessment methods and results including:
        - A description of regional vegetation and local floral (including their structure, dominant plant composition and condition);
        - Recorded alien invasive species;
        - The local diversity of mammals, birds, reptiles, frogs, butterflies, odonata (dragonflies and damselflies), scorpions and megalomorph spiders;
        - Recorded Conservation Important (CI) species of flora and fauna.
    - The wetland assessment methods and results including:
        - The delineation of wetlands (including pans) within 500m of the MPS and ADF footprint based on limited field work.
        - The sediment and water quality analysis of surface water bodies – especially the FEPA to the south-west of the ADF area;
        - An assessment of pan invertebrate diversity through laboratory hatching tests.
        - Wetland ecosystem goods and services;
        - The determination of wetland buffers.

- A qualitative assessment (and mapping) of the relative sensitivity or conservation importance of local floral, faunal and wetland biodiversity.
- A detailed Impact Assessment with recommended impact mitigation measures.
- Concluding remarks.
- References.
- Appendices.

3. Project Team

This assessment was conducted and managed by NSS (**Table 3-1**). The NSS team has extensive experience in project management and fieldwork for numerous ecological and biodiversity studies as well as aquatic and wetland assessments. The team has also been involved in the management of 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. The following professional registrations and accreditations apply to NSS:

- The senior team members are registered Professional Natural Scientists in the ecological, environmental, aquatic and zoological fields.
- The aquatics team are accredited with Department of Water and Sanitation (DWS) to perform the SASS5 (South African Scoring System version 5) for aquatic macro-invertebrate monitoring.
- The Wetland Specialists is acknowledged by the DWS as a Competent Wetland Delineator.

Table 3-1 Project team with associated areas of specialisation

ASPECT INVESTIGATED	SPECIALIST	QUALIFICATIONS
Ecology, Wetlands & Project Management	Susan Abell	M.Sc. Resource Conservation Biology (WITS). Pr.Nat.Sci. Registered – Ecology & Environmental Science. (400116/05)
Wetlands & Fauna	Tyron Clark	M.Sc. – Zoology in progress (WITS).
Fauna	Dr Caroline Lötter	Ph.D. – Zoology (UP). Pr.Nat.Sci. registered (400182/09) – Zoology.
Sediment Analysis	Dr Wynand Malherbe	Ph. D – Aquatic Science. Water Research Group (Ecology) NW University Pr.Nat.Sci. Registered – Zoology (400200/13)
Review	Kathy Taggart	M.Sc. Resource Conservation Biology (WITS). Pr.Nat.Sci. Registered – Ecology & Environmental Science. (400225/08)
GIS mapping	Tim Blignaut	M.Sc. – Geography (UJ) – in progress.

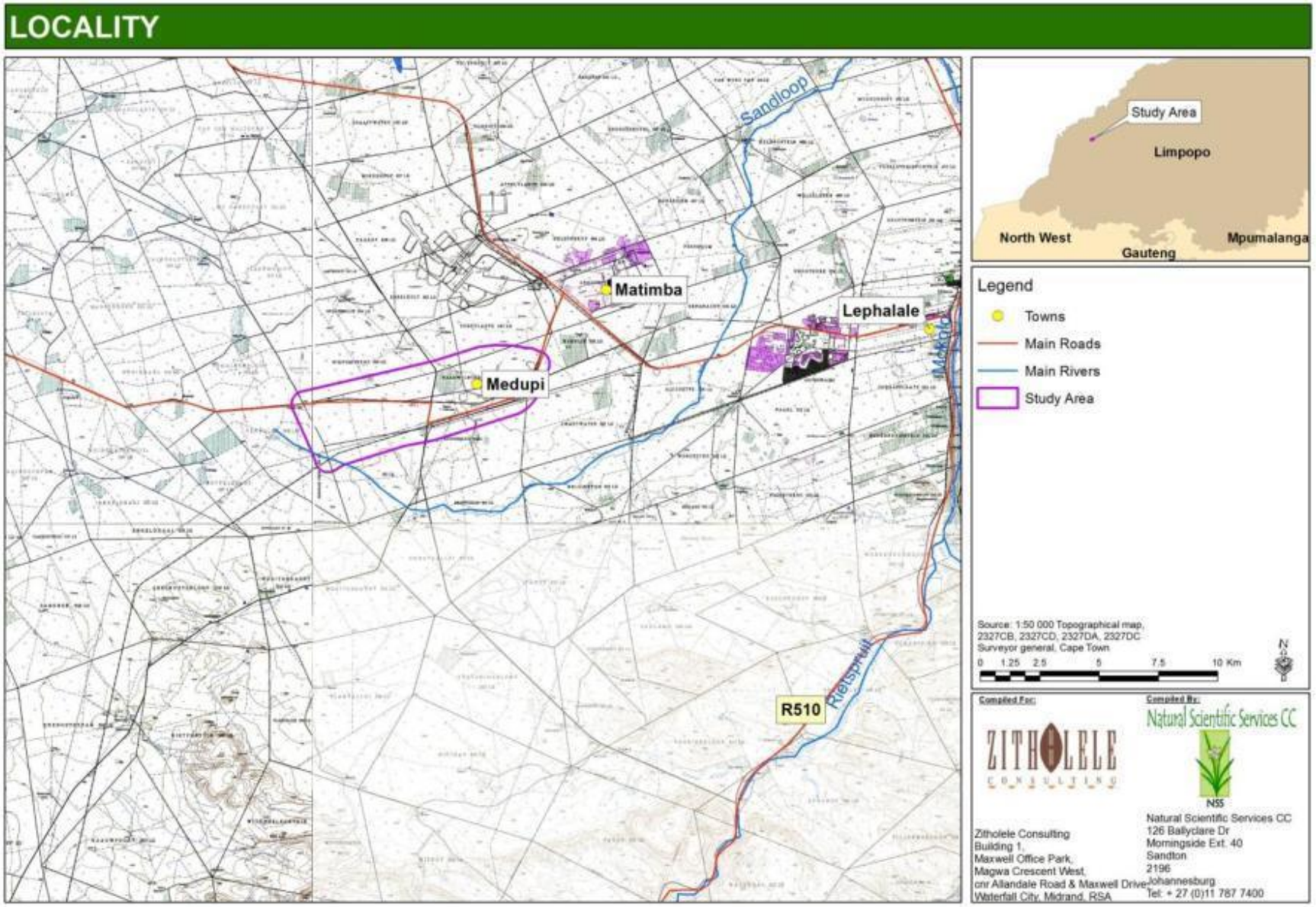
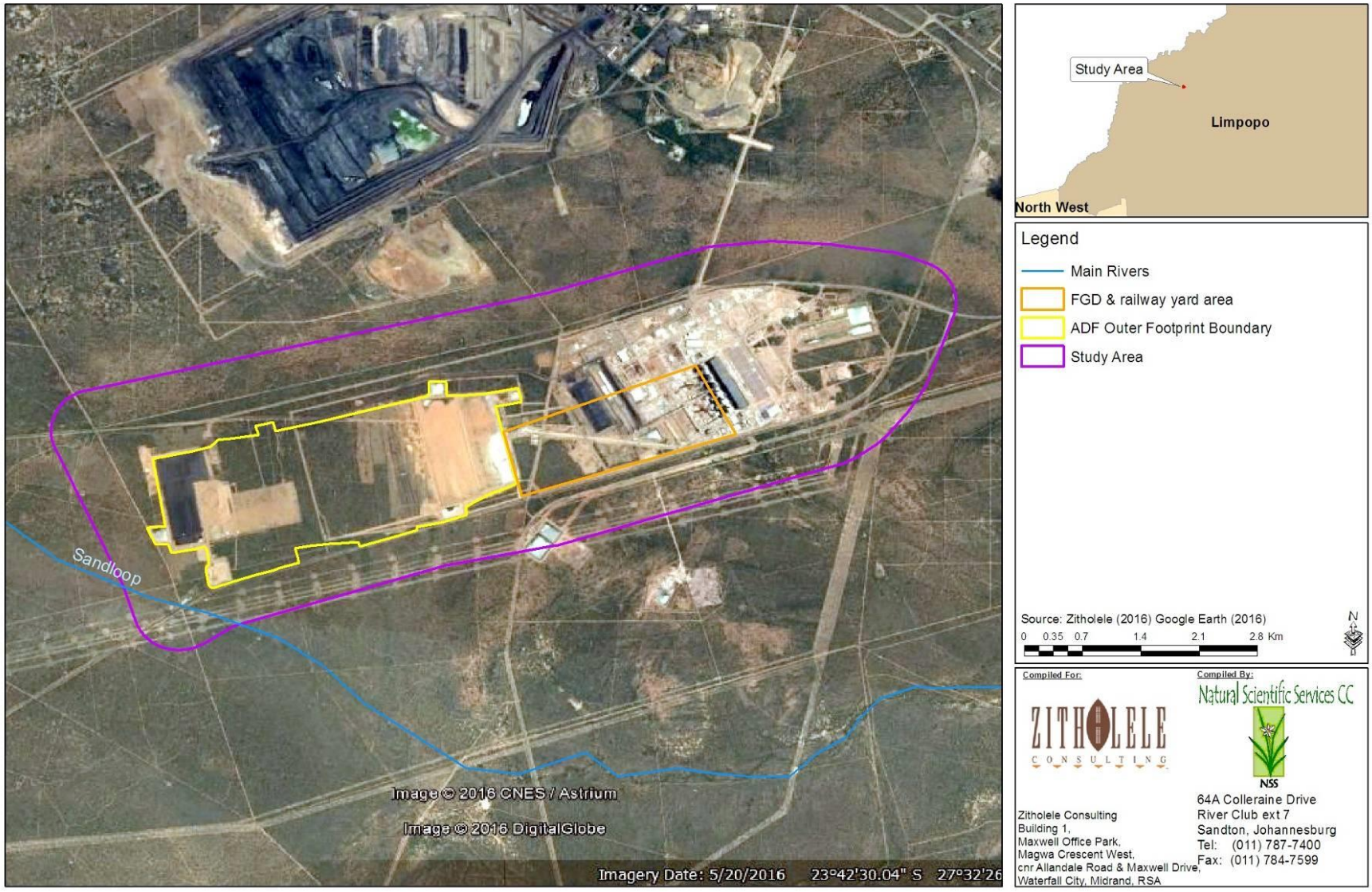


Figure 3-1 Locality map of the study area showing the position of the Sandloop FEPA

ADF FOOTPRINT



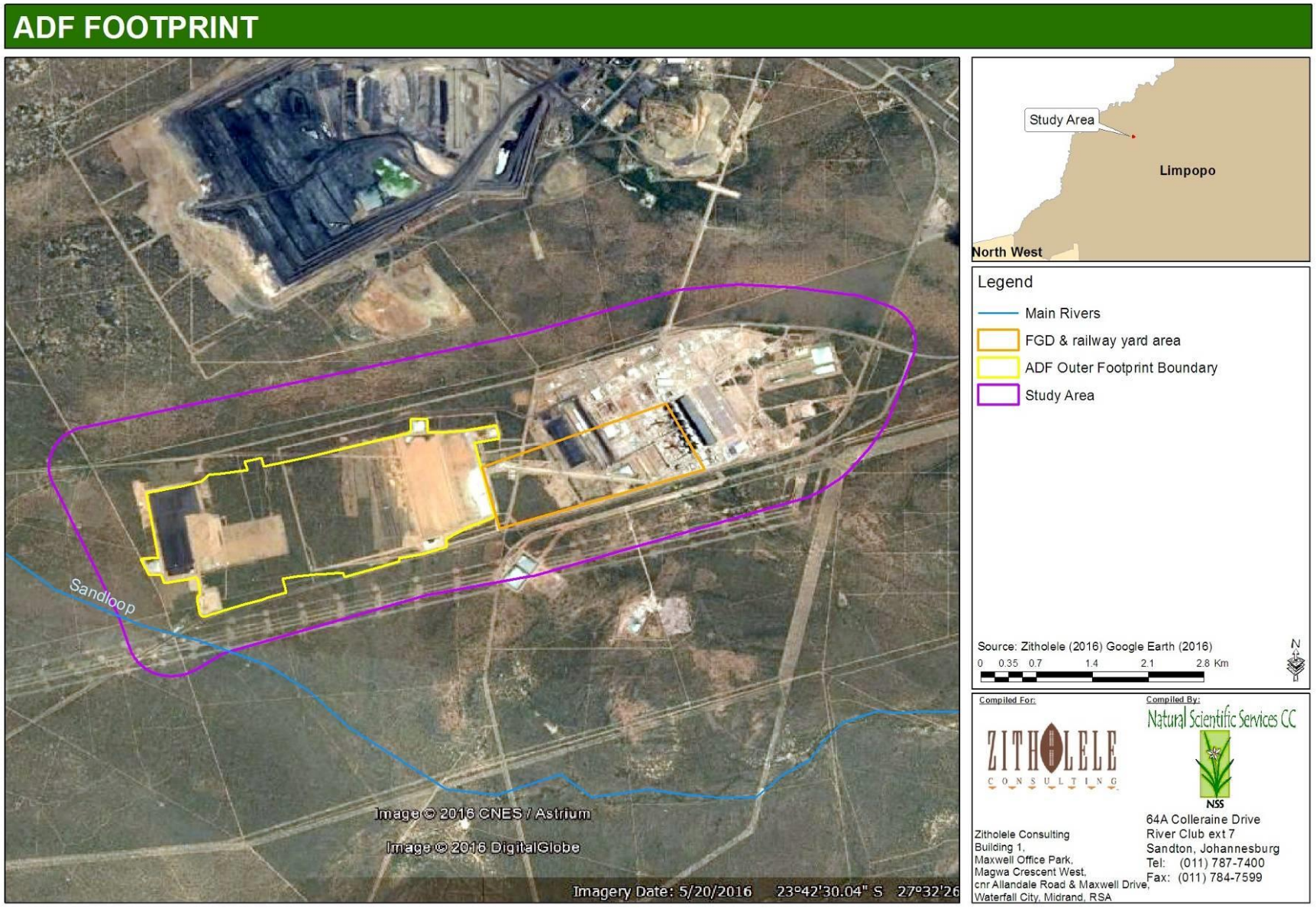


Figure 3-2 Locality map of the study area showing the position of the proposed FGD Footprint area

4. Applicable Legislation

There are several international treaties and considerable national and provincial legislation regarding the sustainable use and conservation of terrestrial and wetland biodiversity including species and ecosystems. As coal fired power stations such as MPS inevitably have the potential to have major negative impacts on biodiversity, all the below-mentioned international, regional, national and provincial legislation, policies and guidelines are applicable to the proposed project. While the list below is extensive, additional legislation, policies and guidelines that have not been mentioned may apply.

4.1. International Agreements

- *World Summit on Sustainable Development*, 2002;
- *Johannesburg Plan of Implementation* (JPoI), Chapter 4, 2002. 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. South Africa uses the National Biodiversity Strategy and Action Plan (NBSAP) as a means to achieve the JPoI biodiversity targets;
- *UN Framework Convention on Climate Change* (UNFCCC), 1994. UNFCCC 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. This agreement, although non-binding, does provide for updates called "protocols," which set mandatory emission limits.
  - *Kyoto Protocol*, 1997. The principal update is the Kyoto Protocol 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.
  - *Copenhagen Accord*, 2009. This 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". 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.

- *17th 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.
- *Paris Agreement* to reduce climate change, and the Paris Pledge for Action. This latest agreement on climate change calls for zero net anthropogenic greenhouse gas emissions to be reached during the second half of the 21st century. The agreement is due to enter into force in 2020, and Parties that have signed the Agreement, including South Africa, will need to adopt the Agreement within their own legal systems. By joining the Pledge, businesses, cities, civil society groups, investors, regions, trade unions and other signatories promise to ensure that the Agreement's ambition to limit the global temperature rise to less than 2ºC is met. A number of mining companies, including those operating in South Africa have joined this Pledge.

- *Convention on Biological Diversity* (Rio de Janeiro, 1992). 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;
- *Agenda 21* and Rio Declaration, 1992;
- The *Bonn Convention* (on conservation of migratory species of wild animals), 1979. South Africa is a party to this Convention, which affords protection to all migratory animals in the project area including various bird, bat and butterfly species;
- *CITES* (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), 1973. 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 accords varying degrees of protection to more than 33,000 species of animals and plants;
- The *World Heritage Convention*, 1972. This aims to preserve the world's natural and scenic areas and historic sites for present and future generations of humanity; 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, with the Mapungubwe Cultural Landscape being the closest to the study area.
- The *Ramsar Convention* (on wetlands of international importance especially as waterfowl habitat). This is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance but also to plan for the "wise use", or sustainable use, of all of the wetlands in their territories. In terms of the site, an

ephemeral system is existing the study area to the south west and there are a number of water bodies present just south of the site; and

- *United Nations Convention to Combat Desertification*.

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.
- *African Convention on the Conservation of Nature and Natural Resources*, 1969.

4.3. National Legislation, Policies and 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). CARA includes the use and protection of land, soil, wetlands and vegetation and the control of weeds and invader plants. 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. Further additions to the law have occurred and are discussed under NEMBA below.
- *Water Services Act* (WSA; Act 108 of 1997). This Act provides for, among other things, the effective water resource management and conservation.
- *White Paper on Environmental Management Policy* for South Africa (1998). Through this Policy, Government undertakes to give effect to the many rights in the Constitution that relate to the environment.
- *National Veld and Forest Fire Act* (NVFFA; Act 101 of 1998). The purpose of this Act is to prevent and combat veld fires in the country. 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 DWS, including:

- Section 19(2) which states that: responsible persons of pollution of any water resources must take all measures to prevent and remedy effects of pollution.
- Section 21 which states that a license for water use is required if activities such as taking water from a water resource; storing water; impeding or diverting the flow of water in a watercourse or engaging in a stream flow reduction activity amongst others. As per the NWA, a General Authorisation from Section 21 (c) and (i) water use is not an entitlement for the use of water in terms of section 21 *(c)* and *(i)* within a 500 metre radius from the boundary of any wetland and is based on the outcome of a Risk Assessment.
- Section 37(2) states that activities (described in Section 37(1)) require authorization before being undertaken and include: irrigation on any land with waste or water containing waste generated through any industrial activity of by a waterworks; intentional recharging of an aquifer with any waste or water containing waste; and 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 35648 of 2012 provides the latest List of Protected Tree Species within the borders of South Africa under the NFA.
- *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.
- *National Environmental Management Protected Areas Act* (NEMPAA: 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* (NEMBA; Act 10 of 2004). A main objective of NEMBA 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 NEMBA 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 NEMBA, 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).
    - *Alien and Invasive Species Regulations, 2014* (GG 37885, 1 August 2014). These regulations listed all declared weeds and invasive plant species in South Africa.

- *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). 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. 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 DWS (DWAF at the time) initiated the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) and River Health Programme (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.
- *National Aquatic Ecosystem Health Monitoring Program* (NAEHMP) & *River Health Program* (RHP). The NAEHMP is a national programme managed by DWS'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.
- *National Freshwater Ecosystem Priority Areas* (NFEPA). The NFEPA project is a multi-partner project between CSIR, South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The NFEPA project aims to:
  - Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems (through systematic biodiversity planning); and
  - Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

  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 (Driver *et al*. 2011).

- *National Environmental Management: Air Quality Act* (NEMAQA; 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 NEMAQA. Amongst other objectives, this Act provides for the "prevention of air pollution and ecological degradation."
- *National Environmental Management: Waste Act* (Act 59 of 2008). This act serves inter alia to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development.
- *Mining & Biodiversity Guideline* (MBG). The mining industry plays a vital role in South Africa's growth and development and indirectly is connected to MPS. The MBG (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.
- *National Water Resource Strategy* (NWRS) 2. The NWRS2 (DWA 2013) builds on the first NWRS published in 2004. The purpose of the NWRS2 is to ensure that national water resources are protected, used, developed, conserved, managed and controlled in an efficient and sustainable manner towards achieving South Africa's development priorities in an equitable manner over the next five to 10 years.
- *Draft National Biodiversity Offset Policy.* The recently published draft National Biodiversity Offset Policy (GG 40733, GN 276, 31 March 2017) aims to ensure that significant residual impacts of developments are remedied as required by NEMA, and in line with the Constitutional right to an environment that is not harmful.

4.4. Limpopo Legislation, Policies and Guidelines

In addition to national legislation, some of South Africa's nine provinces have their own provincial biodiversity legislation, as nature conservation is a concurrent function of national and provincial government in terms of the Constitution (Act 108 of 1996).

