BIODIVERSITY ASSESSMENT REPORT

FOR A PROPOSED SLIMES DAM AT KOFFIEFONTEIN MINE

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NSS Ref No: 1890
Date: November 2015

All pictures taken on site

BIODIVERSITY BASELINE & IMPACT ASSESSMENT REPORT

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EXECUTIVE SUMMARY

Natural Scientific Services CC (NSS) was contracted by Zitholele Consulting (Pty) Ltd (Zitholele) to complete a floral, faunal and wetland assessment for a new slimes dam and associated infrastructure at Petra Diamond Mine near Koffiefontein in the south-western Free State. Three alternative locations for the new slimes dam were considered in the Scoping Phase assessment, which involved fieldwork, and are referred to as Alternatives 1, 2 and 4. During the EIA phase, the need for a further alternative was considered. This was recognised as Alternative 5, which was positioned on an existing slimes dam. This report represents the findings obtained during desktop research and field work during conducted in mid-March and October 2015.

The floral assessment involved desktop and field-based investigation of regional vegetation and local floral communities. Field surveys involved sampling vegetation plots to determine the spatial extent, structure, condition and dominant species composition of the communities on Site, and observed Conservation Important (CI) and alien invasive plant species were recorded. The homogenous shrubveld habitat made it difficult to use a sampling method that would yield different communities. In support of this, there were limited species detected with only 96 recorded during the survey. The site was also in recovery from the previous slimes dam as evident within the 1944 aerial imagery. Phase 1 fieldwork determined the vegetation communities and identified two main/broader plant communities: *Pentzia lanata - Eragrostis x pseud-obtusa* Recovery Shrubveld and *Lycium cinereum- Eriocephalus decussatus* Shrubveld. The Shrubveld included sub communities such as the *Lycium - Sporobolus* Transitional Area (supporting a cryptic wetland), the edge of a rocky outcrop area and a small depression (pan) system. These areas were too small for repeat sampling. Within the study area extremely transformed habitats where historical vegetation structure has been completely altered and now dominated by species such as *Phragmites* and alien invasives, were also evident. During both field sampling phases, searching for CI species was conducted. Two Red IIsted species that are both listed as DDT were detected. One within the rocky outcrops (*Myrothamnus flabellifolius*) and another where Alternative 1 is positioned (*Nananthus vittatus*). In addition to this a number of Protected Species under the Provincial Legislation was also identified.

The faunal assessment initially involved desktop research to compile lists of potentially occurring mammal, bird, reptile, frog, butterfly, scorpion and odonata (dragonfly and damselfly) species. Thereafter two field surveys were conducted in late and early summer (March and October 2015). Both visits involved visual observation, grab-sampling and camera-trapping of fauna, live-trapping of rodents, and a driven acoustic survey to detect bats (6 trapping sites x 6 days = 36 trap days). Additionally the second trap also included the placement of two array traps (for 3 days) aimed at sampling herpetofauna and terrestrial macro-invertebrates. To date NSS surveys within the study area have yielded approximately 60%, 40%, 28% and 64% of all potentially occurring mammal occurring mammal, bird, reptile

and frog species respectively. With regards to CI fauna the study area supports Blue Korhaan (VU) and Secretarybird (NT) with reports of Blue Crane (VU) and Giant Bullfrog (NT) from mine staff. Blue Korhaans were encountered in the vicinity of the large pan which, when inundated is known to support Blue Crane and could provide habitat for other CI bird species such as the Greater Flamingo and Caspian Tern. Secretarybird was observed near the northern-most waterhole which is where the Giant Bullfrogs were reportedly observed during a high rainfall event. Various other CI bird species, e.g. Ludwig's Bustard and Kori Bustard, could forage in the area Termitaria in the locally predominant karooid scrub habitat represent an important resource for fauna including CI species such as the observed Lesser Dwarf Shrew (DD), and the potentially occurring Black-footed Cat and Aurora Snake. Aardvark burrows too, provide important refuge for numerous fauna. Rocky outcrops provide important habitat for reptiles, whereas most frog species were recorded at wetlands (both natural and artificial).

In terms of wetlands, no natural wetlands were identified within the study site. A number of artificial wetlands, dominated by *Phragmites australis*, were however identified. These wetlands were created by run-off and seepage from the existing slimes dams. Within the immediate surrounds one small ephemeral depression (pan) was identified and a "cryptic" temporary wetland system. The main function of these temporary/ephemeral systems is the supply of water for short periods following rainfall events. The impacts on these systems are limited, as they fall outside the footprint of the historical slimes dams, with the main impact being farm roads. A number of larger pan systems, of National Importance, were identified in the broader region (>1km from the study site). The buffer of these pans extend over Alternative 4.

From the investigations a significance map was compiled for all alternatives, where:

High rated areas include:

- The ephemeral endorheic depression.
- Rock outcrops to the north of Alternatives 1 and 2.

Moderate-High rated areas include:

- The identified transitional zone "cryptic wetland". This area provides a unique habitat for faunal species in relation to the surrounding vegetation units.
- A minimum buffer of 50m on the ephemeral endorheic depression.
- A minimum buffer of 50m on rocky outcrops.
- A buffer of 300m around the DDT CI plant species.

Moderate rated areas include:

- Evidence of banded vegetation. Banded vegetation aids in resilience and stability where it has the potential to increase soil porosity and facilitate retention of moisture and nutrients in the system.

- The 1km buffer on the wetland FEPAs, as recommended under the NFEPA, and incorporated in the atlas of the Mining and Biodiversity Guideline. Within the Site, this buffer is fragmented by the R48.
- Recovered shrubveld.
- Shrubveld.

Low sensitive areas include the following transformed areas:

- Completely transformed habitats such as the *Phragmites* Reed beds
- The existing Airfield.
- Excavated areas.
- Dumps.

Low-None sensitive areas include the following highly transformed areas:

- Slimes and Waste Rock Areas.

The preliminary significance map should guide the proposed development where:

- Disturbances should preferentially occur in **Low-None** sensitive areas.
- **High** sensitive areas should be subject to limited disturbance and rigorous mitigation.
- **Moderate-High** sensitive areas may be disturbed with rigorous mitigation.
- **Moderate** sensitive areas may be disturbed with some appropriate mitigation.
- **Low** sensitive areas may be disturbed with minimal mitigation, or rehabilitated if not developed.

The proposed project will result in clearing of vegetation, earth works during the construction phase, increased traffic, machinery and human activity, and final operation of the new slimes dam. Potential impacts include the decline in the integrity of the protective buffer around the wetland FEPAs, destruction or disturbance of CI and other flora and fauna, surface and groundwater contamination, dust, erosion and sedimentation, proliferation of alien flora.