- *Limpopo Environmental Management Act, 2003* (Act No. 7 of 2003). This Act repealed the former Lebowa, Gazankulu, Venda and Northern Province Acts and the Nature Conservation Ordinance (Ordinance 12 of 1983). It provides the lists for Protected and Specially Protected species under Schedule 2, 3 and 12 as well as the stipulation for permit applications to remove these species. In addition it gives protection measures for the terrestrial and aquatic biota and systems. Schedule 9 lists aquatic plant species that are prohibited in the province.
- *Limpopo Conservation Plan version 2,* 2013. This conservation plan is consistent with NEMA principles and the NEMBA. It is designed to support integrated

development planning and sustainable development by identifying an efficient set of CBAs that are required to meet national and provincial biodiversity objectives, in a configuration that is least conflicting with other land uses and activities. Where alternatives are available, the CBAs are designed to avoid conflict with existing IDPs, EMFs and SDFs in the region by favouring the selection of sites that are least conflicting with other land-uses.

- *Municipal Biodiversity Summaries Project,* 2010. This was the most relevant biodiversity conservation plan for Lephalale Municipality, prior to the C-Plan 2 publication.
- *Limpopo State of Environment Report (SoER), 2004*. This report provides a high-level overview of the State of the Environment in Limpopo.
- *Waterberg Environmental Management Plan* (EMP), 2006. The Waterberg EMP provides for the protection of the environment and describes how activities that have, or could have, an adverse impact on the environment, should be mitigated, controlled, and monitored. The Waterberg EMP is a coarse-scale planning tool that outlines strategic objectives. New development in the Waterberg District Municipality should be aligned with these objectives.
- *Waterberg Biosphere Reserve*. The Waterberg Biosphere Reserve, proclaimed in 2001 and recognized by UNESCO, covers a 654, 033ha area in the Waterberg wherein more than 80, 000 people live (DEA 2016). It is managed by the Waterberg Biosphere Reserve Committee and the Limpopo Department of Economic Development, Environment and Tourism (LEDET), which coordinates the provincial Man and the Biosphere Reserves programme. Like most other biosphere reserves, the Waterberg Biosphere Reserve comprises:
  - A (104, 179ha) Core Area for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research and other low-impact uses.
  - A (185, 517ha) Buffer Area for cooperative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism and applied basic research.
  - A (364, 336ha) Transitional Area, which contains a variety of agricultural activities, settlements and other uses in which local communities, management agencies, scientists, non-governmental organizations, cultural groups, economic interest and other stakeholders work together to manage and sustainably develop the area's resources.
- *Waterberg Spatial Development Framework, 2009*. The Waterberg Spatial Development Framework delineated areas of ecological sensitivity within the district, based on the occurrence of threatened species; centres of endemism; existing protected areas; occurrence of rivers and streams; vegetation types of conservation importance; and areas with high aesthetic value (Environomics, 2010).

- *Lephalale Spatial Development Framework, 2008*. The Lephalale Municipality compiled a Spatial Development Framework (SDF) with the purpose of guiding the form and location of future physical development within a Municipal area in order to address the imbalances of the past. This SDF identifies environmentally sensitive areas (e.g. mountain ridges, riverine environments) and makes recommendations regarding proposed developments in these areas.
- *Lephalale Integrated Development Plan (2014-2016)*. The role of an IDP is to facilitate local governments' planning and municipal management. Lephalale Municipality has an environmental function to execute and ensure that the fundamental environmental rights of the community as enshrined in the constitution are realized. The Municipality has sensitive and conservation worthy areas within its jurisdiction, such as the wetlands, river systems, cultural sites, rare and endangered species and part of the Waterberg biosphere. There are also many areas that require remedial attention i.e. the eradication of alien vegetation, soil erosion control and aspects that require special management, such as pollution control and land use management. The Municipality has the capacity to perform duties that enhance sound environmental management practices which include EIA related. Within the 2014/2015 Revenue and Expenditure Framework, no revenue/expenditure has been listed for Environmental and Biodiversity Sectors. However, a forecast of funds for environmental campaigns including educating the communities has been set up going forward (2016-2019).
- *Waterberg Bio-regional Plan* - The Waterberg bioregional plan considers the *Limpopo Conservation Plan version 2,* 2013 and *Waterberg EMF* together to develop an Integrated Development Framework.
- *Waterberg EMF, 2010* - The purpose of the Waterberg EMF is to develop a framework that will integrate policies and frameworks, and align different government mandates in a way that will streamline decision-making to improve cooperative governance and guide future development in an environmentally responsible manner.

5. Study Site Description

5.1. Locality and Land Use

The FGD study area includes the site for the ADF, the MPS precinct and a 500m buffer on this area (**Figure 3-1**). This area is 2745 ha in extent (1629 ha excluding buffer). The site is approximately 1.5km from Grootegeluk Mine, 12km from Lephalale and 4.5km from Marapong ('as the crow flies'). The site falls within the 1:50 000 topographical map Quarter Degree Square (QDS) 2327DA.

Within this greater study area NSS was commissioned to focus on two specific areas:

- The site for the ADF.
- The site for the FGD and associated infrastructure including the railway siding, limestone offtake and storage facilities.

Details on the operation design and conceptual layout of the ADF and FGD infrastructure will be detailed in the EIA and WULA application conducted by Zitholele and in the interim the reader is referred to the technical documents and design philosophies produced by Jones and Wagener and Knight & Piesold Consulting. The basic FGD process is outlined in **Figure 5-1**.

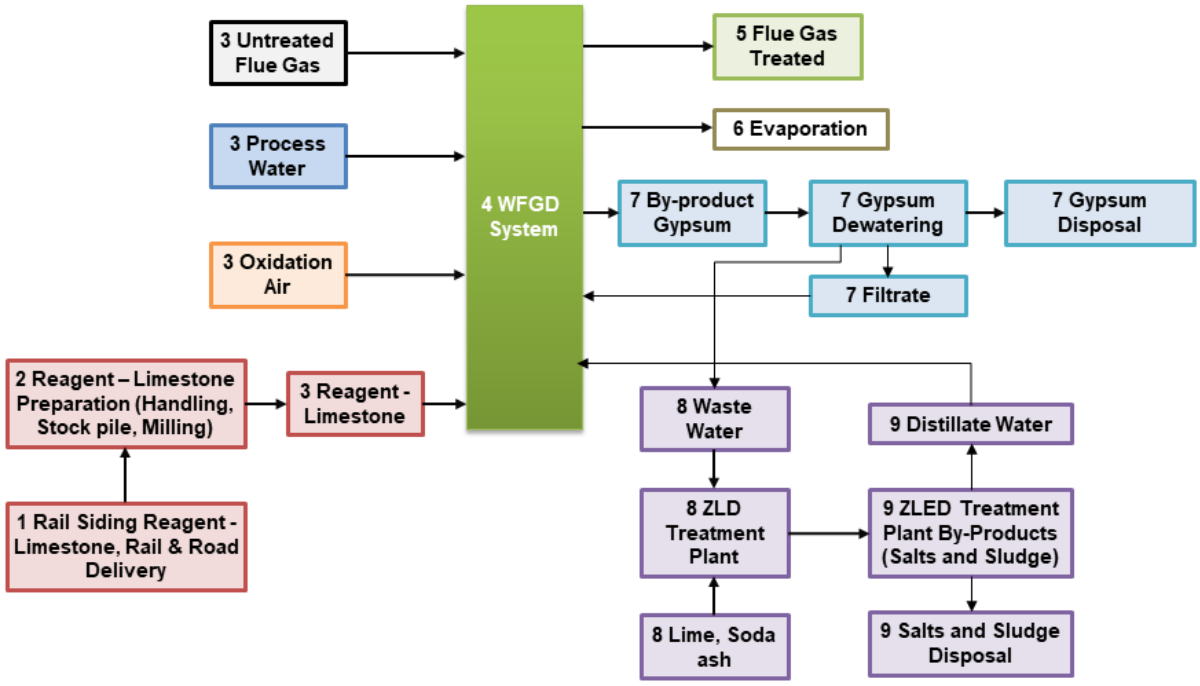


Figure 5-1 Basic process Flow Diagram for the FGD process at Medupi Power Station

Current forms of land use on and surrounding the site are presented in **Figure 5-2**. To the south and west of the study area are game and cattle farms consisting mostly of natural woodland vegetation. To the north of the FGD study area is the Manketti Reserve (the wildlife area of Grootegeluk Mine). To the east of the study area is the Matimba Power Station, game and cattle farms and the towns of Marapong and Lephalale.

5.2. Climate

The study region falls within a summer rainfall region and little to no precipitation is recorded in the months May, August and September whilst the maximum rainfall occurs in November and December. The average annual rainfall is recorded as 410.4mm per year (data from 1993-2009, Station [0674341 8]). The maximum summer temperature is experienced from November to February with an average high of 25°C and maximum temperatures reaching 37°C. The lowest temperatures are experienced between May and August. Monthly rainfall and temperature data measure at Lephalale since September 2014 are shown in **Figure 5-3**.

Game farms

Cattle farms

Mining and industrial related activities

Figure 5-2 Current Land Use for the site and surrounds

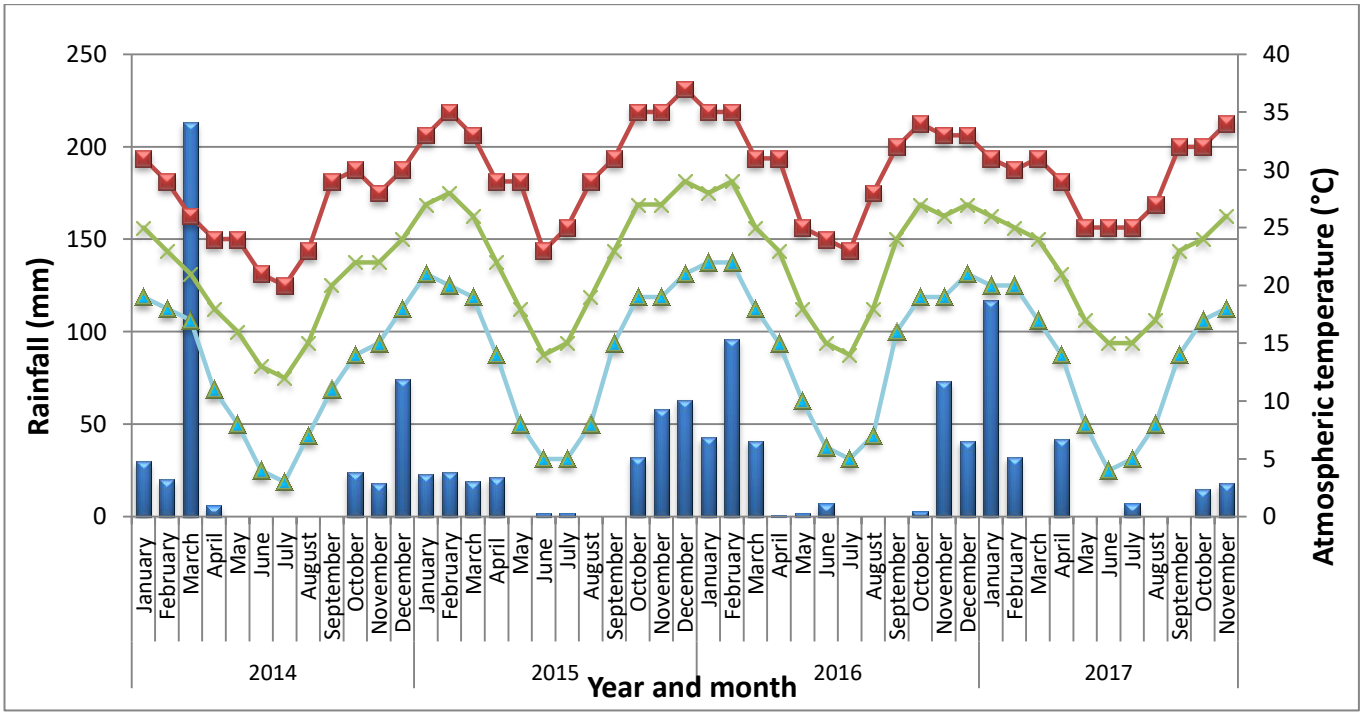


Figure 5-3 Monthly rainfall and temperature data measured at Lephalale

The rainfall data indicate that the study region had received a slightly below-average amount of (329mm) rainfall during the 12-month period preceding the site visit in November 2016. However, the 2016/2017 summer season was not as hot, and more promising in terms of rainfall, than the preceding 2015/2016 and 2014/2015 summer seasons. NSS conducted a number of site visits throughout the seasons and was able to obtain a reasonable understanding of the ephemeral systems within the study area and beyond. This was particularly the case for the December 2015 site visit, where the area received significant rainfall in the weeks preceding the visit. Not as much rain fell prior to the November 2016 visit, which allowed a broader understanding of the dynamics and fluctuation in these systems.

5.3. Geology and Soils

The study area is underlain with a sequence of yellow to purple coloured sandstones and conglomerate rock of the Waterberg Group. The majority of the Waterberg occurs within the Limpopo Province with exposures extending into Botswana. It lies unconformably over the Transvaal Group and is comprised of three subgroups. With regard to economic geology, the Waterberg was mined for lead in the early 20th century and currently is mined for tin in the Rooiberg region. Geohydrological studies indicate that the area is located over aquifers that contain limited amounts of groundwater. Groundwater flowing to the south and east is reported to be contaminated, although to a limited extent, by the ash deposited at the existing Matimba Power Station (Envirolution Consulting, 2009).

Land types represent areas that are uniform with respect to climate, terrain form, geology and soil. According to the Agricultural Geo-referenced Information System (AGIS, 2014), the site is situated in land type Ah86, Bd46 and Ae252 (**Figure 5-5**). This and the surrounding land types are associated with shale, sandstone, mudstone and coal from the Karoo sequence as well as sandstone and conglomerate rock from the Kransberg Subgroup. The study area is situated in a region where erosion rates are considered as moderate to high relative to other parts of the country and soils are generally sandy and rarely more than 3m thick. Clay soils are uncommon in the area.

Across a landscape, usually five terrain units can be identified. Wetlands occur most frequently in valley bottoms (unit 5), but can also occur on crests, mid slopes and foot slopes (units 1, 3 and 4). The catenas within land types Ah86 and Bd46 incorporate all of the four terrain units 1, 3, 4 and 5, whilst land type Ae252 mainly features terrain units 4 and 5 as shown in **Figure 5-4**. Presented in **Table 5-1** is an overview of the soil forms and their extent of coverage, which can be expected within different terrain units in land type Ae252, Ah86 and Bd46.

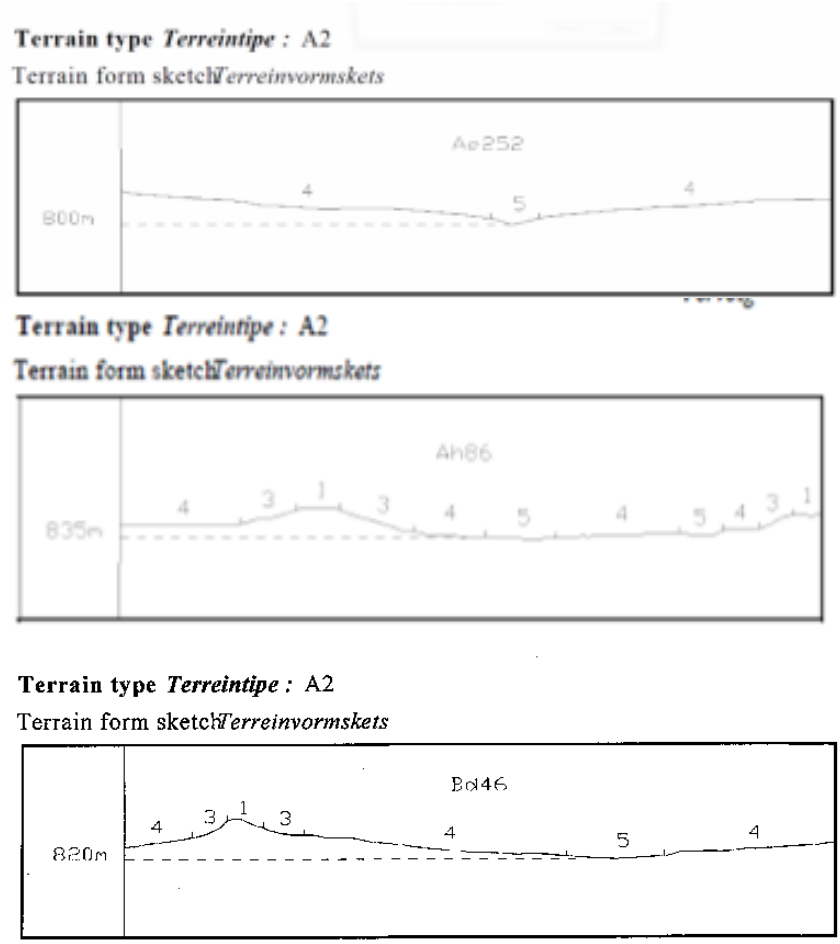


Figure 5-4 Terrain units occurring within land type Ae252, Ah86 and Bd46 (AGIS, 2014)

According to ESS (2015), the most dominant soil units for the study area (**Figure 7-15**) include:

- Shallow (<400mm) sandy to silty loams (salm/silm);
- Moderate to Shallow (400-600mm) sandy loam (salm); and
- Wet based soils with a variety of depths and clay composition.

Specifically important for the wetland assessment are the wet-based soils of varying depths and clay content. According to ESS (2015), the semi-arid climate and negative water balance combined with the horizontal attitude of the sedimentary host lithologies that characterise the Karoo sediments in the area have aided in the development of evaporates within the vadose zone. These include calcrete and in some areas ferricrete or laterite formations. The presence of the ferricrete or hard pan calcretes and plinthic horizons is considered of importance in the soil moisture regime and in many cases the reason for wet features within the soil profile. These soils classify as highly sensitive where they occur in the top 500mm of the profile.

Table 5-1 Soil forms, their wetland potential, coverage, and erodibility classes within the terrain units of land type Ae253, Ah86 and Bd46

SOIL FORM	% COVER PER TERRAIN UNIT			
	1	3	4	5
Ae253				
SLOPE (%)			**0-1%**	**1-2%**
Shigalo Hu46			79	
Mispah Ms10, Muden Ms20			11	10
Portsmouth Hu35			8	
Levubu Oa34, Jozini Oa36,				
Limpopo Oa46				70
Shorrocks Hu36			2	20
Ah86				
SLOPE (%)	**1-2%**	**0-2%**	**0-1%**	**1-3%**
Bontberg Hu25, Portsmouth Hu35	60	55	43	
Gutu Cv25, Denhere Cv35	40	45	38	
Shorrocks Hu36			4	25
Tweefontein Cv20, Ofazi Cv23, Annandale Cv33, Maputa Fw10			5	
Chester Hu22, Moriah Hu32			5	
Vaalsand Lo31			2	20
Windmeul Av35, Newcastle Av25, Soetmelk Av36, Uitkot Gc35			2	5
Lindley Va41, Limpopo Oa46, Mutale Oa47, Killarney Ka20				30
Blinkklip Cv36			1	5
Pans				15
Bd46				
SLOPE (%)	**1-3%**	**2-8%**	**0-1%**	**1-3%**
Denhere Cv35, Sandveld Fw12, Constantia Ct12	20	15	27	
Windmeule Av35, Soetmelk Av36, Leslie Gc36			28	
Paddock We31, Davel We32			14	4
Venda Oa35, Jozini Oa36, Limpopo Oa46, Valsrivier Va40			10	60
Portsmouth Hu35, Shorrocks Hu36	30	25	10	
Valssand Lo31			11	6
Mispah Ms10	50	60		
Slangkop Kd15				15
Stream beds/Stroombeddings				15

5.4. Hydrology

The Study Area falls within the Limpopo Water Management Area (WMA) 1 and is situated in the Mokolo River Catchment area (8387 km^2), where the Mokolo River (also known as the Mogol or Mogolo River) system varies from good to fair health (RHP, 2006). The Mokolo River rises in the western part of the Waterberg (between 1200 and 1600 metres above mean sea level). It originates in a flattish, open area with numerous koppies and flows through a steep gorge emerging above the town of Vaalwater. Here the river flows through a relatively flat area until it enters the Mokolo Dam. From there, it flows through another gorge before entering the Limpopo Plain, near the junction with the Rietspruit. From this point, the Mokolo River flows through flat sandy areas until it reaches the Limpopo River. The main

tributaries joining the Mokolo River downstream of the Mokolo Dam are the Rietspruit, Poer se Loop, and Tamboti River (DWA, 2012a; 2012b, RHP, 2006). The Mokolo River is a major tributary of the Limpopo River and commands a total catchment area of over 8 387 km^2 (Savannah Environmental, 2013) with a total natural mean annual runoff (MAR) of almost 300 Mm^3/a. The towns of Lephalale and Vaalwater are situated in the Mokolo Catchment. Agriculture (irrigation) is the major water user in the catchment (RHP, 2006).

According to the RHP (2006), the river channel of the Mokolo River is dominated by sandy runs and pools, but is heavily infested with reed beds (*Phragmites mauritianus*). The lower part of the Mokolo river is afforded some protection by game farms and other private farms while the wide floodplain and reed beds also limit access. The river flow highly regulated from the Mokolo Dam with sporadic flows being released for the farming community. There are five major road bridges in this area. A number of farm dams are located in the Mokolo River close to the Limpopo confluence and sand mining is widespread. The lower Mokolo River is dominated by hardy, pool dwelling species of fish. It is possible that some species may have been lost due to fragmentation of the river from the Limpopo River. No fish species requiring permanent flow were recorded, but several species that require flowing water for breeding purposes still remain, such as the Large Scale Yellowfish (*Labeobarbus marequensis*) and other *Labeo* species. However, no alien fish species were recorded. The poor habitat diversity caused the invertebrate assemblage to be dominated by hardy families associated with marginal vegetation and sand. The moderately scoring SASS assessments are likely to be as a result of the irregular flow regime. The main vegetation impact is considered to be reed encroachment and there are clear indications that the regulated flow regime is contributing to this problem. Alien vegetation was very sparse and only a few Syringa (*Melia azedarach)* was recorded. Downstream from Lephalale, disturbance to the riparian zone was limited to bridges, sand mining, and agricultural practices (mostly water abstraction pumps and the cutting of vegetation to the river's edge) (RHP, 2006).

The Sandloop is a tributary of the Mokolo River. A summary of the Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and current impacts on the Sandloop is presented in **Table 5-2** (DWS, 2014). The Desktop PES of the Sandloop is moderately modified (C category) where the loss and change of natural habitats and biota have occurred but the basic ecosystem functions are still predominately unchanged. According to the DWS (2014), this river is seriously influenced by cattle grazing and land-use. The instream and riparian habitats are moderately influenced by agricultural fields, low water crossings, erosion, overgrazing and trampling. The WQ is also moderately impacted on by run-off from mining. These habitats are also affected by bed and channel disturbances, small farm dams, inundation, road crossings, urbanisation and vegetation removal but only to a lesser degree. The moderate EI of the Sandloop is due to the one wetland and two riparian habitat types, 12 different types of vegetation cover and three endemic species in this sub-quaternary catchment with a taxon richness of at least 25 species (wetland, riparian and aquatic vegetation). The size of stream, morphology and geomorphic habitat units determine

the ES. The Sandloop has a low sensitivity to modified flow conditions and water level changes because this is an ephemeral system and has a natural lack of surface water (DWS, 2014). The Sandloop is a Lower Foothill and a Least Threatened (LT) system but poorly protected (Nel & Driver, 2012; Driver *et al*. 2011).

Table 5-2 Summary of the Sandloop and Mokolo River's Ecostatus and impacts (DWS, 2014)

Quaternary Catchment	Water Resource	Present Ecological State (PES)	Ecological Importance (EI)	Ecological Sensitivity (ES)	Current Impacts
A42J	Sandloop	**C Moderately Modified**	**Moderate**	**Low**	LARGELY: Cattle grazing (land-use) MODERATE: Agricultural fields, low water crossings, erosion, overgrazing and trampling, run-off from mining SMALL: Bed and channel disturbance, small (farm) dams, inundation, roads, urbanisation and vegetation removal.
A42	Mokolo River (after confluence with Sandloop)	**D Largely Modified**	**High**	**High**	SERIOUS: Water abstraction LARGE: Algal growth, inundation and irrigation MODERATE: Agricultural fields, bed and channel disturbance, small (farm) dams, Runoff and effluent from irrigation, grazing (land-use) and vegetation removal, SMALL: Alien vegetation, overgrazing/trampling and sedimentation.

5.5. Regional Vegetation

Mucina and Rutherford (2006) provide an extensive account of the vegetation of South Africa (in addition to Lesotho and Swaziland) via the employment of appropriate tools for vegetation mapping and description. The Study Area falls within the ***Limpopo Sweet Bushveld (code SVcb 19)*** vegetation type (**Figure 5-5**) as described by Mucina and Rutherford (2006). This area was formerly classified as Arid Sweet Bushveld by Acocks (1953), which was the original vegetation map of South Africa, and forms part of the Savanna Biome in South Africa. The Savanna biome covers the northern and eastern parts of South Africa where a continuously shifting balance occurs between the woody and herbaceous vegetation. The typical vegetation consists of short open woodland. In disturbed areas thickets of *Acacia erubescens*, *Acacia mellifera* and *Dichrostachys cinerea* are almost impenetrable. Important plant species for the Limpopo Sweet Bushveld are presented in **Table 5-3**.

The conservation status of the Limpopo Sweet Bushveld is classified as Least Threatened. In 2006, about 5% of the vegetation type had been transformed, mainly by cultivation and the area is suitable for game and cattle farming due to the high grazing capacity of sweet veld. Subsequent to 2006, the area has been facing increasing pressure from numerous coal mining projects within the vicinity with a much greater percentage of land transformed.

Table 5-3 Important plant species in the Limpopo Sweet Bushveld

SPECIES GROUP	IMPORTANT TAXA
Tall trees	***Acacia robusta*** (d), *Acacia burkei*
Small trees	***Acacia erubescens*** (d), *A. fleckii* (d), ***A. nilotica*** (d), *A. senegal* var *rostrata* (d), *Albizia anthelmintica (d),* ***Boscia albitrunca*** (d), ***Combretum apiculatum*** (d), ***Terminalia sericea***
Tall shrubs	*Catophractes alexandri* (d), ***Dichrostachys cinerea*** (d), *Phaeoptilum spinosum* (d), *Rhigozum obovatum* (d), *Cadaba aphylla, Combretum hereroense, Commiphora pyracanthoides,* ***Ehretia rigida*** **subsp.** ***rigida****,* ***Euclea undulata****,* ***Grewia flava****, Gymnosporia senegalensis*
Low shrubs	*Acacia tenuispina* (d), *Commiphora africana, Felicia muricata, Gossypium herbaceum* subsp. *africanum, Leucospaera bainesii.*
Graminoids	***Digitaria eriantha*** **subsp.** ***eriantha*** (d), *Enneapogon cenchroides* (d), *Eragrostis lehmanniana* (d), *Panicum coloratum* (d), ***Schmidtia pappophoroides*** (d), ***Aristida congesta,*** *Cymbopogon nardus, Eragrostis pallens, E. rigidior, E. trichophora, Ischaemum afrum,* ***Panicum maximum****, Setaria verticillata, Stipagrostis uniplumis,* ***Urochloa mosambicensis****.*
Herbs	*Acanthosicyos naudinianus,* ***Commelina benghalensis****, Harpagophytum procumbens* subsp. *transvaalense, Hemizygia elliotii, Hermbstaedtia odorata, Indigofera daleoides.*
Succulent herbs	*Kleinia fulgens, Plectranthus neochilus*

Source: Mucina & Rutherford (2006)

Key: (d) = dominant species; Species in **Bold** indicate those identified in the study area

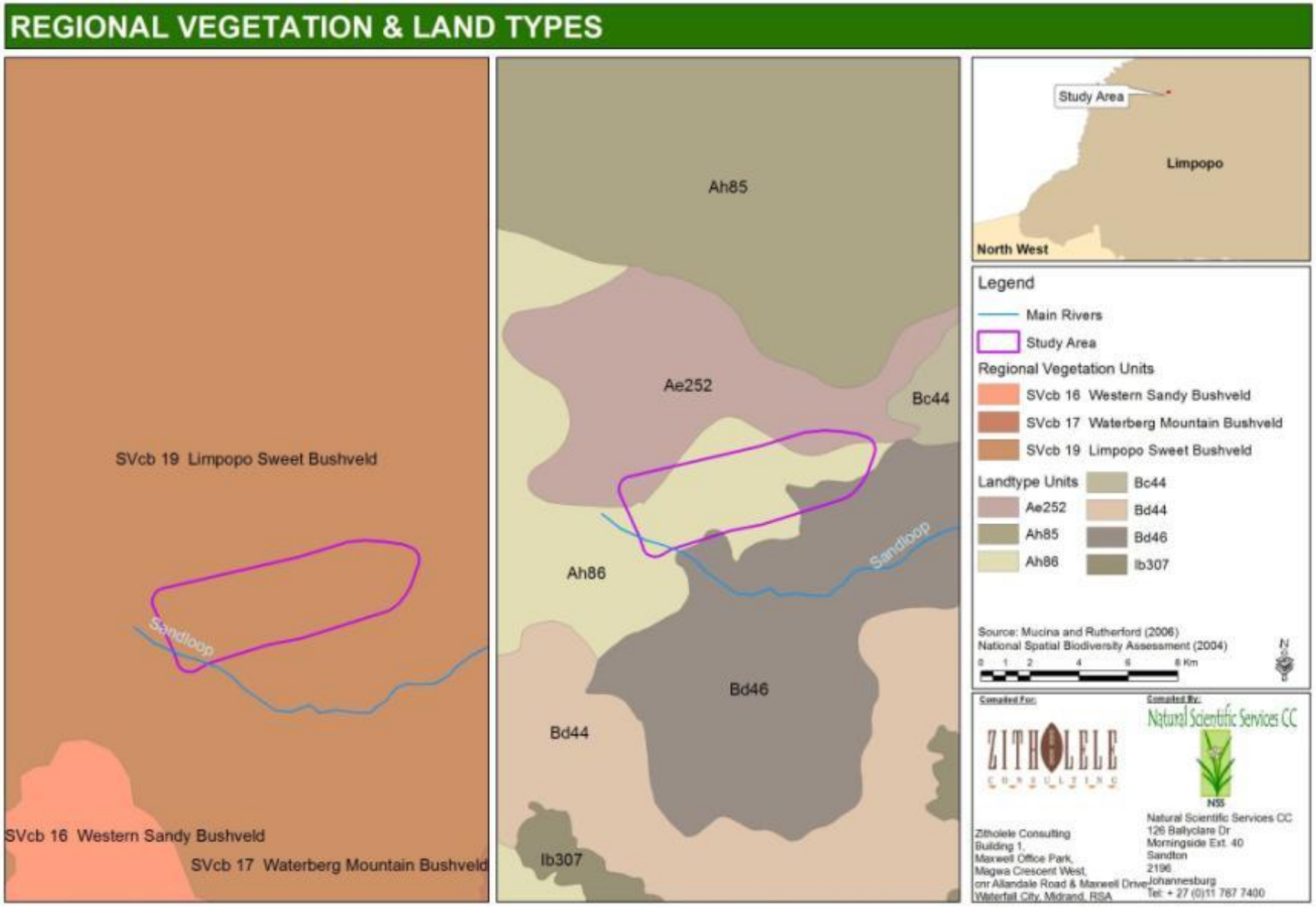


Figure 5-5 Regional Vegetation and Land Types

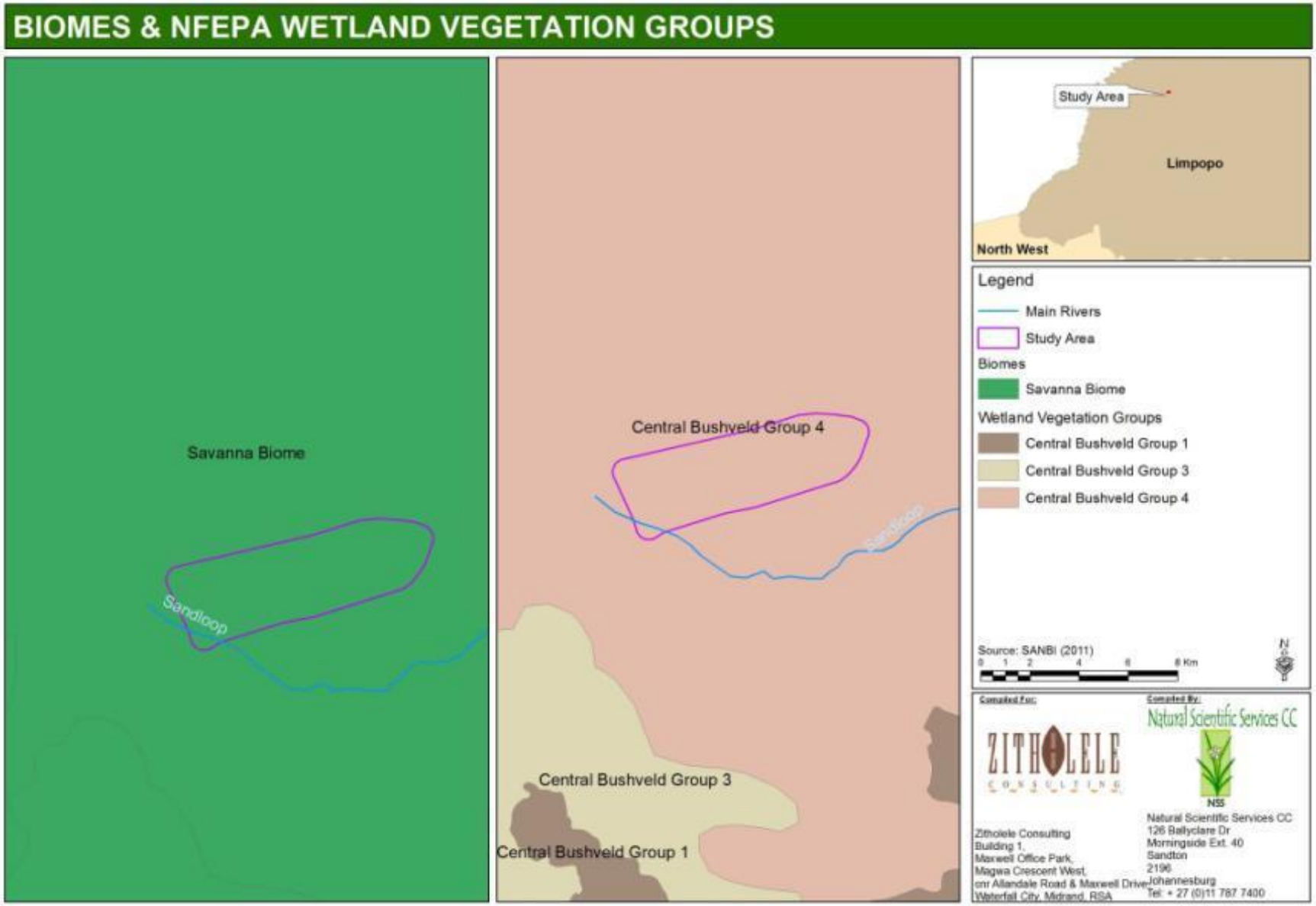


Figure 5-6 Biomes and Wetland Vegetation in the Study Area

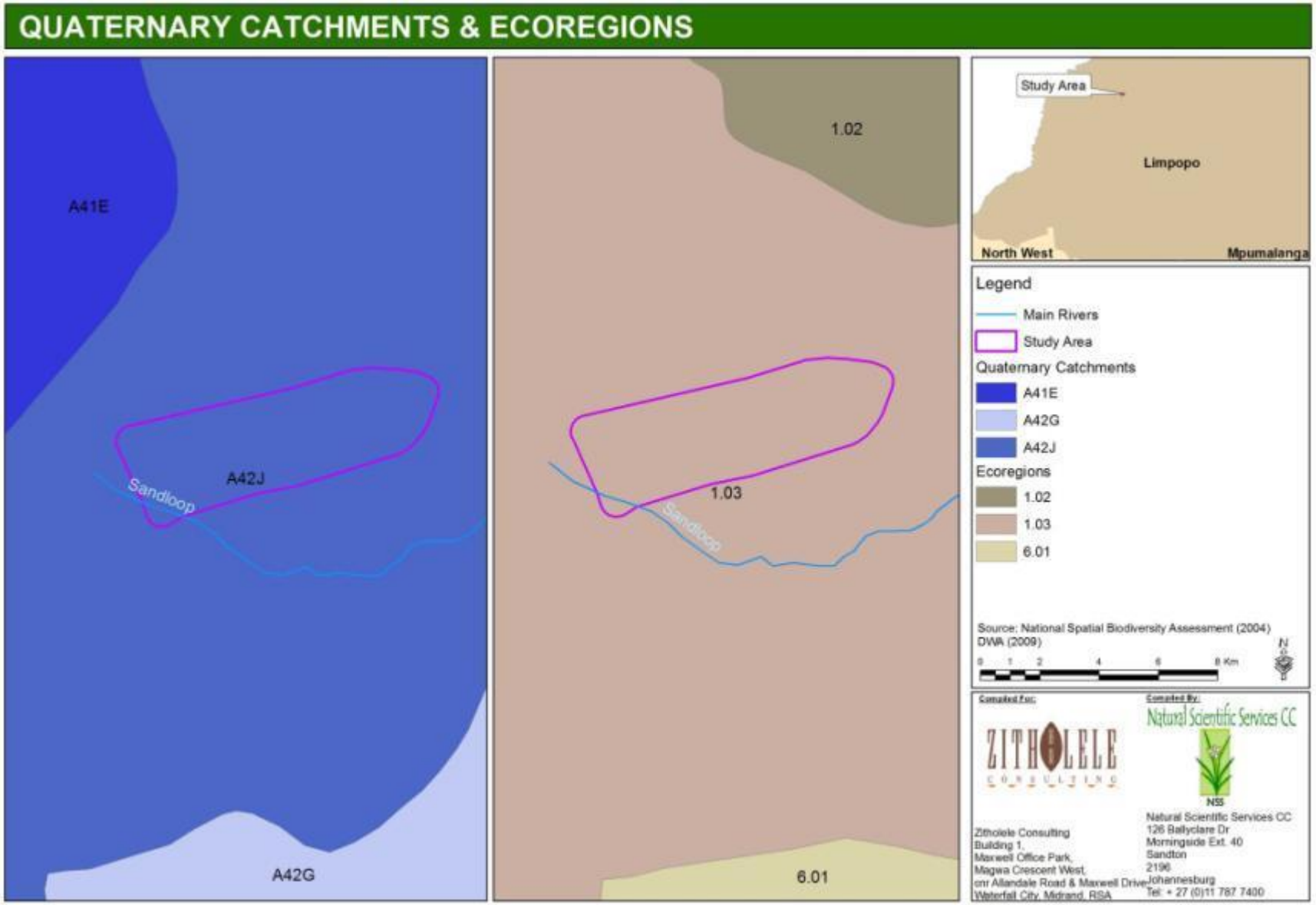


Figure 5-7 Quaternary Catchments and Ecoregion in the Study Area

6. Methodology

6.1. Vegetation & Floral Communities

6.1.1 *Desktop Research*

A desktop investigation of regional vegetation, including Conservation Important (CI) and alien, invasive floral species, was performed by consulting the following information sources:

- Google Earth (recent and historical imagery) and Bing satellite imagery. Historical imagery was incorporated into the assessment due to the continuous earth moving activities and developments occurring within the Medupi ADF, coal stockpile area and FGD portion of the Power Station.
- Mucina & Rutherford's (2006) vegetation map of southern Africa.
- The South African National Biodiversity Institute's (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). For this study, plant species data were obtained for the quarter degree square (QDS) 2327DA.
- CI plant species records in the study region, supplied by Limpopo Conservation.
- The current Limpopo C-Plan (Version 2, 2013).
- The list of declared weeds and invader species as promulgated under the amended regulations (Regulation 15) of the Conservation of Agricultural Resources Act (CARA; Act 43 of 1983), and the Alien and Invasive Species Regulations (August, 2014) under Section 70 of the National Environmental Management: Biodiversity Act (NEMBA; Act 10 of 2004).

6.1.2 *Fieldwork*

Fieldwork was performed during January 2015, November 2015, December 2015 and December 2016 and involved:

- Sampling vegetation plots to determine the spatial extent, structure, condition and dominant species composition of different local floral communities (**Figure 6-1**) 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 6-1**. It must be noted that the habitat in which the site fell was mostly homeogenous in nature, fragmented and disturbed, therefore the use of the Braun-Blanquet approach was limited.
- Walking random transects to detect localised and CI plant species (i.e. Red Data, endemic, protected and cultural species).
- Recording any observed alien and invasive plant species on site.