In summary the cumulative and residual impacts based on the below activities are as follows:

	Clearing of Vegetation		Ground excavations, levelling, compaction, deposition, etc.		Increased traffic, machinery & human activity		Operation & maintenance of the new slimes dam	
	Cumulative	Residual	Cumulative	Residual	Cumulative	Residual	Cumulative	Residual
Alternative 1	High	Moderate	Moderate	Low	Moderate	Low	Moderate	Moderate
Alternative 2	Moderate	Low	High	Moderate	Moderate	Low	High	Moderate
Alternative 4	Moderate	Low	High	Moderate	High	Low	High	Moderate
Alternative 5	Low	Low	Moderate	Low	Moderate	Low	Moderate	Low

Briefly, in terms of mitigation, the Mine should:

- Wherever possible, avoid disturbing **High** and **Moderate-High** sensitive areas.
- Develop and implement highly effective measures to minimize, monitor and rehabilitate contamination from the dam.
- Effectively control dust, erosion and sedimentation.

- Effectively control the proliferation of alien species.
- Relocate all in situ CI species specimens, which can be relocated.
- Implement environmental awareness campaigns for contractors and staff.
- Minimize faunal roadkill and sensory disturbance.

In addition to the above, there are a number of potential research opportunities that could be carried out on the site, to further understand these arid temporary environments.

LIST OF ACRONYMS & ABBREVIATIONS

ACRONYM	DESCRIPTION
1LC	Globally Least Concern
2LC	Regionally Least Concern
a.s.l.	above sea level
AGIS	Agricultural Geo-referenced Information System
B	Breeding
CARA	Conservation Agricultural Resources Act
CBI	Critical Biodiversity Area
CI	Conservation Important
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
D	Declining population trend
DCA	Detrended Correspondence Analysis
DD	Data Deficient
DDT	Data Deficient – Taxonomically
DEA	Department of Environmental Affairs
Dec	Declining
DETEA	Development, Tourism and Environmental Affairs
DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EM3	Echo Meter 3 bat detector
EN	Endangered
End	Endemic
ESA	Ecological Support Area
EWT	Endangered Wildlife Trust
FEPA	Freshwater Ecosystem Priority Area
GG	Government Gazette
GIS	Geographic Information System(s)
GN	Government Notice
GPS	Global Positioning System
HGM	Hydro-geomorphic
I	Increasing population trend
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature and Natural Resources
LC	Least Concern
LoM	Life of Mine
LoO	Likelihood of Occurrence
MBG	Mining and Biodiversity Guideline
NB	Non breeding
NEM:BA	National Environmental Management: Biodiversity Act (Act 10 of 2004)
NEM:BA	National Environmental Management: Biodiversity Act
NEMA	National Environmental Management Act
N-End	Near-Endemic
NEPAD	New Partnership for Africa's Development

ACRONYM	DESCRIPTION
NFEPA	National Freshwater Ecosystem Priority Areas
NSS	Natural Scientific Services CC
NT	Near Threatened
NWA	National Water Act
NWU	North-West University
P	Protected
PES	Present Ecological State
Pr.Nat.Sci.	Professional Natural Scientist
PRECIS	PREtoria Computerised Information System
PS	Protected Species
QDS	Quarter degree square
RE	Remaining Extent
S	Stable population trend
SABAP 1 & 2	First and second Southern African Bird Atlas Projects
SANBI	South African National Biodiversity Institute
SASS	South African Scoring System
Site	One or more of the three project alternatives
Study Area	Area within a 3km radius of the Site
ToPS	Threatened or Protected Species under NEM:BA
TSP	Threatened Plant Species Programme
U	Unknown population trend
UJ	University of Johannesburg
UP	University of Pretoria
UV	Ultra-violet
VU	Vulnerable
WITS	University of the Witwatersrand
WRD	Waste Rock Dump
.wac	Acoustics Compressed
.wav	Wave
.zc	Zero crossing

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1. Introduction

Biodiversity describes the variety of life in an area. This includes the number of different species, their genes as well as the interrelationships between them and their natural environment. Diversity in this context refers not only to diversity between species and ecosystems but also within species. The combined influence of South Africa's unique geology and varied climate gives rise to unique vegetation types and habitats to form nine biomes. South Africa is a country that covers only 2% of the total land area on Earth, but is seen as one of the most bio-diverse countries in the world (EWT 2002 in Driver et al. 2004), as it supports 10% of the world's plant species, and 7% of the world's reptile, mammal and bird species.

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.*

The Koffiefontein Diamond Mine, owned by Petra Diamonds and Re-Teng Diamonds (Pty) Ltd, is located on the Remaining Extent (RE) of the Farm Koffiefontein 733 in the Free State Province, 100km south of Kimberley. The mining infrastructure commenced as open pits in 1870 until 1981, when underground mining was introduced. The underground mining has resulted in the requirement for slimes dams (West Dam, Middle Dam and East Dam) within the mine premises. The mine has limited space for disposal of slimes from the current diamond mining and processing operations. Therefore, a new slimes dam will be required and will be sized to cater to the extension of the Life of Mine (LoM) of 15 years. The slimes dam will be located on mining property, adjacent to existing slimes dams to ensure that even the proposed slime dam is disposed in an environmental responsible manner.

In light of the current legislation and requirements, Zitholele Consulting (Pty) Ltd (Zitholele) has been appointed by Koffiefontein Diamond Mine to perform an Environmental Impact Assessment (EIA) for this proposed additional slime dam and associated infrastructure. As a requirement under biodiversity legislation, Zitholele commissioned Natural Scientific Services CC (NSS) to conduct a Biodiversity/Ecological Assessment for the proposed development focusing on terrestrial fauna and flora and wetland systems. This report

presents findings of the assessment, which were obtained from desktop research and field work during mid-March and October 2015.

2. Terms of Reference

As agreed between NSS and Zitholele, the assessment was to be performed according to the methodology described under **Appendix 12.1**, for two alternative locations for the slimes dam. During the Scoping Phase, a third alternative location for the dam was also considered. These three alternatives were to be investigated during the Scoping Phase of the project. and are referred to as Alternatives 1, 2, and 4. NSS was to investigate these alternatives in the field. Later, within the EIA phase, a fourth alternative was included (Site 5), however, due to the site been positioned on an existing Slimes Dam, the biodiversity assessment did not warrent in-field investigations. All sites are shown in **Figure 2-1**, and collectively referred to in this report as the Site. The term “Study Area” is used to refer to the area within approximately a 3km radius around the Site.

This report provides findings of our assessment detailed under the following ToR:

- An Introduction and Scope of Work.
- A list of applicable legislation, policies, guidelines and biodiversity conservation initiatives.
- A broad description of the biophysical environment.
- A description of the assessment methodology and limitations.
- An assessment of the different habitat and vegetation types found, including structure, dominant plant and animal composition and condition.
- Information on observed or potentially occurring Conservation Important (CI; e.g. Red Data, endemic, or medicinal) species.
- The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of wetland systems identified within the study site.
- Descriptions of current and future potential impacts, and recommended impact mitigation measures.