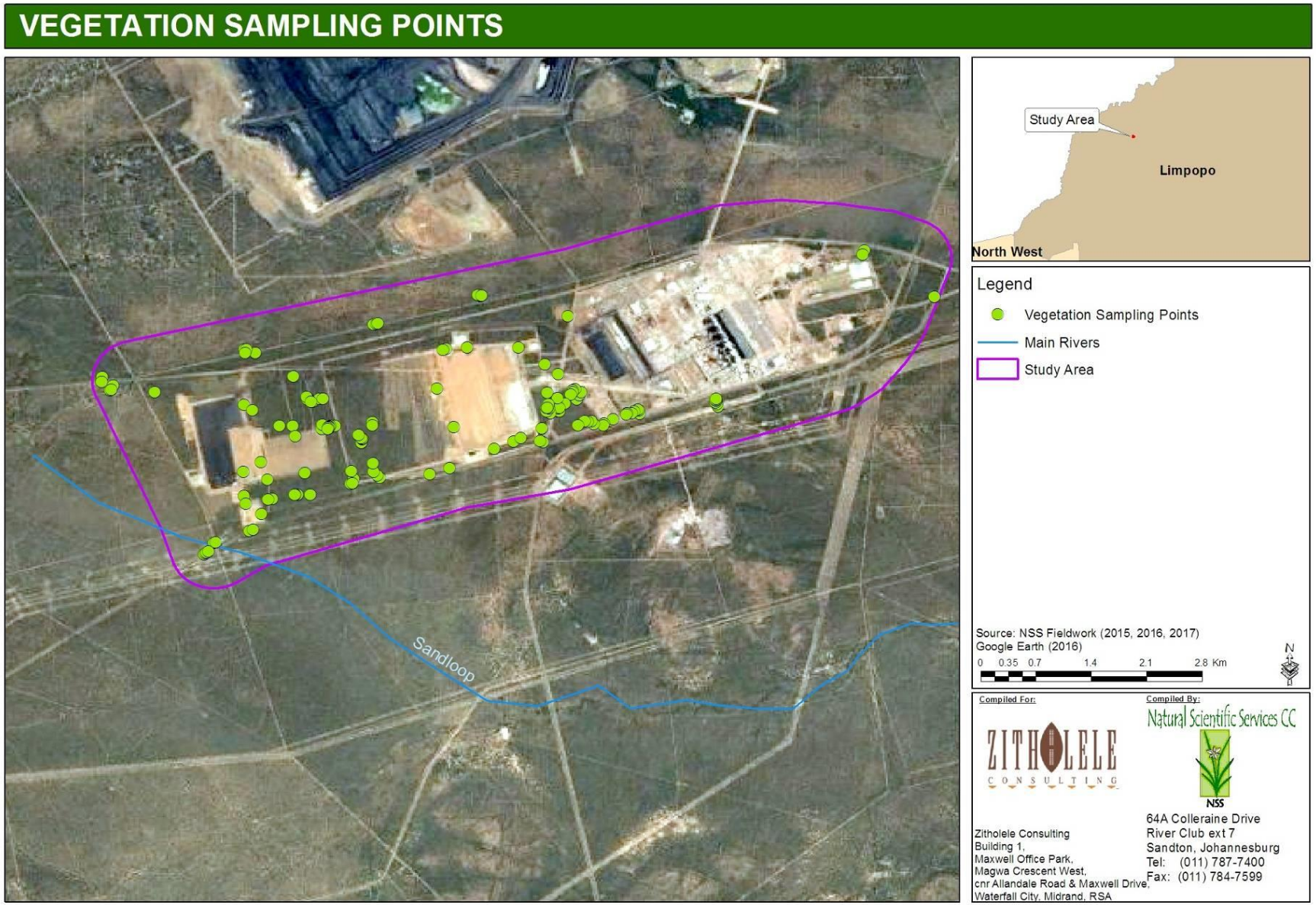


Figure 6-1 Main vegetation sampling points

6.1.3 *Data Analysis*

- The Juice (version 7.0.99) software program for management, analysis and classification of ecological data was used to conduct a TWINSPAN Detrended Correspondence Analysis (DCA) (Tichy & Holt, 2006) on the limited sampling points. 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.
- For CI floral species, Likelihood of Occurrence (LO) rating is assigned to each species based on the availability of suitable habitat using the following scale:
    - Present
    - Highly likely
    - Possible
    - Unlikely
    - No Habitat

Table 6-1 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

6.1.4 *Limitations*

It is important to note that the absence of species on site does not conclude that the species is not present at the site. Reasons for not finding certain species during the different visits (all conducted in mid-summer) may be due to:

- The fragmented nature of the remaining natural vegetation within the boundary of the Medupi Power Station FGD Project area.
- The duration of fieldwork and the period at which rainfall events took place. I.e. while the December 2015 fieldwork took place during a heavy rainfall period – this was beneficial for faunal species. Floral species require some growth time after such events.
- Some plant species, which are small, have short flowering times, rare or otherwise difficult to detect may not have been detected even though they were potentially present on site.

- As an alternative to other vegetation cover methods (such as the Domin method), the Braun-Blanquet cover-abundance scale was used to analyse 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).

6.2. Faunal Communities

6.2.1 *Desktop Research*

Lists of potentially occurring faunal species (**Appendices 2-7**) were based on distribution data sourced for:

- Mammals, using the published species distribution maps in Friedmann & Daly (2004), as well as the online species distribution data provided by the ADU's MammalMap (2018) for the regional QDSs 2327CB, 2327DA, 2327CD and 2327DC.
- Birds, using the online species distribution data from the first and second Southern African Bird Atlas Projects (SABAP 1 & 2, 2018) for QDSs 2327CB, 2327DA and respective pentads 2340_2725 and 2340_2730.
- Reptiles, using the published species distribution maps in Bates *et al.* (2014) and the online species distribution data from ReptileMap (2018) for all four regional QDSs.
- Frogs, using the published species distribution maps in Minter *et al.* (2004) and the online species distribution data from FrogMap (2018) for all four QDSs.
- Butterflies, using the online species distribution data from Mecenero *et al.* (2015) and LepiMap (2018) for all four QDSs.
- Dragonflies and damselflies (odonata), using distribution maps and habitat information provided in Samways (2008).

- Scorpions, using distribution maps and habitat information provided in Leeming (2003).
- Baboon Spiders, using distribution maps provided in Dippenaar-Schoeman (2002).

A Likelihood of Occurrence (LO) rating was then assigned to each species based on distribution and the availability of suitable habitat using the following scale:

1 Present
2 High
3 Moderate
4 Unlikely
5 The species would only occur in the area as a managed population.

Species lists were then supplemented with records obtained by BEC (2006) as part of the Medupi EMPR, as well as combined records from NSS studies in the Vicinity at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station.

6.2.2 *Fieldwork*

NSS visited the greater FGD study area three times i.e. during 12-13 January 2015, 9-11 November 2015 and 7-11 December 2015. During the first two visits a brief scan was performed, which involved active searching, deployment of motion cameras, and night time bat and frog acoustic surveys. The final five day survey followed a similar approach but with the addition of live-trapping.

Visual observations, grab-sampling and netting

Faunal observations were made during active point searches both by day and night on foot and incidentally while driving in and around the study area. Herpetofauna were searched for by turning rocks, logs and mats deployed during the November visit. Holes were investigated using a burrow scope. Tadpoles were sampled by dipnetting, and identified based on morphology and labial tooth row formula. Sweepnetting was used to sample butterflies. Scorpions were searched for under bark and rocks. Mammals were detected from observations of dead or live animals and their spoor, droppings, burrows and any other evidence of their presence. Birds were identified based on direct observation or from their calls and flight behaviour. Spotlighting during slow night drives was used to detect additional nocturnal fauna.

Live-trapping

In total, four live-trapping sites were installed in and around the FGD study area. Each trap site consisted of one array trap and a set of rodent traps. The trap sites operated over five days and four nights, and were checked daily. The location of each trap site is mapped in **Figure 6-5**.

Trap sites and techniques are shown in **Figure 6-2** and **Figure 6-4**, respectively. Additionally three sets of five large Astroturf mats were deployed during the November visit targeting reptiles, frogs and fossorial fauna. The mats were recollected during the December visit.

Trap Site 1 Trap Site 2 Trap Site 3 Trap Site 4

Figure 6-2 Live trapping sites

A schematic layout of an array trap site is presented in **Figure 6-3**. The array traps (Campbell & Christman, 1982) were used to sample herpetofauna (reptiles and frogs) and terrestrial macro-invertebrates. Each array consisted of three arms of plastic drift fencing (30cm high and 8m 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.

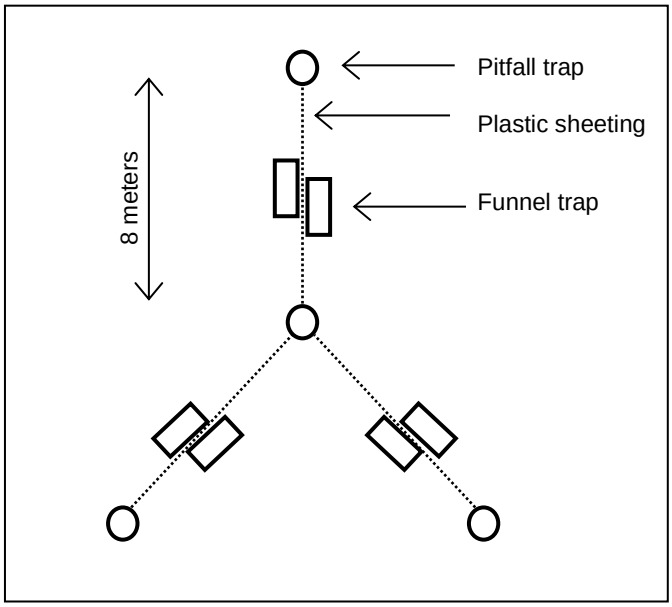


Figure 6-3 Schematic layout of an array trap including drift fences, pitfall and funnel traps

A live rodent trapping transect typically included a series of metal rodent traps spaced at 5-10m intervals. Each series included one pair of multi-entry traps, and 16 Sherman traps. Each trap was baited with a mixture of peanut butter, rolled oats, raisins, sunflower oil and seeds, and supplied with cotton wool and a wooden cover board to provide warmth and shade for trapped animals. The traps were checked daily and re-baited when necessary.

Funnel and pitfall traps along drift fence

Sherman rodent trap

Motion camera

Mat Trap

Figure 6-4 Examples of sampling techniques employed

Acoustic survey for bats and frogs

Bat calls were recorded during a short driven transect in the study area (**Figure 6-5**) using an ultra-sonic Echo Meter 3 (EM3) detector (Wildlife Acoustics, Inc., USA). Wildlife Acoustics Compressed (.wac) files of bat calls recorded by the EM3 detector were converted to zero crossing (.zc) and wave (.wav) 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.

Camera-trapping

Motion-sensitive cameras, set to record both infrared and flash images, were installed in and around the FGD study area where vertebrate activity was deemed likely, such as near water holes, game feeding stations or along paths (**Figure 6-5** and **Figure 6-4**). Some cameras were baited to attract secretive, nocturnal, carnivorous mammals.

Designation of Conservation Status

In the appended faunal species lists the global, national and provincial conservation status of applicable species is provided. Global and National Red Lists are based on the IUCN Red List criteria and categories, shown in **Figure 6-6,** which were developed to provide a simple and effective system for rating the conservation status of species, mainly at global and regional levels. The global status of species was sourced from the IUCN (2017.3) Red List. The latest national Red List status of species was sourced for mammals, birds, reptiles, frogs and butterflies from the atlases and Red Data books by SANBI & EWT (unpubl.), Taylor *et al.* (2015), Bates *et al.* (2014), Minter *et al.* (2004) and Mecenero *et al.* (2013), respectively. A legally-binding national list of Threatened or Protected Species (ToPS, 2015) is provided under the 2004 National Environmental Management: Biodiversity Act (NEMBA). 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.

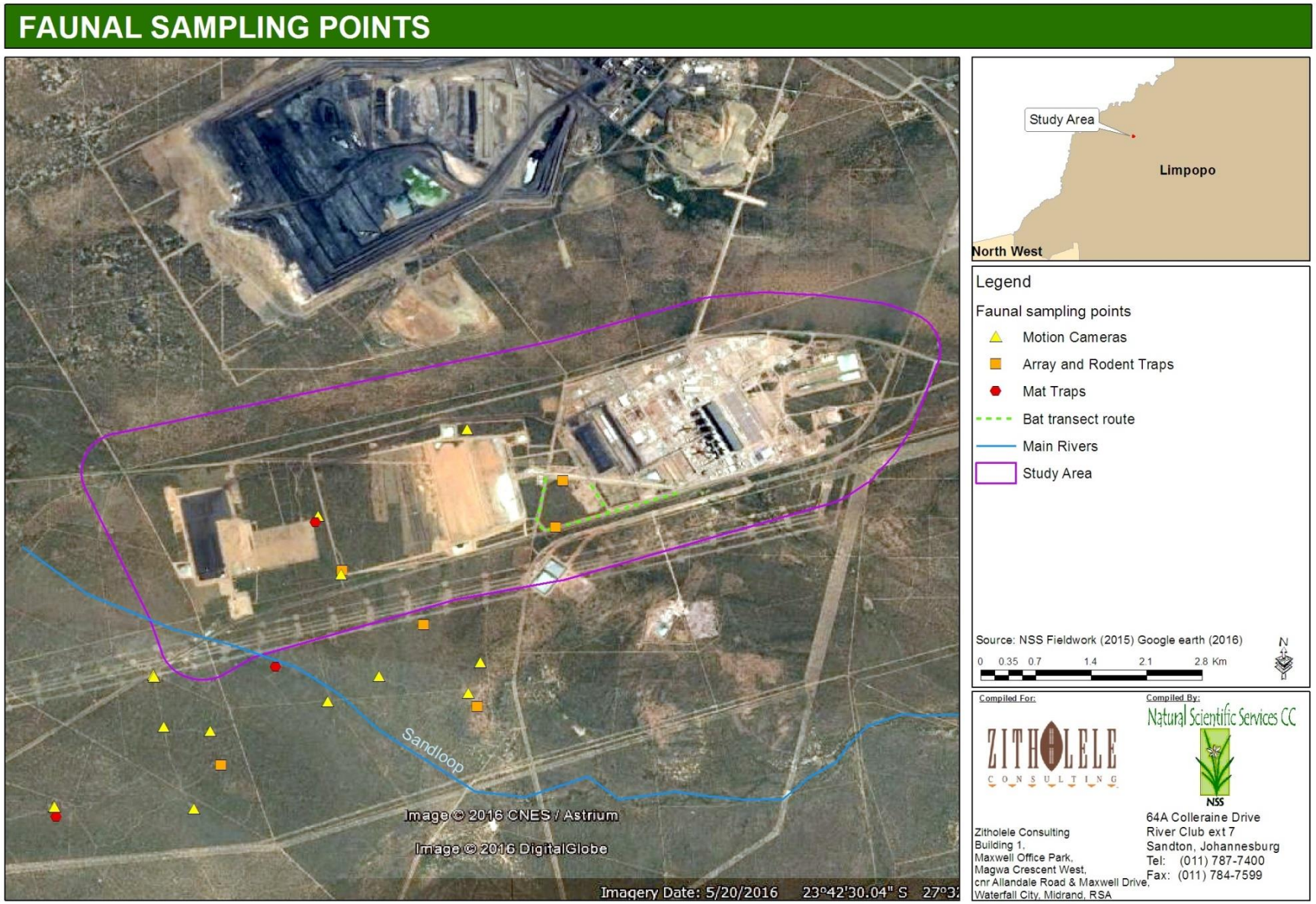


Figure 6-5 Layout of faunal sampling points showing the bat acoustic transect and position of the motion cameras.

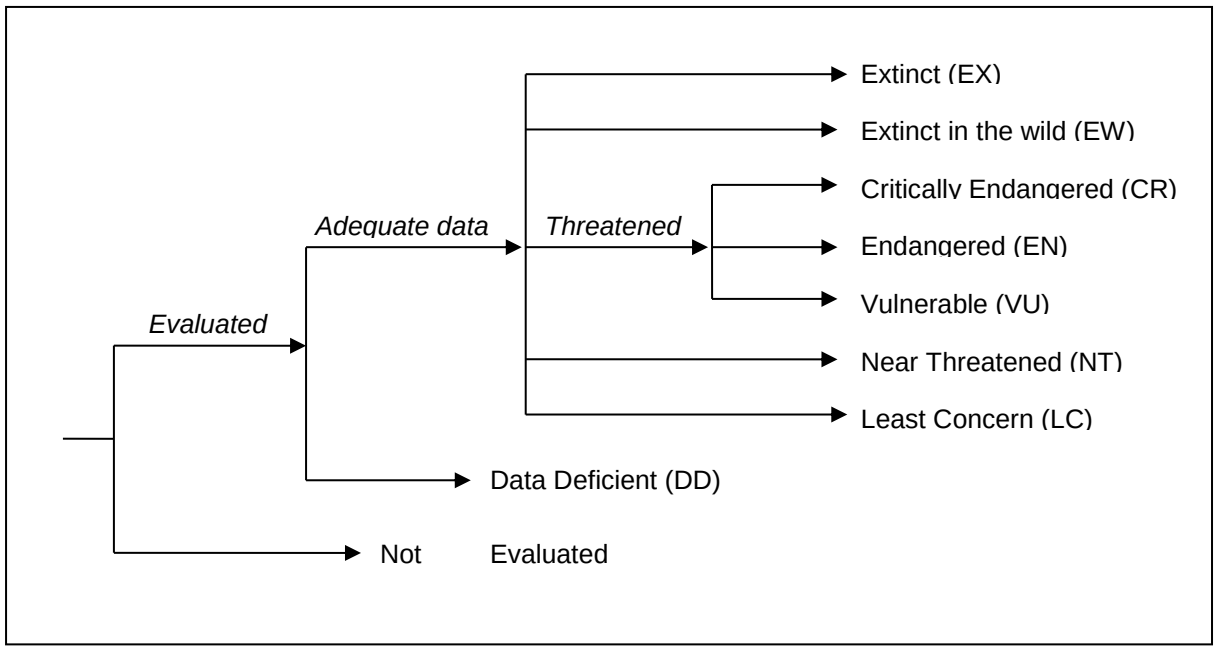


Figure 6-6 IUCN Red List categories

6.2.3 *Limitations*

Several inherent and unavoidable limitations need to be considered when interpreting survey results. Reasons for the lack of detection of some species include:

- Inductions and security protocol which significantly decreased the amount of time spent in the study area.
- The small, fragmented nature of the study area, and disturbances from Medupi Power Station.
- The short duration of each field survey, and the lack of significant rainfall preceding the January survey.
- The cryptic nature of certain species or simply lack of species presence. Some animal species, which are uncommon, small, migratory, secretive or otherwise difficult to find may not have been detected even though they were potentially present in the study area.

6.3. Watercourses, Wetlands and Ephemeral Systems

As part of this study it is important to define what systems are being investigated. As mentioned in **Section 5,** the study area lies within a drier region of the country where evapotranspiration exceeds rainfall. Rainfall in this region is approximately 400mm per annum. Systems, therefore within this region are largely ephemeral and are seen as drainage systems that potentially flow intermittently. These fall under the definition of a Watercourse.

A watercourse defined by the National Water Act (Act 36 of 1998) means –

(a) a river or spring;

(b) a natural channel or depression in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse as defined in the National Water Act, 1998 (Act No. 36 of 1998) and reference to a watercourse includes, where relevant, its bed and banks;

When discussing a wetland, the definition used within this study is that defined by the Ramsar Convention[1] and those used within publications such as the "Classification System for Wetlands and other Aquatic Ecosystems in South Africa" (Ollis *et al*. 2013) which incorporates both the definition of Aquatic Ecosystems[2] and Wetlands[3] as defined by the National Water Act (Act 36 of 1998).

The National Water Act 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".*

Due to the extent of the areas to be investigated, the ToR for NSS was to identify and delineate watercourses and wetland systems at a desktop level within a 500m buffer of the MPS and ADF and to then undertake limited ground truthing (mainly within December 2015 and November 2016) within the areas identified. Prior to any field investigations being undertaken, the area was therefore surveyed at a desktop level using 1:50 000 topographical maps, Google Earth™ Imagery, and available contour data (a relatively flat region, so contour data limiting in this assessment) to determine the layout of potential watercourses and wetlands within the study site and immediate surrounds.

6.3.1 *Classification of the Watercourses and Wetlands*

Where wetlands were found, they were defined using the classification system discussed above by Ollis *et al*. (2013), hereafter referred to as "the Classification System". The Classification System recognizes three broad inland systems: rivers, wetlands and open water bodies. Like Kotze ***et al's.*** (2008) classification of wetlands based on hydro-geomorphic (HGM) units, the Ollis *et al*. (2013) Classification System asserts that the

[1] "*Wetlands – 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 meters*" Ramsar Convention Secretariat, 2011.

[2] Aquatic Ecosystem: *an ecosystem that is permanently or periodically inundated by flowing or standing water, or which has soils that are permanently or periodically saturated within 0.5m of the soil surface.*

[3] [3] NWA 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."*

functioning of an inland aquatic ecosystem is determined fundamentally by hydrology and geomorphology.

The Classification System has a six-tiered structure where under the determination of a system's HGM unit (Level 4) is the most fundamental:

Level 1 – Type of Systems (Marine, estuarine or Inland)
Level 2 – Regional Setting (Level 1 Ecoregions; NFEPA WetVeg units etc)
Level 3 – Landscape Unit (Valley Floor, Slope, Plain, Bench)
Level 4 – Hydrogeomorphic (HGM) Unit
Level 5 – Hydrological Regime
Level 6 – Descriptors (e.g. Natural vs Artificial; Salinity; pH etc)

6.3.1.1 Ephemeral Systems (Watercourses)

Within the study area there are a number of drainage features referred to hereafter as Semi-Ephemeral Washes (SEWs). These are situated in the upper reaches of their catchment and characterised by a very gradual slope (<1%) and cross sectional profile. Although a very slight change in vegetation structure (not composition) is sometimes apparent, no clearly defined channel is obvious and it is often difficult to locate these systems on the ground without the aid of aerial imagery.

6.3.2 *Wetlands and Riparian Extent*

Where required, the wetland delineation methods used in the field were the same as those outlined in the DWS field procedure for identification and delineation of wetlands and riparian areas (DWAF, 2005). The following three indicators described by DWAF (2005) were used:

- *Terrain Unit Indicator*: The topography of the area was used to determine where in the landscape wetlands were likely to occur. During the December 2015 field visit the site experienced 38mm of rainfall in one week. This assisted NSS in determining the flow paths of a number of the ephemeral systems on site. In addition, aerial imagery and contour data were used to identify potential flow paths in the landscape.
- *Soil Wetness Indicator*: The soil wetness and duration of wetness are indicated by the colour of the soil. A grey soil matrix such as a G-horizon is an indication of wetness for prolonged periods of time and mottles indicate a fluctuating water table. In terms of the DWS guidelines (DWAF, 2005), signs of soil wetness must be found within the top 50 cm of the soil surface to classify as a wetland. Temporary wetlands in arid environments however do not usually exhibit mottling, because often the soils have naturally low levels of iron, and the soils are by definition not exposed to the specific conditions under which such indicators are formed so the absence of mottles does not necessarily indicate the absence of a wetland in these systems (Day *et al*, 2010). Where possible, soils data supplied by ESS (2016) for the study area were used to identify wet-based and alluvial soils; and
- *Vegetation Indicator*: Vegetation is a key component of the wetland definition in the National Water Act, 1998 (Act No 36 of 1998), and vegetation can be used as an indicator of wetland conditions. The presence / absence of hydrophytes usually

provide a useful additional criterion in determining the boundaries of wetlands. Within arid environments and the temporary wetlands identified on site it was more the change in vegetation structure and facultative wetland plants (helophytes) that were used as wetland indicators, as opposed to only hydrophytes. (Day *et al*. 2010). The delineation of riparian vegetation was conducted using the three simple steps outlined by Mackenzie & Rountree (2007), for sites that support predominantly indigenous and naturally occurring vegetation, as such:

- Starting at the sides of the channel, identify the edge of the zone of obligate riparian plants using the regional riparian vegetation indicator list.
- Check if there are hydric indicators in the soil, such as G-horizons or soil mottling, or evidence of unconsolidated recent alluvial sediment. Find the outer edges of these indicators.
- Examine the geomorphology (shape) of the channel and river banks. The locations selected based on riparian indicator species or soil features described above, should be at or close to the edge of the "macro-channel bank" (in the case of erosive rivers) or at the edge of an active floodplain / flood zone (in the case of alluvial depositional rivers). At this point, or nearby, should be an inflection point (change of slope) between the riparian area and the upland (terrestrial) slopes. This site can be considered as the edge of the riparian zone.

The study site was traversed, on foot, with select areas chosen from the desktop mapping for limited ground truthing. Soil samples, within the top 50cm and deeper where necessary, of the soil profile, were taken using a hand auger along transects across the property and within areas where wetland vegetation indicators were present. The areas were assessed for the above wetland indicators. Each auger point sampled was marked with a handheld Global Positioning System (GPS) device (Geographic projection, WGS 84 Datum).

6.3.3 *Present Ecological State*

6.3.3.1 Semi-Ephemeral Washes

Although this is not an HGM unit defined specifically in Ollis *et al* (2013), an attempt was made to obtain a PES score using the Level 1 WET-HEALTH tool of Macfarlane *et al.* (2008). In spite of this limitation it is our opinion that the scores attained for the wetlands are representative and therefore afforded a high confidence. The WET-HEALTH tool is designed to assess the health or integrity of a wetland. To assess wetland health, the tool uses indicators based on the main wetland drivers: geomorphology, hydrology and vegetation.

Macfarlane *et al.* (2008) explain that the application and methodology of WET-HEALTH 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 afforestation

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, e.g. erosion or alien plants. This approach is mainly used in the assessment of geomorphology and vegetation health.

With WET-HEALTH a wetland is first classified into HGM units (Level 4 – Ollis *et al.* 2013), and each HGM unit is separately assessed in terms of the extent, intensity and magnitude of impacts on the hydrology, geomorphology and vegetation of the unit, which is translated into a health score as follows:

- The *extent* of impact is measured as the proportion (percentage) of a wetland and/or its catchment that is affected by an activity.
- 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 magnitudes of all activities in each HGM unit are then combined in a structured and transparent way to calculate the overall impact of all activities that affect a unit's hydrology, geomorphology and vegetation, and wetland PES is expressed on a scale of A-F (**Table 6-2**).

Table 6-2 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 discernible 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)

In addition, the threat and/or vulnerability of a wetland must be assessed to determine its likely "trajectory of change" (**Table 6-3**). Overall wetland health is then jointly represented by the wetland's PES and 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 6-3 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)			

6.3.3.2 Pan Systems

Historically there has been little research done in South Africa on pans, especially when compared to palustrine[4] wetlands (Ferreira, 2012). In terms of assessing the functioning and ecosystem services supplied by ephemeral pans, the standard methods used in South Africa are not applicable as these focus on palustrine systems.

Ferreira (2012) undertook his PhD on developing a methodology for determining the ecological integrity of *perennial* endorheic pans within South Africa. Unfortunately this methodology is not applicable to the ephemeral pan system identified within the study area, and no method is available in South Africa to assess the habitat integrity of such systems. In spite of this limitation it is our opinion that the scores attained for the wetlands are representative and therefore afforded a high confidence. The main impacts for the various pan systems have therefore been discussed, based on expert opinion, under **Section 7.6**.

6.3.4 *Predicted Ecological State*

In order to assess the anticipated gains/losses to wetland health, specifically the semi-ephemeral washes associated with upper tributaries of the Sandloop as a result of the proposed development, a hectare equivalent approach was adopted using scoring guidelines and equations as presented in the WRC document WET – RehabEvaluate (Cowden & Kotze, 2008). First an overall ecological health score for the wetland with and without mitigation for all three alternatives was calculated by taking a weighted average of the three wetland drivers namely hydrology, geomorphology and vegetation using a 3:2:2 weighting ratio

[4] Palustrine: All non-tidal wetlands dominated by persistent emergent plants, emergent mosses or lichens, or shrubs or trees (Kotze *et al*, 2008)

respectively. Secondly this score was then used in to calculate hectare equivalents which represent the extent of functional wetland in relation to the total wetland extent. This was done using the following formula:

((Overall Health Score – 10) / 10) x Wetland Area = Hectare Equivalent

6.3.5 *Ecosystem Services*

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. No palustrine wetlands were identified on site, but rather semi-ephemeral drainage features (Washes). This proposed methodology was only utilised in this assessment as a guide to the services offered by the different systems. In spite of this limitation it is our opinion that the scores attained for the wetlands are representative and therefore afforded a high confidence.

6.3.6 *Ecological Importance and Sensitivity*

The assessment of wetland Ecological Importance and Sensitivity (EIS) was based on the EIS Tool developed by Rountree and Kotze (2012). The purpose of assessing the EIS of water resources is to identify those systems that provide higher than average ecosystem services and/or biodiversity support functions, and/or are especially sensitive to impacts.

The Tool collectively considers:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWS and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, which considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of basic human benefits - this suite of criteria consider the subsistence uses and cultural benefits of the wetland system.

It is recommended that the highest scoring of these three criteria be used to determine the overall Importance and Sensitivity category (**Table 6-4**) of the wetland system.

Table 6-4 Ecological importance and sensitivity categories – Interpretation of median scores for biotic and habitat determinants

Range of Median	Ecological Importance & Sensitivity (EIS)	Recommended EMC
>3 and <=4	**Very high** 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** Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems 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** Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems 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.	**C**
>0 and <=1	**Low/Marginal** Wetlands which are not ecologically important and sensitive at any scale. The biodiversity of these systems 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**

6.3.7 *Sediment*

Sediment samples were collected to determine the metal concentrations of the samples. These sediment samples were collected at six of the sampling sites during the high flow season (December 2015) and two additional samples within the November 2016 visit. The sediment samples were collected in PET jars, frozen to prevent any organic decomposition and sent to the Water Research Group (WRG) at the Potchefstroom Campus of North-West University for the metal analysis.

The analysis for metals involved a total digestion of sediments and was based on the methodology of Hassan *et al.* (2007). Each sediment sample was oven-dried for 2–4 days at 70°C. A known amount of each sample (approximately 0.5 g) was digested with Suprapur nitric acid (HNO_3) in a MARS 5 Microwave Digester for 20 minutes. The samples were then diluted and filtered with 0.45 µm cellulose nitrate under vacuum pressure. The filtered extract was analysed by Inductively Coupled Plasma – Optical Emission Spectrophotometer (ICP-OES) and an Inductively Coupled Plasma – Mass Spectrophotometer (ICP-MS). The results are expressed as mg/kg. Currently no sediment quality guidelines (SQGs) exist for freshwaters in South Africa. Therefore, the concentrations for each of the metals are compared to international standards and other local studies.

6.3.7.1 Invertebrate Hatching

The aim of the invertebrate hatching was to determine if any invertebrate resting eggs were present in the sediment from selected pans in the study area. Certain invertebrates, especially Branchiopoda, form resting eggs of ephippia to overcome the harsh conditions experienced in ephemeral wetlands. These resting eggs within the sediment are thus called the egg bank. The resting eggs remain in the sediment until the correct environmental triggers and conditions are present. The hatchlings are the first inhabitants of these ephemeral pans before other insect taxa colonise the system. When these ephemeral systems are dry it is impossible to determine what the biological community will comprise of when it is inundated. However, determining what the initial community will be comprised of can go a long way to provide an indication of the potential community.

Sediment samples from site MD7 and site MD8 were dried, at room temperature, upon receiving the samples from the field investigations, for a minimum of 48 hours. The hatching experiments were completed at a room temperature of approximately 22 °C. Each sample was hatched in triplicate. A known amount of sediment, 25g, was placed into 2L plastic containers for the hatching experiment. The experiment was initiated when 1L of distilled water was added to each hatching container. Due to time constraints the hatching experiment was allowed to run for 10 days but it would have been ideal to continue for up to 28 days. The hatching containers were examined every three to four days for any sign of invertebrate hatchlings. A small amount of oxygen was also added to each container when they were examined for invertebrate hatchlings. Both sites, MD7 and MD8, indicated that hatching of invertebrates occurred more or less after three days.

6.3.7.2 Comparative analysis with Water Quality Results

NSS collected water quality samples for Golder & Associates Surface Water Quality Assessment at the same time and position as the Sediment Samples. Water quality (WQ) is used to describe the aesthetic, biological, chemical and physical properties of water that 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 WQ properties. For example, in some cases anthropogenic activities can cause the physio-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 an aquatic ecosystem crosses these thresholds, it will be difficult to recover or regain its functional capacity without mitigation. It must also be taken into consideration that determining the effects of changes in WQ on aquatic ecosystems is considered complex, as these systems can fluctuate spatially and temporally. For this project the results from the WQ analysis were used to compare those found within the sediment analysis.

6.3.8 *Limitations*

Even though all attempts were made to take samples under optimal conditions certain limitations were encountered. The limitations to this study included:

- Wetland assessment techniques are inherently subjective.
- The PES and EcoServices were also not designed for systems such as Ephemeral Washes
- The boundary determined by infield wetland delineation can often occur within a certain tolerance because of the potential for the change in gradient of the wetness zones within wetlands.
- The modification of the soil profile related to agricultural activities and the clearing of the site and the modification of the hydrological conditions within disturbed sites limits the accuracy of the resulting boundary as the sampling methodology relies heavily on interpretation of undisturbed soil morphology and characteristic.
- The use of vegetation indicators (seasonal and temporary zones) was limited to non-existent due to the ephemeral nature of the systems. Riparian vegetation was even not evident. Only vegetation structure in comparison to surrounding areas was conducted.
- Water was limited to sandy pools within the drainage features in the study area.
- None of the biomonitoring indices (**Box 1**) could be used due to the ephemeral nature of these systems (Not within this Scope). Instead Invertebrate hatching at two pans in the ADF site was conducted. Due to time constraints the hatching experiment was allowed to run for 10 days but it would have been ideal to continue for up to 28 days.

Box 1

* The assessment of macro-invertebrate communities in a river system is a recognised means of determining river "health". Macro-invertebrates are good indicators because they are visible, easy to identify and have rapid life cycles (Dickens & Graham, 2002). According to Dickens & Graham (2002), the SASS5 (South African Scoring System, version 5) method is designed for low/moderate flow hydrology and is not applicable in wetlands, impoundments, estuaries and other lentic habitats. In addition, it has not been tested in ephemeral rivers and so should be used with caution.

* No fish sampling was performed during the current study as the sampling sites were shallow pools with limited water levels. The Fish Response Assessment Index (FRAI) developed by Kleynhans (2008) cannot not be used in these ephemeral systems.

7. Results

7.1. Vegetation Communities

SANBI frequently collect/collate floral data within Southern Africa and update their PRECIS database system (National Herbarium Pretoria (PRE) Computerised Information System) which is captured according to QDS. For this study, the site falls with 2327DA. Species within the POSA database for this QDS do not exceed 311 species (Date extracted February 2015) and represent 68 Families. The dominant families being FABACEAE, POACEAE and MALVACEAE (**Table 7-1**), with the herbs representing 30.87%, dwarf shrubs 14.47%, shrubs to small trees 15.76% and graminoids representing 11.25% of the total species listed for the area. This is a typical representation of vegetation structure for savanna communities.

Table 7-1 Top Ten Dominant Families and Most Dominant Growth Forms obtained from the POSA website for the QDS 2327DA

IMPORTANT FAMILIES	No. OF SPP	GROWTH FORMS	% TOTAL SPP
FABACEAE	38	Herb	30.87
POACEAE	35	Dwarf shrub	14.47
MALVACEAE	35	Graminoid	11.25
ACANTHACEAE	17	Shrub	9.65
ASTERACEAE	16	Shrub to small tree	6.11
CONVOLVULACEAE	11	Climbers	5.14
APOCYNACEAE	11	Geophyte	4.5
EUPHORBIACEAE	10	Succulent	3.86
HYACINTHACEAE	9	Tree	3.54
RUBIACEAE	8	Bryophyte	2.57

7.1.1 *Vegetation Communities*

For a more detailed sampling of the project area, sample points were investigated in various natural and semi natural habitats of the study area and analysed using TWINSPAN. The study area was very homogenous in nature, fragmented and largely disturbed through clearing etc. This made it difficult to use a sampling method that would yield different communities. The main plant communities were identified based on understory coverage and disturbances (**Table 7-2** and **Figure 7-2**). These communities were mainly *Acacia* dominated Woodlands with associated Wetlands and included: *Acacia nigrescens* - *Grewia* Open Veld; *Acacia nigrescens –Combretum apiculatum* dominated woodland, *Acacia erubescens* - *Grewia* Thornveld, Disturbed *A nigrescens-Dicrostachys-Grewia* fragmented Thornveld and Disturbed *Acacia* mixed woodland. Associated wetland and hydromorphic areas included the *Acacia* dominated Wetland Flats, Depressions and Artificial Waterbodies.

Acacia nigrescens –Combretum apiculatum dominated woodland

Acacia nigrescens - Grewia Open Veld

A nigrescens-Dicrostachys-Grewia fragmented Thornveld

Depressions within the *Acacia* Woodlands

Depressions within the *Acacia* Woodlands

Acacia erubescens - Grewia Thornveld

Acacia erubescens - Grewia Thornveld

Waterbodies

Waterbodies

Acacia mixed woodland

Acacia dominated Wetland Flat

Figure 7-1 Photographic representation of the different vegetation found within the study area

Table 7-2 Vegetation Communities

UNIT	HABITAT & VEGETATION COMMUNITIES	% COVERAGE
A	**Main Vegetation Communities – Acacia Woodlands**	
	Acacia nigrescens - Grewia Open Veld	9.19
	Acacia nigrescens –Combretum apiculatum dominated woodland	22.87
	Acacia erubescens - Grewia Thornveld	2.26

UNIT	HABITAT & VEGETATION COMMUNITIES	% COVERAGE
B	**Disturbed Woodlands**	
	A nigrescens-Dicrostachys-Grewia fragmented Thornveld	8.27
	Acacia mixed woodland	6.59
C	**Transformed**	
	Disturbed (previously scraped)	11.47
	Cleared areas and stockpiles	14.61
	Roads and Storm Water	4.32
	Infrastructure	16.21
D	**Wetland Areas / Hydromorphic Grasslands**	
	Acacia dominated Wetland Flat	3.56
	Depressions	0.37
	Artificial water points / Waterbodies	0.15

A description and photographic evidence for each main natural vegetation unit is provided in the Tables below (**Table 7-3** to **Table 7-7**). This excludes depressions (lack of vegetation, with only occasional hydromorphic species present), waterbodies and transformed areas such as the alien bushclumps and any agricultural areas. The *Acacia* dominated Wetland Flats were situated within the *Acacia* Woodland Communities and showed limited variation from the surrounding vegetation other than a denser leaf coverage and height change. Wetlands constituted over 4% of the study area.