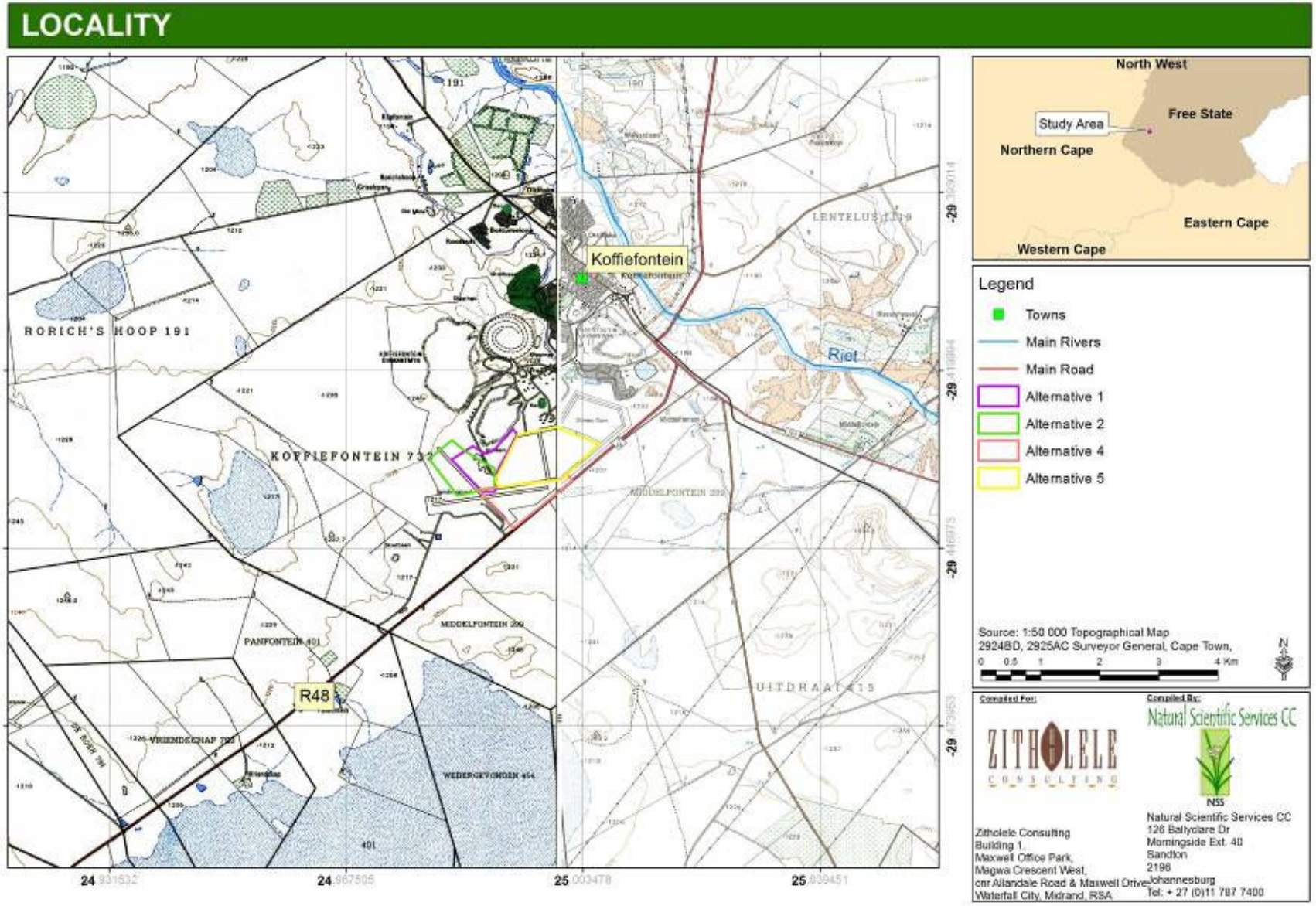


Figure 2-1 The four alternative slimes dam locations

3. Project Team

The assessment was managed and executed by NSS (**Table 3-1**). NSS has extensive experience in project management, and desktop- and field-based biodiversity assessments. NSS has also been involved in the management of Environmental Impact Assessments, Environmental Management Programme Reports, Strategic Management Plans and Environmental Management Plans for the conservation, mining, waste, commercial and industrial sectors.

Senior NSS team members are registered Professional Natural Scientists in the ecological, environmental, aquatic and zoological fields, as is legally required by the Natural Scientific Professions Act of 2003.

Table 3-1 NSS project team

PROJECT ROLE	NAME	QUALIFICATIONS
Project Manager & Floral Specialist	Susan Abell	M.Sc. – Resource Conservation Biology (WITS). Pr.Sci.Nat. Registered – Ecology & Environmental Science.
Wetland Specialist	Kathy Taggart	M.Sc. – Resource Conservation Biology (WITS). Pr.Sci.Nat. Registered – Ecology & Environmental Science. DWS acknowledgement – Competent Wetland Delineator.
Faunal Specialist	Dr Caroline Lötter	Ph.D. – Zoology (UP). Pr.Sci.Nat. Registered – Zoology.
Faunal Specialist	Tyron Clark	B.Sc. Honours - Zoology (WITS).
Floral Field & Office Assistant	Samantha Bradley	Ten year's work experience with NSS.
GIS Specialist	Tim Blignaut	M.Sc. – Geography (UJ) – in progress.

4. Applicable Legislation, Policies & Guidelines

International, regional, national and provincial legislation, policies and guidelines, which could apply to impacts of the proposed project on biodiversity are listed below. Although the list is comprehensive, additional legislation, policies and guidelines that have not been mentioned may apply.

4.1. International Agreements

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- (Ramsar) Convention on Wetlands of International Importance, especially as Waterfowl Habitat.

- (World Heritage or Stockholm) Convention Concerning the Protection of World Cultural and Natural Heritage.
- (Bonn) Convention on the Conservation of Migratory Species of Wild Animals.
- Convention on Biological Diversity including eco-systems and genetic resources.
- Agenda 21 regarding the sustainable development at global and national levels.
- United Nations Framework Convention on Climate Change.
- Kyoto Protocol on global warming.
- Johannesburg Declaration and Plan of Implementation for sustainable development.
- Copenhagen Accord on Climate Change.
- 17th Conference of the Parties on Climate Change.

4.2. International Policies & Guidelines

- International Council on Mining and Metals: good practice guidance on mining and biodiversity (Johnson & Starke 2006).

4.3. Regional Agreements

- Action Plan of the Environmental Initiative of NEPAD for sustainable development in Africa.

4.4. National Legislation

- Conservation of Agricultural Resources Act (Act 43 of 1983).
- Environmental Conservation Act (Act 73 of 1989).
- Constitution of the Republic of South Africa (Act 108 of 1996).
- Water Services Act (Act 108 of 1997).
- National Water Act (Act 36 of 1998).
- National Forests Act (Act 84 of 1998) and Protected Tree Species.
- National Veld and Forest Fire Act (Act 101 of 1998).
- National Environmental Management Act (NEMA; Act 107 of 1998).
- National Heritage Resources Act (Act 25 of 1999).
- National Mineral and Petroleum Resources Development Act (Act 28 of 2002).
- National Environmental Management: Protected Areas Act (Act 57 of 2003).
- National Environmental Management: Biodiversity Act (NEM:BA; Act 10 of 2004):
- Threatened, Protected, Alien and Invasive Species Regulations (2007).
- Alien and Invasive Species Regulations (Government Gazette [GG] 37885, 1 August 2014).
- National list of Ecosystems Threatened and in need of Protection under Section 52(1) (a) of NEM: BA (GG 34809, Government Notice [GN] 1002, 9 December 2011).
- National Environmental Management: Air Quality Act (Act 39 of 2004).
- GN R. 704: regulating the use of water for mining and related activities.
- National Water Resource Strategy (2004).

4.5. National Policies, Guidelines & Programmes

- National Biodiversity Strategy and Action Plan.
- National Spatial Biodiversity Assessment including Terrestrial Priority Areas & Threatened Ecosystems.
- National Aquatic Ecosystem Health Monitoring Program and River Health Program.
- National Freshwater Ecosystem Priority Areas (FEPAs).
- Review of biodiversity management in the mining industry in South Africa by Kuntonen-van't Riet (2007).
- Mining and Biodiversity Guideline (MBG) by the DEA *et al*. (2013).

4.6. Provincial Legislation, Policies & Guidelines

- Free State Environment Outlook (2008) - A report on the state of the environment in the Free State Province.
- Free State Nature Conservation Ordinance (Act 8 of 1969).
- Ordinance Free State Nature Conservation Regulations (1983).
- Free State Nature Conservation Bill, published under Notice No. 10, Provincial Gazette 23, dated 7 May 2010.

5. Study Region

5.1. Locality & Land Use

The Site is situated adjacent to Koffiefontein Diamond Mine on the remaining extent of the Farm Koffiefontein 733 in the Free State Province. The Study Area falls within the 1:50 000 topographical map 2924BD and 2925AC Quarter Degree Squares (QDSs). The four Site alternatives occupy a combined area of approximately 213ha.

The main forms of land-use in the region include the Koffiefontein mining operations, human settlement, and farming, which is focussed on cattle and sheep farming, and the cultivation of lucerne, potatoes and ground nuts. Land around Petra Diamonds Operation that is not currently being mined, represents vacant veld, which supports grazing by some domestic livestock and a significant diversity of large ungulate game (Petra Diamonds Game Farm) and other wildlife (**Figure 5-1**). Although there is limited built infrastructure, the Site is currently intersected by an airfield. In the past this airfield and surrounding vegetation formed part of the Mine's slimes dam. This is supported by aerial imagery that was captured in 1944 (**Figure 5-2**). Therefore the majority of the site under investigation should be considered transformed as recovery shrubveld.