Table 7-3 ***Acacia nigrescens - Grewia*** **Open Veld Vegetation Description**

Acacia nigrescens - Grewia Open Veld	
Photographic representation	 
National Zones:	C-Plan Ecological Support Area; Waterberg CBA-Optimal, LC Vegetation Type ; Sweet Limpopo Bushveld
Sub-Community	*A nigrescens-Dicrostachys-Grewia fragmented Thornveld*
% Site Coverage	9.19 % - mainly in the northern region; Fragmented Habitat – 8.27%
Condition:	▪ Limited to no alien encroachment ▪ Quicker establishing grass species – dominated by Increaser 2 and sub-climax species
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT) ▪ *Spirostachys africana Sond.* (PT)
Common	▪ *Abutilon cf austro-africanum* ▪ *Digitaria eriantha Steud.*

Acacia nigrescens - Grewia Open Veld		
species:	*Hochr.* ▪ *Acacia karroo Hayne* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Agathisanthemum bojeri Klotzsch subsp. bojeri* ▪ *Alistilus bechuanicus N.E.Br.* ▪ *Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter* ▪ *Aristida stipitata Hack.* ▪ *Asparagus cf cooperi Baker* ▪ *Boscia albitrunca (Burch.) Gilg & Gilg-Ben.* ▪ *Chlorophytum recurvifolium (Baker) C.Archer & Kativu* ▪ *Clerodendrum ternatum Schinz* ▪ *Combretum apiculatum Sond. subsp. apiculatum* ▪ *Commelina africana L. var. africana* ▪ *Commelina benghalensis L.* ▪ *Cyperus margaritaceus Vahl var. margaritaceus*	▪ *Dipcadi viride (L.) Moench* ▪ *Eragrostis superba Peyr.* ▪ *Evolvulus alsinoides (L.) L.* ▪ *Gomphocarpus tomentosus Burch. subsp. tomentosus* ▪ *Grewia flavescens Juss.* ▪ *Grewia monticola Sond.* ▪ *Heliotropium ciliatum Kaplan* ▪ *Hermannia spp* ▪ *Ipomoea bolusiana* ▪ *Kyllinga alba Nees* ▪ *Oxygonum dregeanum Meisn. subsp. canescens (Sond.) Germish. var. canescens* ▪ *Panicum maximum Jacq.* ▪ *Pavonia burchellii* ▪ *Polygala amatymbica Eckl. & Zeyh.* ▪ *Polygala sphenoptera var. sphenoptera* ▪ *Schmidtia pappophoroides Steud.* ▪ *Solanum panduriforme Dr œge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis* ▪ *Terminalia sericea Burch. er DC.*
Species Examples:		
	Agathisanthemum bojeri	*Pavonia burchellii*
Current Conservation Status	**Medium**	
Current Conservation Status - *A nigrescens-Dicrostachys-Grewia fragmented Thornveld*	**Medium-Low**	

* Alien Species; *[1] Category 1 Alien Invasive; PT: Protected –DAFF;

Table 7-4 *Acacia nigrescens –Combretum apiculatum* Woodland Vegetation Description

***Acacia nigrescens –Combretum apiculatum* dominated woodland**	
Photographic representation	 
National Zones:	C-Plan Critical Biodiverse Area;Ecological Support Area; Waterberg CBA, LC Vegetation Type; Sweet Limpopo Bushveld
% Site Coverage	22.87 % - central region
Condition:	▪ Limited to no alien encroachment ▪ Similar species contribution to *Acacia nigrescens - Grewia* Open Veld ▪ Pioneer to sub-climax species; Increaser 2 species the most common
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT)
Common species:	▪ *Abutilon cf austro-africanum Hochr.* ▪ *Acacia erubescens Welw. er Oliv.* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Agathisanthemum bojeri Klotzsch subsp. bojeri* ▪ *Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter* ▪ *Aristida congesta Roem. & Schult. subsp. congesta* ▪ *Aristida stipitata Hack.* ▪ *Asparagus cf cooperi Baker* ▪ *Boscia albitrunca (Burch.) Gilg & Gilg-Ben.* ▪ *Cenchrus ciliaris L.* ▪ *Combretum apiculatum Sond. subsp. apiculatum* ▪ *Cyperus margaritaceus Vahl var. margaritaceus* ▪ *Eragrostis superba Peyr.* ▪ *Evolvulus alsinoides (L.) L.* ▪ *Gomphocarpus tomentosus Burch. subsp. tomentosus* ▪ *Grewia flavescens Juss.* ▪ *Grewia monticola Sond.* ▪ *Kyllinga alba Nees* ▪ *Oxygonum dregeanum Meisn. subsp. canescens (Sond.) Germish. var. canescens* ▪ *Panicum maximum Jacq.* ▪ *Polygala sphenoptera var. sphenoptera* ▪ *Schmidtia pappophoroides Steud.* ▪ *Sida ovata Forssk.* ▪ *Solanum panduriforme Droge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis*

Acacia nigrescens –Combretum apiculatum dominated woodland		
	▪ *Commelina africana var. africana*	
Species Examples:		
	Polygala sphenoptera var. sphenoptera	*Gomphocarpus tomentosus*
Current Conservation Status	**Medium**	

Table 7-5 *Acacia erubescens - Grewia Thornveld* Vegetation Description

Acacia erubescens - Grewia Thornveld		
Photographic representation		
National Zones:	Sandloop FEPA, C-Plan Critical Biodiverse Area; Waterberg CBA; LC Vegetation Type ; Sweet Limpopo Bushveld	
% Site Coverage	2.26 % - western section	
Condition:	▪ Limited to no alien encroachment ▪ Limited herbacous and grass cover present (even during the mid-summer sampling months)	
CI Species:	▪ *Ammocharis coranica (P)*	
Common species:	▪ *Acacia erubescens* ▪ *Acacia karroo Hayne* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter* ▪ *Aristida stipitata Hack.* ▪ *Asparagus spp*	▪ *Evolvulus alsinoides (L.)* ▪ *Eragrostis spp* ▪ *Grewia flava.* ▪ *Heliotropium ciliatum Kaplan* ▪ *Hermannia spp* ▪ *Ipomoea bolusiana* ▪ *Kyllinga alba Nees* ▪ *Oxygonum dregeanum Meisn.* ▪ *Panicum maximum Jacq.* ▪ *Pavonia burchellii* ▪ *Polygala amatymbica Eckl. &*

Acacia erubescens - Grewia Thornveld		
	▪ *Chlorophytum recurvifolium (Baker) C.Archer & Kativu* ▪ *Clerodendrum ternatum Schinz* ▪ *Commelina africana L. var. africana* ▪ *Digitaria eriantha Steud.* ▪ *Eragrostis superba Peyr.*	*Zeyh.* ▪ *Schmidtia pappophoroides Steud.* ▪ *Solanum panduriforme Dr ge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis* ▪ *Terminalia sericea Burch. er DC.*
Species Examples:		
	Ammocharis coránica flowers	*Ammocharis coránica* leaves
Current Conservation Status	**Medium**	

* Alien Species; *[1] Category 1 Alien Invasive; P: Protected under the ordinance;

Table 7-6 *Acacia* Mixed Woodland Vegetation Description

Acacia* mixed *woodland	
Photographic representation	 
National Zones:	C-Plan Ecological Support Area; LC Vegetation Type; Sweet Limpopo Bushveld
% Site Coverage	6.59% - eastern and southern region
Condition:	▪ Alien encroachment evident, specifically weedy species such as *Gomphrena* present ▪ Very fragmented habitat ▪ Quicker establishing grass species – dominated by Increaser 2 and sub-climax species
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT)
Common species:	▪ *Acacia erubescens Welw. er Oliv.* ▪ *Acacia karroo Hayne* ▪ *Evolvulus alsinoides (L.) L.* ▪ *Gomphocarpus tomentosus Burch.*

Acacia* mixed *woodland		
	▪ *Acacia mellifera (Vahl) Benth. subsp. detinens (Burch.) Brenan* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Aristida congesta Roem. & Schult. subsp. congesta* ▪ *Aristida stipitata Hack.* ▪ *Cenchrus ciliaris L.* ▪ *Chenopodium album L.** ▪ *Combretum apiculatum Sond. subsp. apiculatum* ▪ *Commelina africana L. var. africana* ▪ *Commelina benghalensis L.* ▪ *Conyza bonariensis (L.)Cronquist** ▪ *Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var. africana* ▪ *Eragrostis superba Peyr.*	*subsp. tomentosus* ▪ *Gomphrena celosioides Mart.** ▪ *Grewia flavescens Juss.* ▪ *Grewia monticola Sond.* ▪ *Ipomoea bolusiana* ▪ *Kyllinga alba Nees* ▪ *Melinis repens (Willd.) Zizka subsp. grandiflora (Hochst.) Zizka* ▪ *Monsonia glauca R.Knuth* ▪ *Panicum maximum Jacq.* ▪ *Pavonia burchellii* ▪ *Peltophorum africanum Sond.* ▪ *Schmidtia pappophoroides Steud.* ▪ *Sclerocarya birrea (A.Rich.) Hochst. subsp. caffra (Sond.) Kokwaro* ▪ *Sida ovata Forssk.* ▪ *Solanum panduriforme Droge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis* ▪ *Terminalia sericea Burch. er DC.*
Species Examples:		
	Terminalia sericea	*Justica flava*
Current Conservation Status	**Medium-Low**	

Table 7-7 Transformed Areas

Transformed Areas	
Photographic representation	 
National Zones:	C-Plan Ecological Support Area; LC Vegetation Type; Sweet Limpopo Bushveld
% Site Coverage	46.61% but constantly increasing due to the construction of the ADF and coal stockyard
Condition:	▪ Alien species scattered throughout these areas ▪ Very fragmented habitat ▪ Dominated by Pioneer, Increaser 2 and sub-climax species
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT)
Common species:	▪ *Acacia karroo Hayne* ▪ *Achyranthes aspera* ▪ *Aristida congesta Roem. & Schult. subsp. congesta* ▪ *Cenchrus ciliaris L.* ▪ *Chenopodium album L.* ▪ *Commelina benghalensis L.* ▪ *Conyza bonariensis (L.) Cronquist* ▪ *Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var. africana* ▪ *Gomphocarpus tomentosus Burch. subsp. tomentosus* ▪ *Gomphrena celosioides Mart.* ▪ *Melinis repens (Willd.) Zizka subsp. grandiflora (Hochst.) Zizka* ▪ *Monsonia glauca R.Knuth* ▪ *Nicotiana glauca* ▪ *Nidorella resedifolia DC. subsp. resedifolia* ▪ *Sida ovata Forssk.* ▪ *Solanum panduriforme Dr*ge er Dunal* ▪ *Urochloa brachyura (Hack.) Stapf* ▪ *Verbesina encelioides* ▪ *Xanthium strumarium L.*
Species Examples:	 *Dactyloctenium aegyptium*  *Monsonia cf angustifolia*
Current Conservation Status	**Low**

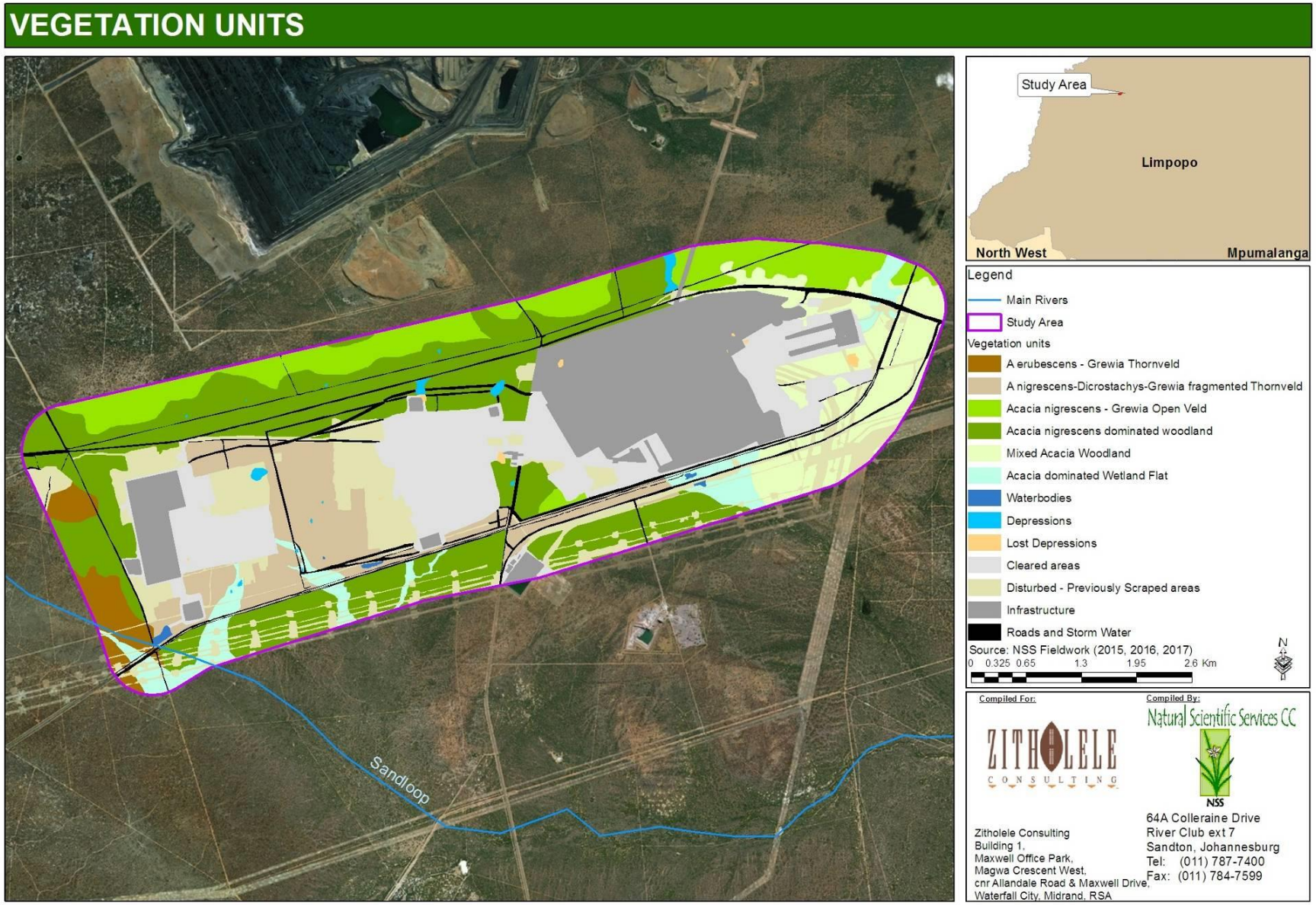


Figure 7-2 Vegetation Units for the study area

7.1.2 *Conservation Important (CI) 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). However, homogenous landscapes, either natural or that have been transformed through historical farming practices and infrastructural development contain minimal diversity and endemism. The FDG Study Area is situated in an area that is both natural and modified through soil stockpiling, fragmentation and clearing for construction of the ADF and MPS associated infrastructure. The remaining fragmented natural areas largely consist of *Acacia* woodland habitat that is homogenous in nature.

The Threatened Plant Species Programme (TSP) is an ongoing assessment that revises 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 Red Data list of South African plant taxa (POSA, March 2015), there are 212 Red Data listed species (**Table 7-8**) within Limpopo Province (including Data Deficient species) of which 14 species are Critically Endangered (CR), 17 Endangered (EN) and 40 are Vulnerable (VU).

Table 7-8 Numbers of conservation important plant species per Red Data category within South Africa and Limpopo

Threat Status	South Africa	Limpopo	2327DA
EX (Extinct)	28	0	0
EW (Extinct in the wild)	7	2	0
CR PE (Critically Endangered, Possibly Extinct)	57	2	0
CR (Critically Endangered)	332	14	0
EN (Endangered)	716	17	0
VU (Vulnerable)	1 217	40	0
NT (Near Threatened)	402	21	1
Critically Rare (known to occur only at a single site)	153	5	0
Rare (Limited population but not exposed to any direct or potential threat)	1 212	45	1
Declining (not threatened but processes are causing a continuing decline in the population)	47	19	0
LC (Least Concern)	13 856	3598	287
DDD (Data Deficient - Insufficient Information)	348	13	0
DDT (Data Deficient - Taxonomically Problematic)	904	34	1
Total spp. (including those not evaluated)	**23 399**	**4799**	**311**

**POSA last updated in 2012 – data may be out of date

From the POSA website (QDS 2327DA) and the data supplied by Limpopo for the surrounding farms, 3 CI species have been recorded in the region. The most threatened species recorded within the QDS is the *Eulalia aurea,* which is listed as **Near Threatened**. However, habitat availability for

this species is unlikely. *Corchorus psammophilus* could occur on site based on its habitat requirements. The conservation status of these species and others, their habitat preferences and the possibility of occurring on site has been provided in **Table 8.2** below. Although no Red Listed species were recorded, *Ammocharis coranica* and *Crinum buphanoides* were considered a Protected species under the Nature Conservation Ordinance, 12 of 1983, before Limpopo Province released more recent legislation [which repeals the Ordinance] - Limpopo Environmental Management Act NO. 7 OF 2003, the Protected Status of these species were revised and are no longer on the list.

Government Notice 39433 of 2015 provides the latest List of Protected Tree Species within the borders of South Africa under the NFA. A number of CI Protected Tree species were located during this study. Those found are represented in **Figure 7-3 and Table 7-9.**

- *Boscia albitrunca* (Burch.) Gilg & Gilg-Ben.
- *Sclerocarya birrea* (A.Rich.) Hochst. subsp. caffra (Sond.) Kokwaro
- *Spirostachys africana* Sond.

Boscia albitrunca (Burch.) Gilg & Gilg-Ben and *Sclerocarya birrea* are both Keystone species. Further information on these species and their importance is provided in **Section 9.1.5** below. In terms of Section 15(1) of the *National Forests Act* (NFA; Act 84 of 1998) 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.

Table 7-9 Species recorded in the surrounding farms QDG (PRECIS Data)

Family	Species	Threat status	Habitat	LoO
EUPHORBIACEAE	*Acalypha caperonioides Baill. var. caperonioides*	DDT	In grassland, *Brachystegia* woodland and at margins of vleis, typically after grass fires.	Unlikely
POACEAE	*Eulalia aurea (Bory) Kunth*	NT	In water, along rivers and in occasionally inundated soils.	Unlikely
EUPHORBIACEAE	*Euphorbia waterbergensis R.A.Dyer*	Rare	Quartzite ridges and outcrops, mixed bushveld, 900-1100 m.	Unlikely
MALVACEAE	*Corchorus psammophilus Codd*	Threatened	Sandy flats in open *Terminalia sericea* veld.	Possible

NT = Near Threatened; DDT= Data Deficient Taxonomically; P = Protected Limpopo

Spirostachys africana bark

Spirostachys africana leaves

Boscia creating habitat and shade for numerous faunal species

Sclerocarya birrea- Fruit

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

7.1.3 *Local Disturbances*

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)
    - NEM:BA Regulations August 2014 -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 NEMBA. 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) and promulgated in August 2014 (Government Gazette Vol. 590, No. 37885). The regulations list the categories for alien and listed invasive species. These are:

- Exempted species.
- **Category 1a** Listed Invasive Species -Species requiring compulsory control.
- **Category 1b** Listed Invasive Species - Invasive species controlled by an invasive species management programme.
- **Category 2** Listed Invasive Species- Invasive species controlled by area (2).
- **Category 3** Listed Invasive Species - Invasive species controlled by activity (3).

An updated set of Invasive Species Lists (as per the NEMBA Regulations) were published on 29 July 2016. This legislation became law on 1 October 2016 and replaced any earlier lists. Note: A species may be listed in different categories for different parts of the country.

According to POSA, over 55 species of Aliens have been recorded within the QDS. Of these 8 species are considered Category 1b species under NEMBA and must be controlled from any property on which they are found (i.e. an invasive species management programme needs to be in place). Patches of natural areas remain within the study area, specifically within the western section and therefore alien species did not completely dominate the landscape. Category 1 species that were identified on site occurred within the soil stockpile areas and included species such as *Nicotiana glauca* and *Xanthium strumarium*. (**Figure 7-4** and **Table 7-10**). These species will need to be controlled by the EO and team as part of MPS's management plan. A list of the main species recorded is supplied in **Table 7-10**.

Table 7-10 Main Alien Invasive Species found within the Study Area

FAMILY	SPECIES	GROWTH FORMS	CARA	NEMBA
AMARANTHACEAE	*Gomphrena celosioides Mart.*	Herb	Weed	Weed
ASTERACEAE	*Conyza cf. bonariensis (L.) Cronquist*	Herb	Weed	Weed
AMARANTHACEAE	*Achyranthes aspera*	Herb	1	
ASTERACEAE	*Xanthium strumarium L.*	Herb	1	1b
ASTERACEAE	*Verbesina encelioides*	Herb/shrub	Weed	Weed
CHENOPODIACEAE	*Chenopodium album L.*	Herb	Weed	Weed
SOLANACEAE	*Nicotiana glauca*	Shrub, tree	1	1b
VERBENACEAE	*Verbena cf bonariensis*	Herb		1b

* Highlights in green represent Category 1 species through either CARA or NEMBA

One species that was prolific in the soil stockpile areas close to the MPS was Golden crownbeard, (*Verbesina encelioides*). This species is part of the Asteraceae family from North America to the tropics and is an annual flowering shrub. As an invasive weed, it grows aggressively in stands within sandy soils, shading out indigenous vegetation, competing for nutrients and water as well as producing chemicals that are toxic to indigenous plants. Flowers produce up to 350 wind dispersed seeds by both cross- and self-pollination and stands self-seed annually. The seeds exhibit highest rate of germination in open, disturbed areas with sandy soils.

Conyza bonariensis

Achyranthes aspera

Nicotiana glauca

Nicotiana glauca in transformed area

Gomphrena celosioides

Verbesina encelioides

Figure 7-4 Evidence of Alien species found within the study area

7.2. Faunal Communities

NSS surveys in and around the FGD study area yielded 43 mammal, 158 birds, 20 reptile, 16 frog, nine butterfly, two dragonfly and one scorpion species, greatly contributing to the overall Medupi inventory. Context for these figures is provided in **Table 7-11** which gives a comparison of the observed species richness, with that expected at both local and regional scales**.** From **Table 7-11** it is evident that remaining natural and semi-natural areas in and around Medupi support a considerable proportion of the region's faunal diversity. Lists of potentially occurring faunal species are provided in **Appendices 2-9,** and the bat call data are presented in **Appendix 9**. Examples of some of the observed species are shown in **Figure 7-6** to **Figure 7-11**.