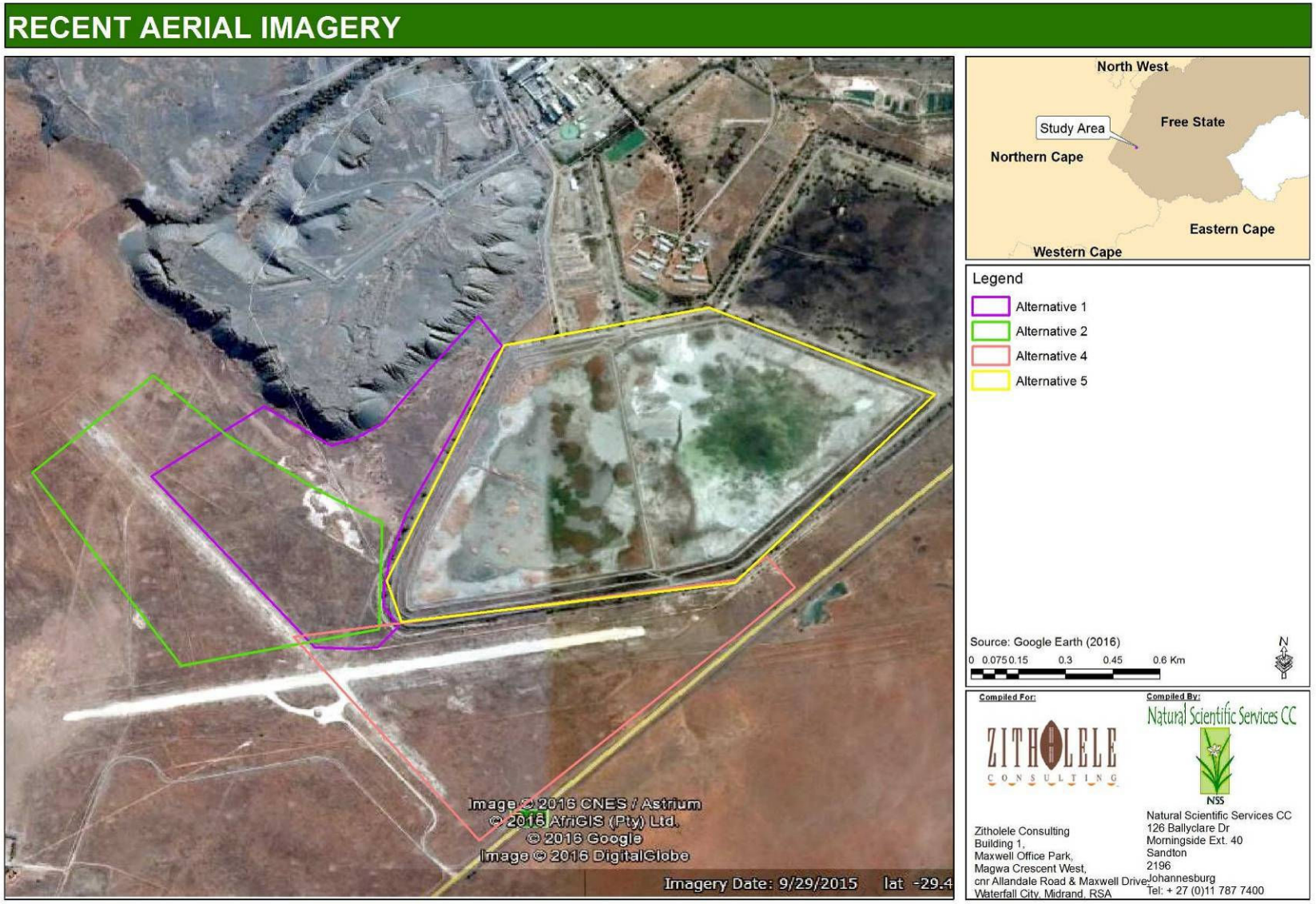


Figure 5-1 Recent Google Earth imagery of the Study Area

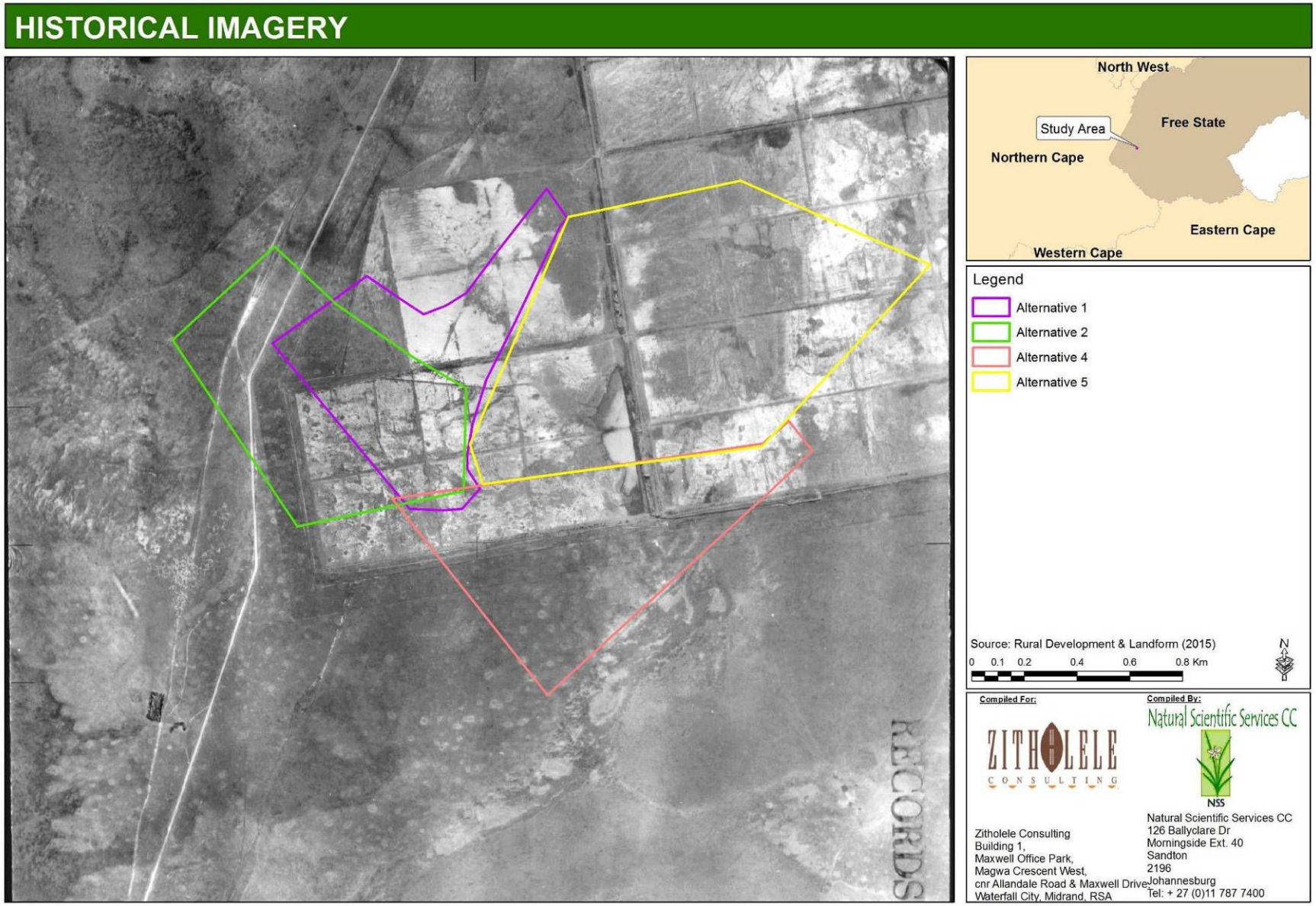


Figure 5-2 Aerial imagery of the Study Area from 1944

5.2. Climate

The vegetation in the Study Area is characterized by mean annual precipitation of roughly 200-400mm (Mucina & Rutherford 2006), with peak rainfall in autumn i.e. March (when our late summer survey was performed). Mean daily maximum and minimum temperatures in the larger region for January and July, are approximately 37°C and -4°C, respectively. Overall mean annual temperature is approximately 16.5°C. Frost is frequent in winter (37 frost days per annum on average).

Shown in **Figure 5-3** is the monthly amount of rainfall measured at Kimberley between March 2014 and October 2015 (data obtained from Weather SA, 2015). During the 12-month period preceding March 2015, when NSS performed the late summer field surveys, a total of 331mm rain was measured at Kimberley. This approximate rainfall data suggest that the Koffiefontein Study Region received an average amount of rainfall during the 12 months preceding the first visit. The period between April and October 2015 yielded an additional 75mm. The approximate temperature data in **Figure 5-4** indicates that conditions were typically mild to warm during March 2015 and dry and hot (reaching maximum temperatures of 33°C) in the October field investigations. During the October field investigations, significant rain fell within the late afternoons, yielding faunal results that would typically not have been detected (**Figure 5-5**).

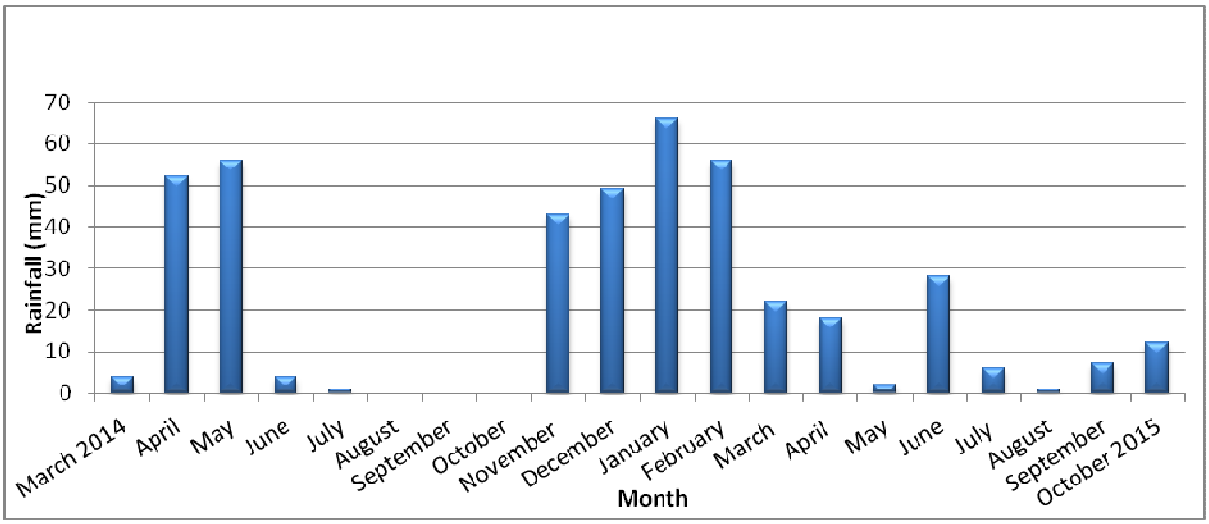


Figure 5-3 Measurements of monthly rainfall at Kimberley (Weather SA, 2015)