Table 7-11 Summary of faunal species richness in the study area as compared to a regional scale

FAUNAL GROUP	SPECIES RICHNESS						
	POTENTIAL			OBSERVED			
	REGION[1]	QDS[2]	MEDUPI[3]	BEC (2006)	FGD	MEDUPI	VICINITY[4]
Mammals	124	41	89	18	43	47	54
Birds	345	314	304	67	158	183	211
Reptiles	96	83	47	7	20	20	46
Frogs	27	22	20	8	16	19	14
Butterflies	176	149	88	3	9	26	15
Dragonflies & Damselflies	66	66	48	0	2	3	1
Scorpions	11	11	11	0	1	1	2
Megalomorph Spiders	4	4	2	0	0	0	1

KEY

[1]Species recorded during atlas projects within the four regional QDSs 2327CB, 2327DA, 2327CD & 2327DC

[2]Species that have been recorded during atlas projects within the QDS 2327DA wherein Medupi is situated

[3]Species that are likely to occur (LoO of 2 or 3) in Medupi

[4]Species recorded during NSS studies in the vicinity: Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station

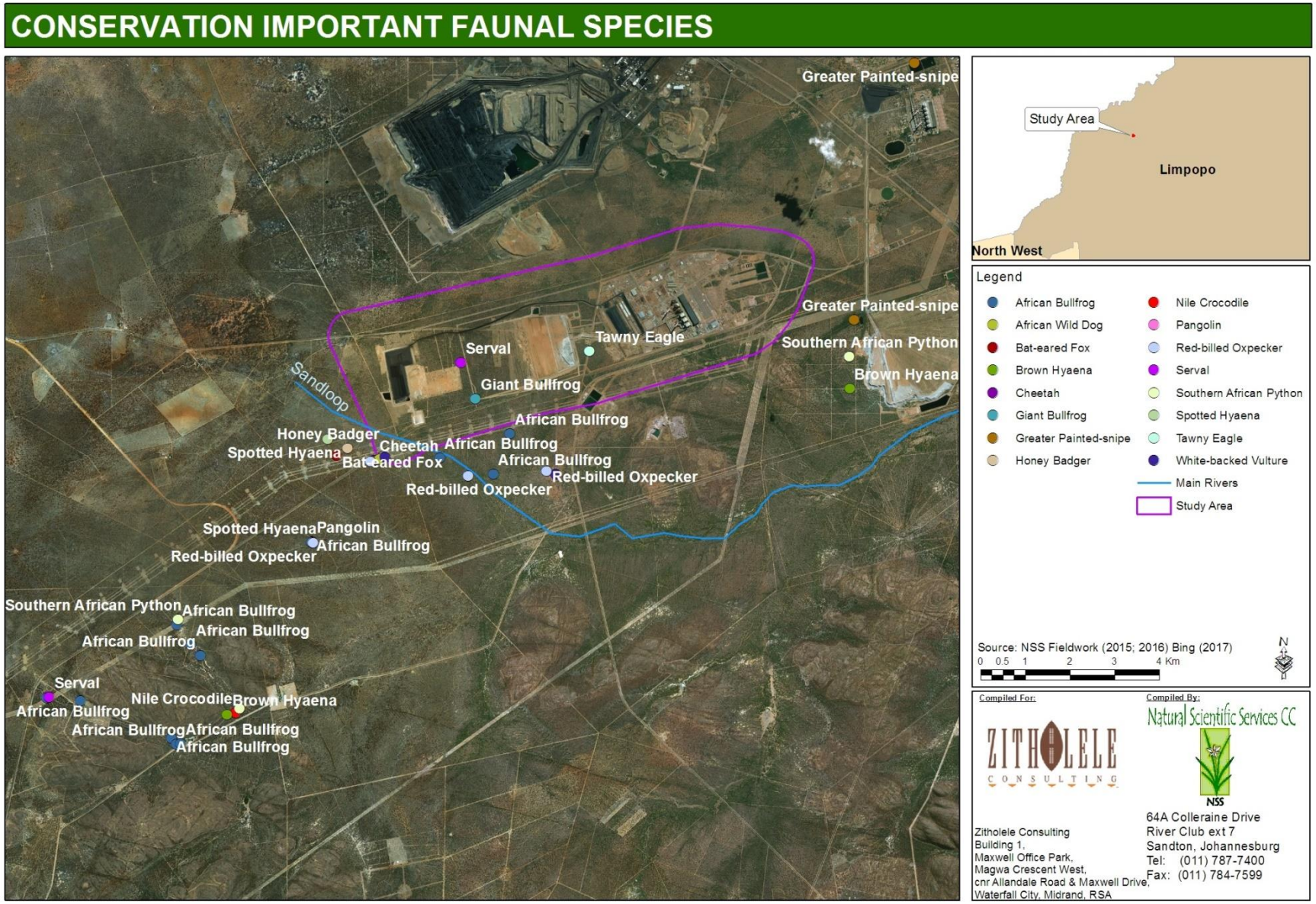


Figure 7-5 Localities of Conservation Important Fauna

Notable faunal observations in and around the FGD study area included Serval (**NT**), Brown Hyaena (**NT**), White-backed Vulture (**EN**), Tawny Eagle (**VU**) and Red-billed Oxpecker (**NT**), African Bullfrog (**PS**) and Giant Bullfrog (**NT**), and also an out of range observation of Sanderling (nearest SABAP 2 record 190km east near Polokwane), and a 300km westwards range extension on Green House Bat (*Scotophilus viridis*) based on recorded bat call data.

Local farmers reported the presence Leopard (**VU**), Cheetah (**VU**), African Wild Dog (**EN**), Spotted Hyaena (**NT**) and Pangolin (**VU**) as well as Southern African Python (**PS**) and Nile Crocodile (**EN**, now absent). African Bullfrogs were found to be particularly abundant in the more natural areas in and near the southern section of Medupi, where there are a number of breeding sites for this species. As both bullfrog species appear to utilize the same type of breeding habitat (Du Preez & Carruthers, 2009), this area and its pans might also provide suitable breeding habitat for Giant Bullfrog. However, only a dam along the southern boundary of the ADF yielded potential signs of this species in the form of a single froglet.

7.2.1 *Mammals*

Of the approximately 124 regionally-occurring mammal species some 89 species (with a LoO of 1, 2 or 3 in **Appendix 2**) are considered likely to occur, based on the species' known distributions and the diversity of available habitats where natural and semi-natural areas remain in and around the southern section of Medupi. MammalMap (2018) has records for 41 species from the four regional QDSs. To date a total of 43 mammal species (36 observed, seven anecdotal) has been recorded in the FGD study area (47 species for the greater Medupi premises). On a regional scale 18 Conservation Important (CI) mammal species occur naturally (i.e. excluding managed game species). Of these, eight are likely to occur in the study area, one of which was recorded on site, i.e. Serval (**NT**; **Figure 7-5)**.

The sandy substrates of the Limpopo Sweet Bushveld provide suitable habitat for the **VU** Pangolin and a host of CI carnivores. Observed species included Serval (**NT**) on the ADF site and Brown Hyaena (**NT**) further to the south-west. Local farmers reported the presence of illusive species such as Leopard (**VU**), Cheetah (**VU**), Spotted Hyaena (**NT**; captured on NSS motion camera but image is poor quality), Pangolin (**VU**) and African Wild Dog (**EN**). These are wide ranging, free-roaming species whose persistence in the region is threatened by persecution and structures that fragment their habitat and restrict their movement such as fences (electric and Bonnox), roads and mines. Other carnivore species which may occur include Black-footed Cat (**VU**), African Weasel (**NT**), Honey Badger (**PS**) and Cape Fox (**PS**).

Serval
(*Leptailurus serval*)

Caracal
(*Caracal caracal*)

Black-backed Jackal
(*Canis mesomelas*)

Black-backed Jackal with prey

African Civet
(*Civettictis civetta*)

Aardwolf
(*Proteles cristatus*)

Slender Mongoose
(*Galerella sanguinea*)

Warthog
(*Phacochoerus africanus*)

Giraffe
(*Giraffa camelopardalis*)

Plains Zebra
(*Equus quagga*)

Blue Wildebeest
(*Connochaetes taurinus*)

Kudu
(*Tragelaphus strepsiceros*)

Waterbuck
(*Kobus ellipsiprymnus*)

Impala
(*Aepyceros melampus*)

Common Duiker
(*Sylvicapra grimmia*)

Grey Rhebok
(*Pelea capreolus*)

Gemsbok
(*Oryx gazelle*)

Tree Squirrel
(*Paraxerus cepapi*)

Chacma Baboon
(*Papio ursinus*)

Aardvark
(*Orycteropus afer*)

Figure 7-6 Examples of some of the mammal species detected in the study area

Juliana's Golden Mole (**EN**), which has a very small and fragmented distribution, mainly between Pretoria and Polokwane, is considered highly unlikely to occur in Medupi. Three elephant shrew species may occur sympatrically in the area, but can be distinguished by habitat preference and size. Rock Elephant-shrew is restricted to rocky substrates, whereas the Bushveld (length 24 cm; mass 50 g) and Short-snouted (length 21 cm; mass 44 g) elephant-shrews occur in sandy substrates (Stuart & Stuart, 2007). Other insectivores that may occur in sandy habitats include the Reddish-grey and Lesser musk shrews, as well as Southern African Hedgehog (**NT**).

Table 7-12 Present and potentially occurring CI mammal species

ORDER & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[1,3,5,6]	MEDUPI*	VICINITY**	ATLAS[6]
		GLOBAL RED LIST[1]	S.A. RED LIST[2,3]	S.A. TOPS LIST[4]				
AFROSORICIDA (Golden moles)								
Neamblysomus julianae	Juliana's Golden Mole	**EN (U)**	**EN**	**VU**	4			
EULIPOTYPHLA (Hedgehogs & shrews)								
Atelerix frontalis	Southern African Hedgehog	LC (S)	**NT**	**PS**	3			
CHIROPTERA (Bats)								
Cloeotis percivali	Percival's Short-eared Trident Bat	LC (U)	**EN**	**-**	4			
PHOLIDOTA (Pangolin)								
Manis temminckii	Pangolin	**VU (D)**	**VU**	**VU**	4	x		x
RODENTIA (Rodents)								
Dasymys incomtus	Water Rat	LC (U)	**NT**	**-**	4			
CARNIVORA (Carnivores)								
Crocuta crocuta	Spotted Hyaena	LC (D)	**NT**	**PS**	4			
Hyaena brunnea	Brown hyaena	**NT (S)**	**NT**	**PS**	3	x	x	x
Acinonyx jubatus	Cheetah	**VU (D)**	**VU**	**VU**	4	x		x
Panthera pardus	Leopard	**VU (D)**	**VU**	**VU**	3	x	x	x
Panthera leo	Lion	**VU (D)**	**VU**	**VU**	5			
Felis nigripes	Black-footed Cat	**VU (D)**	**VU**	**PS**	4			
Leptailurus serval	Serval	LC (S)	**NT**	**PS**	1	x		
Lycaon pictus	African Wild Dog	**EN (D)**	**EN**	**EN**	4	x		
Vulpes chama	Cape Fox	LC (S)	LC	**PS**	3			
Mellivora capensis	Honey Badger	LC (D)	LC	**PS**	3			x
Poecilogale albinucha	African Weasel	LC (U)	**NT**	**-**	2			
PROBOSCIDEA (Elephant)								
Loxodonta africana	African Elephant	**VU (I)**	LC	**PS**	5			
PERISSODACTYLA (Zebras)								
Ceratotherium simum	White Rhinoceros	**NT (I)**	**NT**	**PS**	5	x	x	
Diceros bicornis	Black Rhinoceros	**CR (I)**	**EN**	**EN**	5			
RUMINATA (Even-toed ungulates)								
Connochaetes gnou	Black Wildebeest	LC (I)	LC	**PS**	5			
Damaliscus lunatus	Tsessebe	LC (D)	**VU**	**EN**	5	x	x	
Hippotragus equinus	Roan	LC (D)	**EN**	**VU**	5			
Hippotragus niger	Sable	LC (S)	**VU**	**-**	5		x	
Redunca arundinum	Reedbuck	LC (S)	LC	**PS**	4			x
Redunca fulvorufula	Mountain Reedbuck	**EN (D)**	**EN**	**-**	4		x	

ORDER & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[1,3,5,6]	MEDUPI*	VICINITY**	ATLAS[6]
		GLOBAL RED LIST[1]	S.A. RED LIST[2,3]	S.A. TOPS LIST[4]				
Pelea capreolus	Grey Rhebok	NT (D)	NT	-	2		x	
Ourebia ourebi	Oribi	LC (D)	EN	EN	5			
Key								
Status: CR = Critically Endangered; D = Declining; EN = Endangered; I = Increasing; LC = Least Concern; NT = Near Threatened; PS = Protected Species; S = Stable; U = Unknown; VU = Vulnerable								
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; 5 = May occur as a managed population								
Sources: [1]IUCN (2017.3); [2]SANBI & EWT (unpubl.); [3]Monadjem *et al.* (2010); [4]ToPS List (2015); [5]Friedmann & Daly (2004); [6]MammalMap (2018)								
*Includes records from BEC (2006) and other NSS projects at Medupi								
**Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

Hedgehogs inhabit a diversity of habitats in the temperate to semi-arid interior of South Africa where there is thick, dry vegetation cover suitable for nesting, and an abundance of insects and other food items (Skinner & Chimimba 2005; Stuart & Stuart 2007). Although widespread, hedgehogs are nowhere common. Rupicolous fauna (e.g. Jameson's Red Rock Rabbit, Klipspringer, Rock Dassie) are largely precluded from Medupi by a lack of significant rocky outcrops. However, a distinct stony/rocky substrate south-west of Medupi may provide habitat for Rock Elephant-shrew and Namaqua Rock Mouse.

More or less heavily fenced game areas immediately south and south-west of Medupi support at least nine of the 22 regionally occurring large game species. These include Plains Zebra, Giraffe, Nyala, Blue Wildebeest, Red Hartebeest, Blesbok, Waterbuck, Eland and Gemsbok. The **NT** Grey Rhebok was seen just south of Medupi. Multiple fences along boundaries likely prevent access of larger species such as most carnivores, ungulates, Aardvark and Pangolin. Chacma Baboon (*Papio ursinus*) were observed jumping fences without much difficulty to drink at a water trough and as such it is likely that other primates such as Vervet Monkey and Lesser Galago are also present.

Analysis of bat acoustic data suggests the presence of Cape Serotine and Green House Bat. The latter species record may represent a 300km westwards range extension, although its presence cannot be conclusively supported without an actual capture. Monadjem *et al.* (2010), however, do highlight that the species is likely under sampled and probably occupies a broader range than currently known.

Several other bat species certainly occur in the study area but most likely comprise species that do not require specialised subterranean roosting habitat, such as Mauritian Tomb Bat (*Taphozous mauritianus*), Egyptian Free-tailed Bat (*Tadarida aegyptiaca*), Rusty Pipistrelle (*Pipistrellus rusticus*), Yellow-bellied House Bat (*Scotophilus dinganii*) and Midas Free-tailed Bat (*Mops midas*). The Rusty Pipistrelle has been recorded by NSS in the nearby vicinity (Grootegeluk Mine 2009-2010). It frequents savanna woodland where it roosts in rock

crevices and under tree bark (Stuart & Stuart, 2007). Smither's, Geoffroy's, Darling's and Bushveld horseshoe bats may occur based on distribution. However, their preferred roosting habitat in the form of subterranean caves or mine shafts is distinctly lacking (although it should be noted that all of these species have, occasionally, been known to roost in trees or buildings and as such their presence in Medupi, albeit low, cannot be ruled out). Little is known regarding the ecology of the Botswana Long-eared Bat (*Laephotis botswanae*) which may occur.

7.2.2 *Birds*

Of the approximately 345 regionally-occurring bird species some 304 species (with a LoO of 1, 2 or 3 in **Appendix 3**) are considered likely to occur, based on the species' known distributions and the diversity of available habitats within the FGD study area and greater Medupi. A total of 314 species was recorded in QDSs 2327CB and 2327DA and pentads 2340_2730 and 2340_2725 covering the study area during the SABAP1 (310 spp.) and 2 (218 spp.), respectively.

To date, NSS has detected 158 bird species in and near the FGD study area (183 from all studies for the greater Medupi). Of the 20 regionally occurring CI bird species, eight are likely to occur within the study area (**Table 7-14**), two of which were found to be present namely White-backed Vulture (**EN**) and Tawny Eagle (**EN**).

A single White-backed Vulture (**EN**) was observed flying high near the southern boundary of Medupi. A key aspect in designation of the area south of Medupi as a CBA1 in the Limpopo C-Plan is said to be its importance with regards to this species (LEDET pers. comm.). White-backed Vultures are generally associated with dry woodland and tall trees, which they are dependent upon for breeding. Although no nests were detected within the boundaries of Medupi, trees suitable for nesting (in terms of height, structure and species) do occur to the south and south-west. The species constructs large stick nests at the tops of tall trees (>5 m) particularly *Terminalia prunoides*, *Acacia nigrescens*, *Boscia albitrunca* and *B. foetida*, normally nesting in small colonies of two to six pairs. The total population of White-backed Vulture is estimated at less than 10 000 individuals and is in decline. The greatest threats include a loss of habitat and decreased food availability. Collision, electrocution, poisoning and drowning also threaten this species (Barnes, 2000).

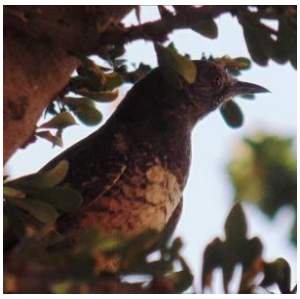
Tawny Eagle (**EN**) was observed where the ADF is located. The species inhabits mostly wooded to lightly wooded areas but is generally scarce outside of major reserves. This once widespread raptor has suffered major range contractions having lost as much as 20% of its regional population in recent years. Currently there are probably less than 800 pairs in South Africa making it one of the most threatened eagles in the country. The fact that this species may occasionally scavenge makes it particularly susceptible to poisoning. Additionally, the species suffers from persecution mainly through shooting and gin traps but drowning in sheer-walled water reservoirs accounts for many deaths too. Other threats include collision

and electrocution with transmission lines, roadkill and reduction in prey base due to habitat transformation (Barnes, 2000).

Although no longer Red Listed (Taylor *et al.* 2015), it is still worth mentioning that Red-billed Oxpeckers were observed to the south and south-west of Medupi. Although formerly widespread these birds suffered local population declines particularly in the Eastern Cape and Pilanesberg National Park as a result of hunting of game and the use of arsenic-based 'purple label' cattle dips which poison both ticks and oxpeckers. More recent ongoing re-introductions and the use of oxpecker-friendly green-label dips, together with the oxpecker's adaptability to feed on domestic livestock, are bringing them back from localised extinctions (Barnes, 2000).

Other potentially occurring avifaunal CI species recorded during NSS studies in the vicinity include the **EN** Cape and Lappet-faced Vultures (motion camera at carcass, Mafutha Project, pentad 2340_2705, farm Geelbuilt), the **VU** Greater Painted-snipe (nomadic, locally scarce species with a highly fragmented population; detected twice at Matimba Power Station during summer, pentads 2335_2735 and 2340_2735), the **NT** Kori Bustard (uncommon resident especially outside reserves; motion camera, Mafutha Project, pentad 2340_2705, farm Geelbuilt), **NT** European Roller (nonbreeding Palaearctic migrant; Mafutha Project 2340_2720) and **NT** Short-clawed Lark (uncommon resident; Mafutha Project, pentad 2340_2705, farm Geelbuilt).

European Bee-eater
(*Merops apiaster*)



Barred Wren-warbler
(*Calamonastes fasciolatus*)

Pied Crow
(Corvus albus)

Brown-hooded Kingfisher
(*Halcyon albiventris*)

Red-billed Oxpecker
(*Buphagus erythrorhynchus*)

Rufous-cheeked Nightjar
(*Caprimulgus rufigena*)

Swainson's Spurfowl
(*Francolinus swainsonii*)

Tawny Eagle
(Aquila rapax)

Pearl-spotted Owlet
(*Glaucidium perlatum*)

Southern Pied-babbler
(*Turdoides bicolor*)

Spotted Eagle-owl
(*Bubo africanus*)

Barn Swallow
(Hirundo rustica)

Figure 7-7 Examples of some of the bird species detected in the study area

Provided in **Figure 7-8** is a comparison of the numbers of bird species with different feeding habits, which are listed for pentads 2340_2725 and 2340_2730 (SABAP 2, 2018), and which have been recorded in Medupi by NSS and BEC (2006). Species were categorized according to a modified version of Newman's (2002) 12 bird categories (**Table 7-13**).

Table 7-13 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 & 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.