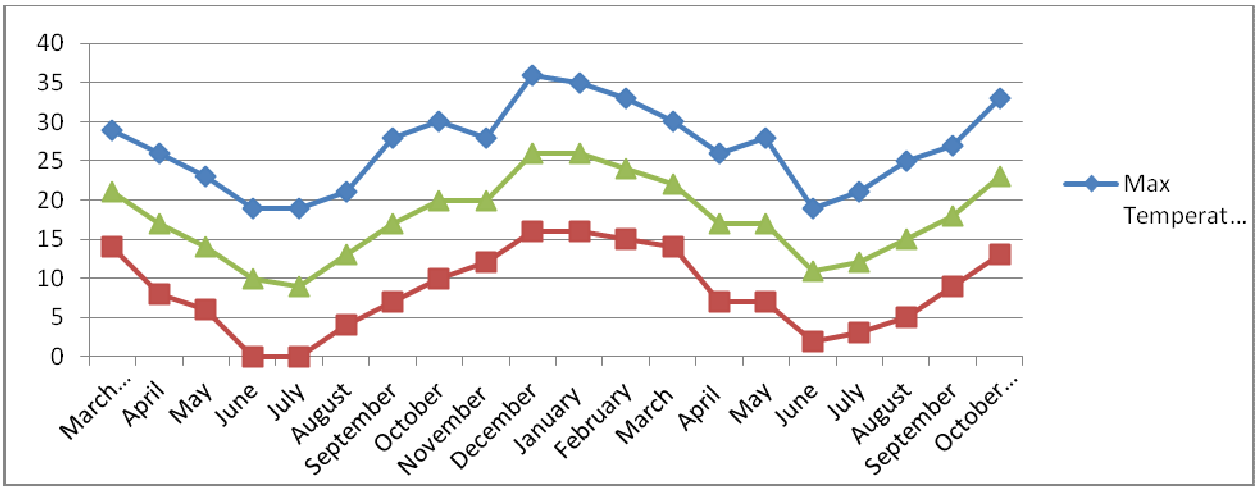


Figure 5-4 Measurements of air temperature at Kimberley (AccuWeather 2015)

Figure 5-5 Rainfall duirng October 2015 visit

5.3. Land Types

"Land types," which have been identified by the ARC's Institute for Soil, Climate and Water, represent areas that are uniform with respect to climate, terrain form, geology and soil. The data, obtained through the Agricultural Geo-referenced Information System (AGIS, 2010), provide useful baseline information on land capability (especially agricultural potential). According to this data, the Study Area is situated in a single land type referred to as Ae279 (**Figure 5-6)**. This land type features "wide stretches of land covered by superficial deposits including calcretes of the Kalahari Group. Soils are variable from shallow to deep, red-yellow, apedal, freely drained soils to very shallow Glenrosa and Mispah forms" (Mucina & Rutherford 2006). The terrain is flat to gently sloping, and interspersed with small, rocky outcrops and pans. Elevation across the Study Area ranges from approximately 1240 m to 1220ma.s.l.

5.4. Hydrology

The Rietspruit flows approximately 3.5km north-east of the Site, and the only other perennial river that traverses the Nama Karoo Ecoregion 26 is the Orange River. Other rivers that

drain this Ecoregion are seasonal. The Study Area is situated within the C51K quaternary catchment (**Figure 5-7**), which according to the DWAF (2011) has a Moderate EIS (although this rating is associated with a Low level of confidence). Quaternary catchments with a Moderate EIS are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use.

5.5. Vegetation

The Study Area is situated in the Nama-Karoo biome and features one main vegetation type (**Figure 5-6**) referred to as NKu3 Northern Upper Karoo by Mucina & Rutherford (2006). This vegetation type represents a type of "shrubland dominated by dwarf karoo shrubs, grasses and *Acacia mellifera* subsp. *detinens* and some other low trees (especially on sandy soils)" such as north of the Study Area. As Northern Upper Karoo represents a transitional vegetation type between the Nama-Karoo, arid Kalahari savanna and arid Highveld grasslands (Mucina & Rutherford 2006), the Study Area could support a slightly greater diversity of flora and fauna than what might typically be expected for a semi-arid environment. Although Northern Upper Karoo has a Least Concern conservation status (Mucina & Rutherford 2006), it supports several endemic or biogeographically important plant taxa, and none of this vegetation type is statutorily conserved. "About 4% has been cleared for cultivation (the highest proportion of any type in the Nama-Karoo) or irreversibly transformed by building of dams (Houwater, Kalkfontein and Smart Syndicate dams)." Human settlement is increasing and almost 50% of the Northern Upper Karoo vegetation type is affected by a moderate erosion. The agriculturally-important alien invasive *Prosopis glandulosa* occurs in isolated patches.

5.6. Conservation Important Biodiversity Features

As inferred in the preceding legislation section of this report, a number of features in the Study Area, which are of recognized national conservation importance, require consideration.

5.6.1. Water Resources

A broad spectrum of international, regional and national legislation and guidelines applies to the protection of wetlands and their biodiversity (including e.g. CI species such as the grass-owl and bullfrog). The National Water Act (NWA; Act 36 of 1998) is the principle legal instrument relating to water resource management in South Africa. Under the NWA, all wetlands and their buffer zones are protected.

The NWA points out that it is:

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

According to Chapter 3 of the NWA on the protection of water resources:

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

Wetlands (artificial, natural and "cryptic") that were identified on Site are discussed further on in this report.

5.6.2. National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Area (NFEPA) project (Driver *et al.* 2011) provides strategic spatial priorities for conserving freshwater ecosystems and supporting sustainable use of water resources in South Africa. Freshwater Ecosystem Priority Areas (FEPAs) were identified using a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries.

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

The NFEPA spatial data indicate that there is no Category 1 FEPA on Site (**Figure 5-8**). There is, however, a cluster of recognized wetland FEPAs situated between approximately 1km and 2.5km south-east of the Site. There are also several large pans to the south, west and north-west of the Site, which could be important but have not yet been classified under the NFEPA.

The NFEPA guidelines indicate that FEPAs should be regarded as ecologically important and as generally sensitive to changes in water quality and quantity, owing to their role in protecting freshwater ecosystems and supporting sustainable use of water resources. FEPAs that are in a good condition should remain so, and FEPAs that are not in a good condition should be rehabilitated to their best attainable ecological condition. Land-use

practices or activities that will lead to deterioration in the current condition of a FEPA are considered unacceptable, and land-use practices or activities that will make rehabilitation of a FEPA difficult or impossible are also considered unacceptable.

"Applications for mining and prospecting in FEPAs and associated sub-quaternary catchments should be subject to rigorous environmental and water assessment and authorisation processes, as mining has a widespread and major negative impact on freshwater ecosystems" (Driver et al. 2011). Furthermore: Mining in any form should not be permitted in wetland FEPAs, or within 1km of a wetland/riverine FEPA buffer.

5.6.3. Mining and Biodiversity Guideline

The mining industry plays a vital role in South Africa's growth and development. But if mining is not strategically planned and carefully implemented, it has significant negative impacts on Biodiversity and ecosystems, in particular, catchments, rivers and wetlands that support water-related services. The Mining and Biodiversity Guideline (MBG) 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, in partnership with the Department of Environmental Affairs and the Department of Mineral Resources, and with technical input and co-ordination by the SANBI Grasslands Programme.

A large portion of Alternative 4 for the proposed slimes dam comprises land that has been zoned under the MBG as having the Highest Importance for Biodiversity and thus the Highest Risk for mining (**Figure 5-9**), based on the nearby cluster of FEPA wetlands and the required buffers around these. The MBG stipulates that in areas of Highest Importance for Biodiversity:

"Environmental screening, EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision-making for mining, water use licences, and environmental authorisations.

If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services. These areas are viewed as necessary to ensure protection of biodiversity, environmental sustainability, and human well-being. Authorisations may well not be granted. If granted, the authorisation may set limits on allowed activities and impacts, and may specify biodiversity offsets that would be written into licence agreements and/or authorisations."

5.6.4. BirdLife IBA: Kalkfontein Nature Reserve

Status: Sub-Regional IBA (C4i, ii)
Protection: Fully Protected Size: 5 240 ha
Number: SA050

Kalkfontein Dam (1 100–1 400m a.s.l) is a recognized Important Bird Area (IBA) by BirdLife. The dam is situated 20km south-east of Koffiefontein and the Study Area, in the south-western Free State. It is used mainly for downstream irrigation purposes, and as a water supply for Koffiefontein and Petra Diamond Mine (with management through a water user's association). According to BirdLife South Africa, there are about 170 bird species that have been recorded in the Kalkfontein Dam IBA. This wetland supports large numbers of migratory and locally resident waterbirds; the highest recorded number of waterbirds is 13 556, representing 40 species. Numbers of bird species and individuals vary seasonally and annually, especially when the dam's level fluctuates due to release of water for irrigation.

Threatened bird species that have been recorded in the Kalkfontein Dam IBA include the: Lesser and Greater flamingos, Caspian Tern, Blue Korhaan, Secretary bird, Ludwig's Bustard, Yellow-billed Stork and Sickle-winged Chat. The arid grasslands surrounding the dam support Melodious Lark and Blue Crane. The rare rock catfish *Austroglanis sclateri,* Serval and African Striped Weasel have also been reported from the region.

There is an existing Technical Cooperation Permit for sections of the Free State, including the Kalkfontein Dam IBA, for petroleum exploration (shale gas), which is likely to be by means of hydraulic fracturing. There is, therefore, a potential threat of petroleum mining/fracking over the medium term in or around the IBA, but its formal protection status may exclude such activities within it. Another threat, which needs to be quantified, is posed by power lines.

5.6.5. Free State Conservation Plan

The Free State Department of Economic Development, Tourism and Environmental Affairs (DETEA) are in the process of finalising their Systematic Biodiversity Plan, the spatial component is complete whilst the technical report and land-use guidelines are still in progress. The DETEA have provided NSS with the planning units for the Site and immediate surrounds (**Figure 5-10**). Like other provincial level spatial conservation assessments, essentially seeks to classify land into one of several main classes that represent the level of protection and/or conservation status of a given area. Typically these classifications (in order of conservation significance) are as follows; Protected, Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs), Degraded, Other and No Natural Areas

The northern region of the study area (Most of Alternative 2) is classified as disturbed, the central-south portion as ESA2 (Site 1, 4 and 5) while a small portion along the southern most

boundary of Alternative 4 is zoned as ESA 1. Mining is seen as an incompatible land-use for both categories ESA1 and ESA2. A definition of each ESA category is given below:
ESA1 (Ecological Support Area: Natural): Planning units identified to be ESAs and of which <= 10 percent of the surface has been transformed or degraded. Planning units belonging to this category are mostly natural and are considered to represent prime corridor areas.
ESA2 (Ecological Support Area: Other): Planning units identified to be ESAs and of which <= 50 percent of the surface has been transformed. It follows that Planning units of which 100% of their area has been degraded are included in this class. Degraded areas mostly consist of old lands on which some form of natural vegetation has established and are therefore considered to be suitable areas to facilitate animal movement.

In general ESAs are not usually regarded as being essential for meeting biodiversity targets but play an important role in supporting Irreplaceable and Important areas and/or in delivering ecosystem services. CBAs (which occur much further north) include Irreplaceable and Important Areas. Irreplaceable Areas are considered critical for meeting provincial biodiversity targets, and are required to ensure the persistence of species and the functioning of ecosystems.

The ***draft*** land-use guidelines for these categories highlight the following key objectives:
Maintain ecosystem functionality and connectivity allowing for limited loss of biodiversity pattern (ESA1)
Avoid additional / new impacts on ecological processes (ESA2).

After discussions with the Conservation Division of the DETEA, it is clear that the ESA1 and ESA2 areas were categorised as such due to their overlap with suitable areas outside of the study area or because of suitable small remnants within them. DETEA recognises that the majority of the site can be dealt with as Degraded (and in some areas, in a state of recovery).