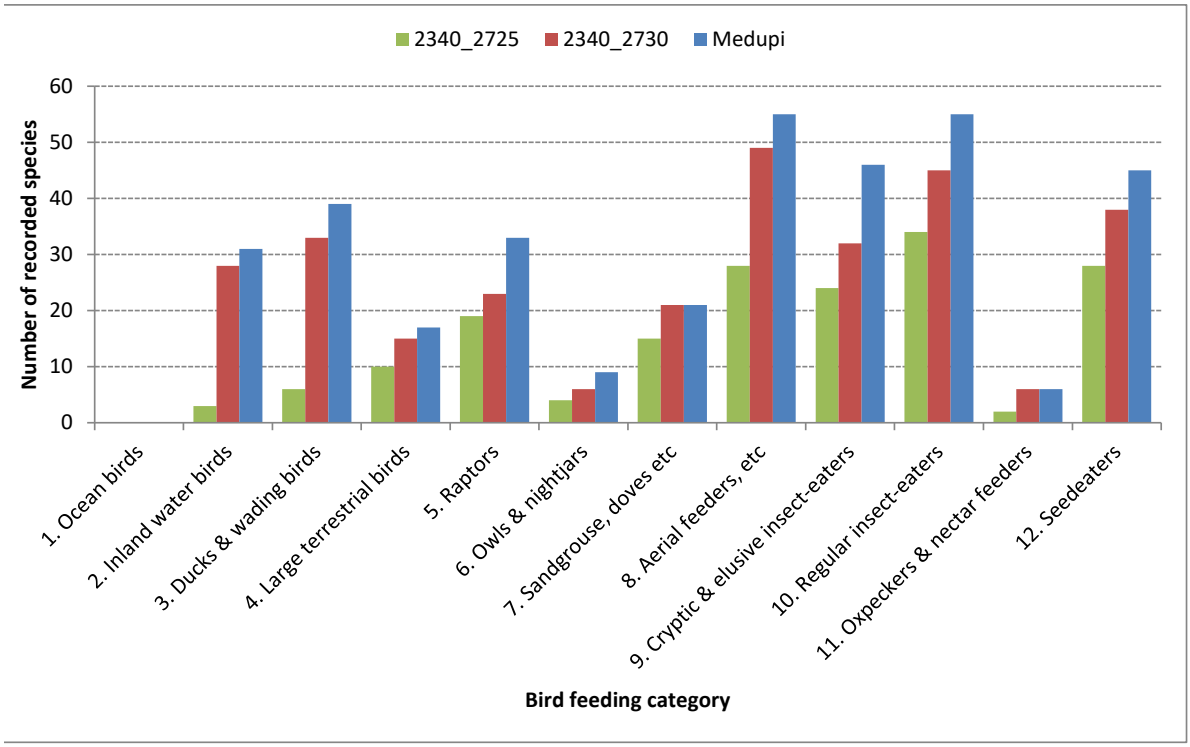


Figure 7-8 Comparison of the number of bird species with different feeding habits, recorded in pentads 2340_2725 and 2340_2730 during the SABAP 2, and in Medupi by NSS

Evidently the pattern of bird diversity recorded in Medupi is similar to that recorded in the region during the SABAP 2. The extensive tracts of relatively undisturbed Limpopo Sweet Bushveld south and south-west of Medupi supports high representations of aerial feeding, regular insect- and seed-eating species. The disproportionately high numbers of waterbird species in Medupi compared to pentad 2340_2725 is attributable to the presence of several large shallow (albeit artificial) waterbodies with extensive wading bird habitat, which is lacking southwards where very few waterbird species were detected.

Table 7-14 Present and potentially occurring CI bird species

CATEGORY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[3]	MEDUPI*	VICINITY**	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. TOPS LIST[2]				
2. Inland water birds								
Ciconia nigra	Black Stork	LC (U)	**VU**	-	4	4		x
Leptoptilos crumeniferus	Marabou Stork	LC (I)	**NT**	-	4	4		x
Mycteria ibis	Yellow-billed Stork	LC (D)	**EN**	-	4	4		x
Phoenicopterus roseus	Greater Flamingo	LC (I)	**NT**	-	4	4		x
Phoeniconaias minor	Lesser Flamingo	**NT (D)**	**NT**	-	4	4		x
Glareola nordmanni	Black-winged Pratincole	**NT (D)**	**NT (NB)**	-	4	4		x
3. Ducks & wading birds								
Nettapus auritus	African Pygmy-goose	LC (D)	**VU**	-	4	4		
Oxyura maccoa	Maccoa Duck	**NT (D)**	**NT**	-	4	4		x
Rostratula benghalensis	Greater Painted-snipe	LC (D)	**VU**	-	4	4	x	
4. Large terrestrial birds								

CATEGORY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[3]	MEDUPI*	VICINITY**	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. TOPS LIST[2]				
Sagittarius serpentarius	Secretarybird	VU (D)	VU	-	2	3		x
Ardeotis kori	Kori Bustard	NT (D)	NT	PS	4	4	x	
5. Raptors								
Gyps coprotheres	Cape Vulture	VU (D)	EN	EN	2	1	x	x
Gyps africanus	White-backed Vulture	EN (D)	EN	EN	1	1	x	x
Torgos tracheliotos	Lappet-faced Vulture	VU (D)	EN	EN	2	2	x	x
Aquila rapax	Tawny Eagle	LC (S)	EN	EN	1	1	x	x
Polemaetus bellicosus	Martial Eagle	VU (D)	EN	EN	2	2		x
Terathopius ecaudatus	Bateleur	NT (D)	EN	EN	4	4		x
Falco biarmicus	Lanner Falcon	LC (I)	VU	-	2	3		
8. Aerial feeders, etc								
Coracias garrulus	European Roller	NT (D)	NT	-	2	2	x	x
9. Cryptic & elusive insect-eaters								
Certhilauda chuana	Short-clawed Lark	LC (D)	NT	-	4	4	x	
Key								
Status: D = Declining; EN = Endangered; I = Increasing; LC = Least Concern; NB = Non-breeding; NT = Near Threatened; PS = Protected Species; S = Stable; U = Unknown population trend; VU = Vulnerable								
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low								
Sources: [1]Taylor *et al.* (2015); [2]ToPS List (2015); [3]SABAP 1 & 2 (2018)								
*Includes records from BEC (2006) and other NSS projects at Medupi								
**Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

7.2.3 *Reptiles*

Of some 96 regionally-occurring reptile species, 50 are considered highly likely to occur (with a LoO of 1 or 2 in **Appendix 4**), based on the species' known distributions and the diversity of available habitats in and around the FGD study area. An additional 33 species may also occur (LoO 3 in **Appendix 4**). Available atlas data include records for 47 species from the four regional QDSs (ReptileMap, 2018; Bates *et al.* 2014). At a more local scale NSS has recorded 46 species in the general vicinity (Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station). To date, a total of 20 reptile species (15 observed, four anecdotal) have been detected by NSS and / or reported anecdotally within the study area (**Appendix 4** and **Figure 7-9**).

Fossorial species, terrapins and snakes in general, are underrepresented due to the difficulties involved in their detection. Of the two regionally-occurring CI reptile species, only one, the Southern African Python, is likely to occur naturally. The other species is the Nile Crocodile, which apart from occurring in the Limpopo River, is largely restricted to managed populations within reserves in the region (**Table 7-15**). Although no pythons were detected they likely occur throughout the study region and anecdotal reports were numerous, particularly near water to the south-west of Medupi. A large individual was photographed by Mr Gavin Cronk (farm manager) eating a Bushbuck ram at a dam in the south-west (**Figure 7-9**). Although currently listed as Least Concern (LC) these large snakes are classified as **Protected** Species (ToPS, 2015). They are threatened by commercial trade and listed as a

CITES Appendix II species due to high levels of persecution for their skin which is used in the leather industry. A single Nile Crocodile (**EN**) of approximately 1.5m was reportedly observed at a dam also to the south-west of Medupi. The individual was seen approximately eight years ago and has not been seen since.

The local diversity of reptiles is largely comprised of a subset of tortoises, snakes, lizards and geckos that are generally adapted to the soft red sands that characterise the Limpopo Sweet Bushveld. Although a band of rockier substrate is present to the south-west of Medupi, it is probably too small and fragmented to support any of the locally occurring yet strictly rupicolous species such as Waterberg Dragon Lizard (recorded at the base of a small rocky ridge on a neighbouring farm to the west), Wahlberg's Snake-eyed Skink, and Southern Rock Agama.

Large trees, *Boscia* spp. in particular, proved to be important microhabitats for reptiles and frequently yielded Wahlberg's Velvet Gecko, Common Dwarf Gecko, Variable Skink, Southern Rock Monitor and Southern Tree Agama. Two tortoise species were recorded south of Medupi. Leopard Tortoise was the more widespread and ubiquitous of the two, with sightings of Speke's Hinged-back Tortoise[5] being far less frequent and more closely associated with rocky substrates. No Kalahari Tent Tortoises were detected.

Observed venomous species included Puff Adder, Boomslang and Black Mamba, but species such as Vine Snake, Snouted Cobra and various other elapids certainly occur. Some interesting, less frequently encountered species (which may occur but were not detected) include; Serrated Hinged Terrapin, Serrated Tent Tortoise, Jones' Girdled Lizard, Kalahari Dwarf Worm Lizard, Cape Worm Lizard, Bicoloured Quill-snouted Snake, Jalla's Sand Snake, Two-striped Shovel-snout, Common Shield Cobra, Sundevall's Garter Snake, Eastern Tiger Snake, Limpopo Dwarf Burrowing Skink, Common Purple-glossed Snake and Eastern Bark Snake.

c.f. Speke's Hinged-back Tortoise (*Kinixys spekii*)

Leopard Tortoise (*Stigmochelys pardalis*)

Spotted Sand Lizard (*Pedioplanis l. lineoocellata*)

Waterberg Dragon Lizard (*Smaug breyeri*)

[5] Identification tentative due to sympatry with the similar congeneric Lobatse Hinged-back Tortoise.

Southern Tree Agama
(*Acanthocercus a. atricollis*)

Turner's Gecko
(*Chondrodactylus turneri*)

Common Tropical House Gecko
(*Hemidactylus mabouia*)

Common Dwarf Gecko
(*Lygodactylus c. capensis*)

Southern Rock Monitor
(*Varanus albigularis albigularis*)

Puff Adder
(*Bitis arietans arietans*)

Boomslang
(*Dispholidus typus*)

Western yellow-bellied Sand Snake
(*Psammophis subtaeniatus*)

Southern African Python (*Python natalensis*) **Image courtesy of Gavin Cronk**

Figure 7-9 Examples of some of the reptile species detected in the study area

Table 7-15 Present and potentially occurring CI reptile species

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[1,3]	MEDUPI**	VICINITY***	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]				
PYTHONIDAE (Python)								
Python natalensis	Southern African Python	-	LC	**PS**	1*	x	x	x
CROCODYLIDAE (Crocodile)								
Crocodylus niloticus	Nile crocodile	LC	**VU**	**PS**	1*	x	x	
Key								
Status: LC = Least Concern; PS = Protected Species; VU = Vulnerable								
Likelihood of Occurrence (LoO): 1 = Present								
Sources: [1]Bates *et al.* (2014); [2]ToPS List (2015); [3]ReptileMap (2018)								
*Anecdotal records only								
**Records from other NSS studies at Medupi								
***Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

7.2.4 *Frogs*

Combined NSS surveys at Medupi show that the power station premises support 20 frog species, representing 74% of the regional amphibian diversity. Of the 27 regionally occurring species only Natal Sand Frog and Muller's Platanna are considered unlikely to occur based on their marginal distributions. FrogMap (2018) lists 22 species for the four regional QDSs. In total 16 frog species were detected within the FGD study area (**Appendix 5 and Figure 7-10**). Both of the two regionally occurring CI species, namely African and Giant Bullfrog, were recorded in the FGD study area (**Table 7-16**).

During our December 2015 visit, a high rainfall event (38mm on 8 December 2015) triggered the emergence of exceptionally high densities of winged termites, and subsequently, African Bullfrog and various other frog species appeared en masse. The breeding frenzy that ensued, drastically increased detection rate, and emphasised the exceptional abundance of amphibian species in the study area.

Both Giant and African Bullfrog occur sympatrically in the region, with the latter generally being regarded as the more ubiquitous of the two in warm bushveld regions (Du Preez and Carruthers, 2009). Whereas the Giant Bullfrog has only been recorded once in 2327CB (C. Lotter; V. Kleynhans and N. Kleynhans) and twice in 2327DA (one VMUS record submitted by L. Verburgt and one questionable Minter *et al.* 2004 record), the African Bullfrog has been recorded in all four regional QDSs (Yetman *et al*. 2015). Indeed, African Bullfrog were found to be exceptionally abundant, and likely breed at the majority of the pans / depressions in and around the FGD study area, while in contrast, Giant Bullfrog was only potentially recorded where the ADF is situated at a small (historically natural) pan which has been deepened and widened by excavation.

Plain Grass Frog
(*Ptychadena anchietae*)

Sand Frog
(*Tomopterna* sp.)

Eastern Olive Toad
(*Amietophrynus garmani*)

Mottled Shovel-nosed Frog
(*Hemisus marmoratus*)

Bushveld Rain Frog
(*Breviceps adspersus*

Common Platanna
(*Xenopus laevis*)

Bubbling Kassina
(*Kassina senegalensis*)

Red Toad
(*Schismaderma carens*)

adspersus)

Ornate Frog (*Hildebrandtia ornata*)

Boettger's Caco (*Cacosternum boettgeri*)

Banded Rubber Frog (*Phrynomantis bifasciatus*)

Southern Foam Nest Frog (*Chiromantis xerampelina*)

Giant Bullfrog froglet (*Pyxicephalus adspersus*)

African Bullfrog (*Pyxicephalus edulis*)

African Bullfrog pair in amplexus

African Bullfrog tadpoles

Figure 7-10 Examples of some of the frog species detected in the study area

The Giant Bullfrog observation was of a single froglet (identification tentative based on absence of pale half-moon on tympanum, which is usually indicative of African Bullfrog. Specimen age precluded confirmation by labial tooth row formula or adult colouration and morphology). Species distinction among froglet bullfrogs is notoriously difficult (A. Channing pers. comm.). A recent publication by Yetman and Verburgt (2015) provides the first records of Giant Bullfrog in the Lephalale region and the greater Limpopo Sweet Bushveld. The study highlights that the species is likely more widespread and common in the region than was previously thought, and that low detection levels are likely the result of irregular emergence and breeding only during sufficiently wet summers in this dry region.

Suitable breeding habitat appears to be present for both African and Giant Bullfrogs at multiple locations, but Giant Bullfrog breeding was not detected by NSS due to timing. The presence of both of these large conservation important frog species warrants the commissioning of a specialist bullfrog study to better understand the extent and occurrence of these species in the study area, and to minimise loss of breeding sites and foraging habitat from the construction of the ADF and other infrastructure. Based on this recommendation, Medupi has commissioned NSS to assess the suitability of local wetlands for bullfrog breeding, and the Endangered Wildlife Trust to relocate bullfrogs between wetlands where necessary, in collaboration with NSS.

Table 7-16 Present and potentially occurring CI frog species

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[2,3]	MEDUPI**	VICINITY***	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST*				
PYXICEPHALIDAE (African Common Frogs)								
Pyxicephalus edulis	African Bullfrog	LC (U)	LC	**PS***	1	x	x	x
Pyxicephalus adspersus	Giant Bullfrog	LC (D)	**NT**	**PS***	1	x		x
Key								
Status: LC = Least Concern; NT = Near Threatened; PS = Protected Species								
Likelihood of Occurrence (LoO): 1 = Present; 2 = High								
Sources: [1]ToPS List (2007); [2]IUCN (2013.1); [3]Minter *et al.* (2004); [4]Du Preez & Carruthers (2009); [5]FrogMap (2015)								
***Old ToPS (2007) status, newToPS (2015) amphibian status still pending								
**Includes records from other NSS studies at Medupi								
***Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

7.2.5 *Terrestrial Macro-invertebrates*

The focus of this component was directed towards invertebrate groups for which there is a workable body of literature, distribution data and species conservation statuses namely butterflies, dragonflies and damselflies, baboon spiders and scorpions. Some examples of the macro-invertebrates observed in the FGD study area are presented in **Figure 7-11**.

A list of the approximately 176 regionally occurring and observed butterfly species is provided in **Appendix 6**. Atlas records from the ADU's LepiMap (2018) list 88 species for the QDS covering the study area. Nine butterfly species were recorded in the study area bringing the list for the greater Medupi premises to 26 species representing 15% of the regional diversity. Clearly there is considerable scope for detection of other species with blues, tips and acraeas being particularly under-represented.

Barbet Percher (*Diplacodes luminans*) male

Barbet Percher female

Banded Groundling (*Brachythemis leucosticte*)

Natal Browns (*Coenyropsis natalii*)

Large Striped Swordtail (*Graphium antheus*)

Solifuge (order: Solifugae)

Opistacanthus asper under UV light

Opistacanthus asper

Giant Longhorn
(*Tithoes confinis*)

Figure 7-11 Examples of some of the invertebrate species detected in the study area

Distribution data for dragonflies and damselflies provided in Samways (2008) suggests that some 66 odonata species have the potential to occur in the region **Appendix 7**. However, the vast majority of these species are likely precluded by the absence of significant rivers and lakes with suitable substrate and vegetation. As such, only a subset of just less than 50 species that are frequently found away from water and / or require only temporarily inundated areas are considered highly likely to occur (see **Appendix 7**). Of the seven regionally occurring CI species[6] only five, namely the Sudan Sprite, Little Wisp, Black Emperor, Strong Skimmer and Silhouette Dropwing are considered more or less likely to occur in the FGD study area (**Table 7-17**). The Makabusi Sprite (**VU**) and Spined Fairytail (**NT**) are likely precluded by a lack of sluggish perennial rivers in the study area. The greater diversity of wetland habitat immediately south of Medupi is expected to support the greatest diversity of odonata. Three dragonfly species were identified during the NSS site visit namely Banded Groundling, Green Hooktail and Barbet Percher.

Table 7-17 Present and potentially occurring CI terrestrial macro-invertebrate species

SPECIES	COMMON NAME	STATUS	LoO IN FGD	MEDUPI	VICINITY
Dragonflies					
Chlorolestes fasciatus	Mountain Malachite	-	4		
Chlorolestes tessellatus	Forest Malachite	-	4		
Pseudagrion makabusiense	Makabusi Sprite	**VU**	4		
Pseudagrion sudanicum	Sudan Sprite	LC	3		
Agriocnemis exilis	Little Wisp	-	3		
Anax tristis	Black Emperor	-	3		
Lestinogomphus angustus	Spined Fairytail	**NT**	4		
Orthetrum stemmale	Strong Skimmer	-	3		
Trithemis donaldsoni	Denim Dropwing	-	4		
Trithemis hecate	Silhouette Dropwing	-	3		

[6] Red listed species or those species with a Dragonfly Biotic Index score of 4 or higher are considered here to be of conservation importance.

SPECIES	COMMON NAME	STATUS	LoO IN FGD	MEDUPI	VICINITY
Beetles					
Manticora spp.	Monster Tiger Beetles	**PS****	2		
Scorpions					
Opistacanthus asper	Creeping scorpions	**PS****	1	x	
Hadogenes troglodytes	Flat rock scorpions	**PS****	4		
Opistophthalmus glabifrons	Burrowing scorpions	**PS****	3		
Opistophthalmus carinatus	Burrowing scorpions	**PS****	3		
Opistophthalmus whalbergii	Burrowing scorpions	**PS****	3		x
Spiders					
Ceratogyrus bechuanicus	Starbust Horned Baboon Spider	**PS****	3		
Ceratogyrus brachycephalus	Rhino Horned Baboon Spider	**PS****	3		
Pterinochilus junodi	Soutpansberg Starburst Baboon Spider	**PS****	4		
Pterinochilus pluridentatus	-	**PS****	4		
Harpactira sp.	Common Baboon Spiders	**PS****	3		x
Key					
Status: LC = Least Concern; NT = Near-threatened; PS = Protected Species; VU = Vulnerable					
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low					
Sources: BEC (2006); Samways (2006); ToPS (2007); Leeming (2003); Dippenaar-Schoeman (2002); Mecenero *et al.* (2013)					
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station					
**Old ToPS (2007) status					

The distribution ranges of 11 scorpion species (**Appendix 8**) overlap Medupi and its immediate surrounds (Leeming, 2003). Under the old (2007) ToPS list, five of these species were classified as **Protected** species (one *Hadogenes,* three *Opistophthalmus* and one *Opistacanthus* species; **Table 7-17**). However, the latest (2015) ToPS list no longer recognises these species as **Protected**. The lack of rocky substrates in the FGD study area precludes *Hadogenes troglodytes* and potentially *Parabuthus transvaalicus and P. mossambicensis*. During our surveys only one species namely *Opistacanthus asper* was detected.

Dippenaar-Schoeman (2002) lists four baboon spiders for Limpopo Province namely *Ceratogyrus bechuanicus*, *C. brachycephalus*, *Pterinochilus junodi* and *P. pluridentatus* but *Harpactira* sp. may also occur. Of these, only the horned baboon spiders *Ceratogyrus bechuanicus* and *C. brachycephalus* and common baboon spiders of the genus *Harpactira* are likely to occur in the FGD area (**Table 7-17**). No baboon spiders were detected (**Appendix 9**). As with the scorpions none of these are now recognised as **Protected** species in the latest (2015) ToPS list. However the Limpopo Environmental Management Act (Act No 7 of 2003) still lists baboon spiders of the genera *Ceratogyrus*, *Harpactira* and *Pterinochilus* as requiring permits for capture, hunting or trade.