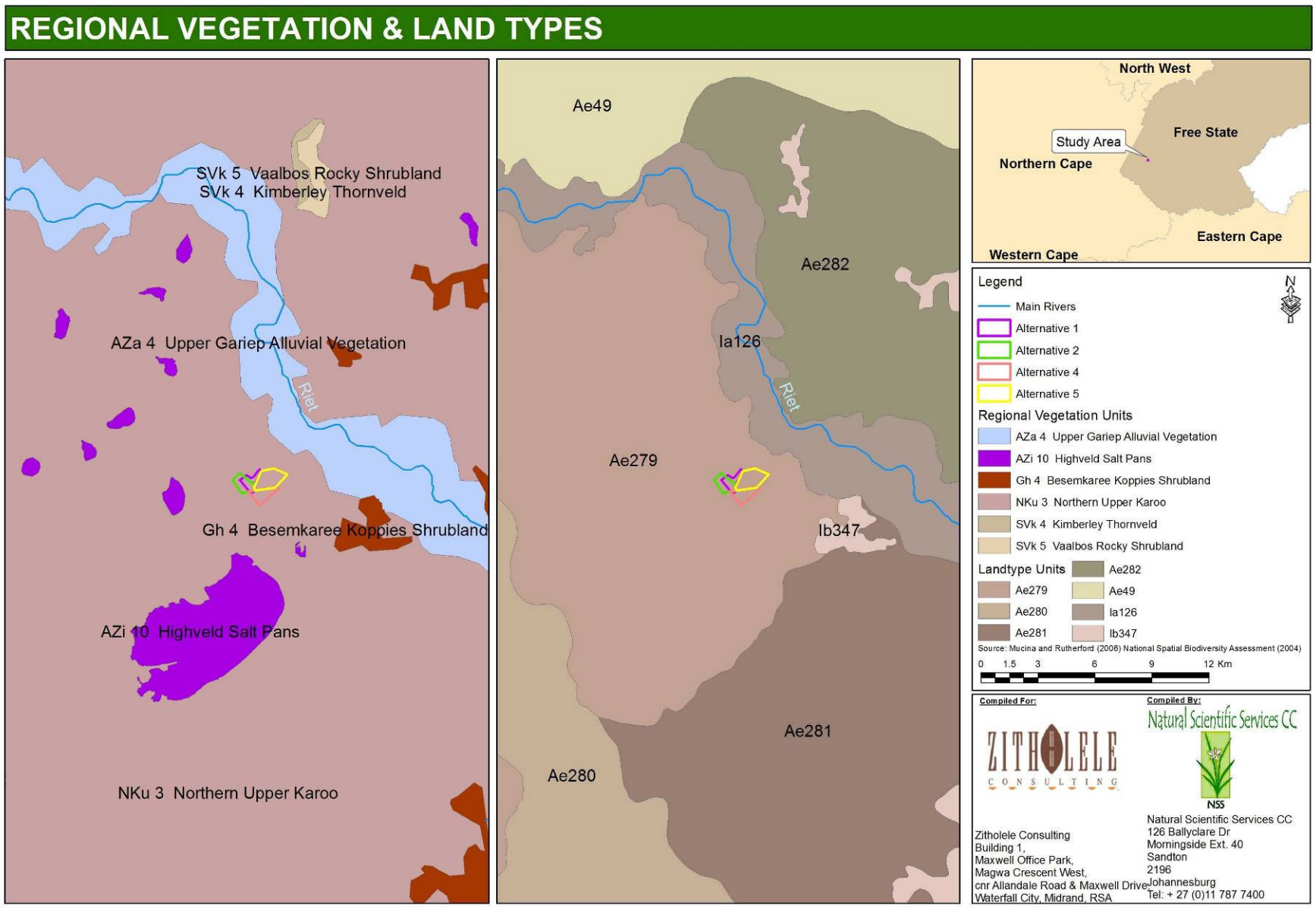


Figure 5-6 Regional vegetation and land types in the Study Region

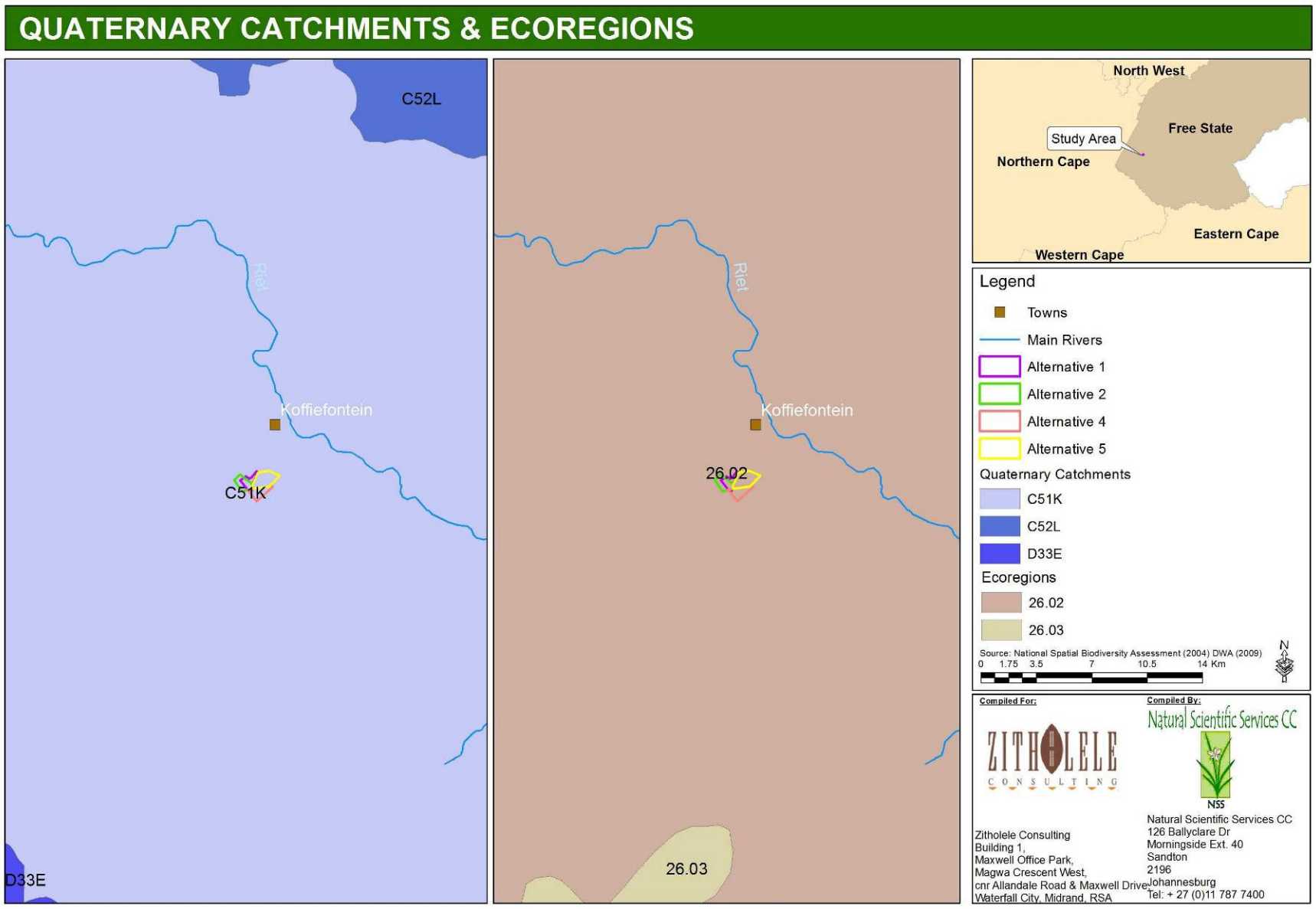


Figure 5-7 Quaternary catchments and ecoregions in the Study Region

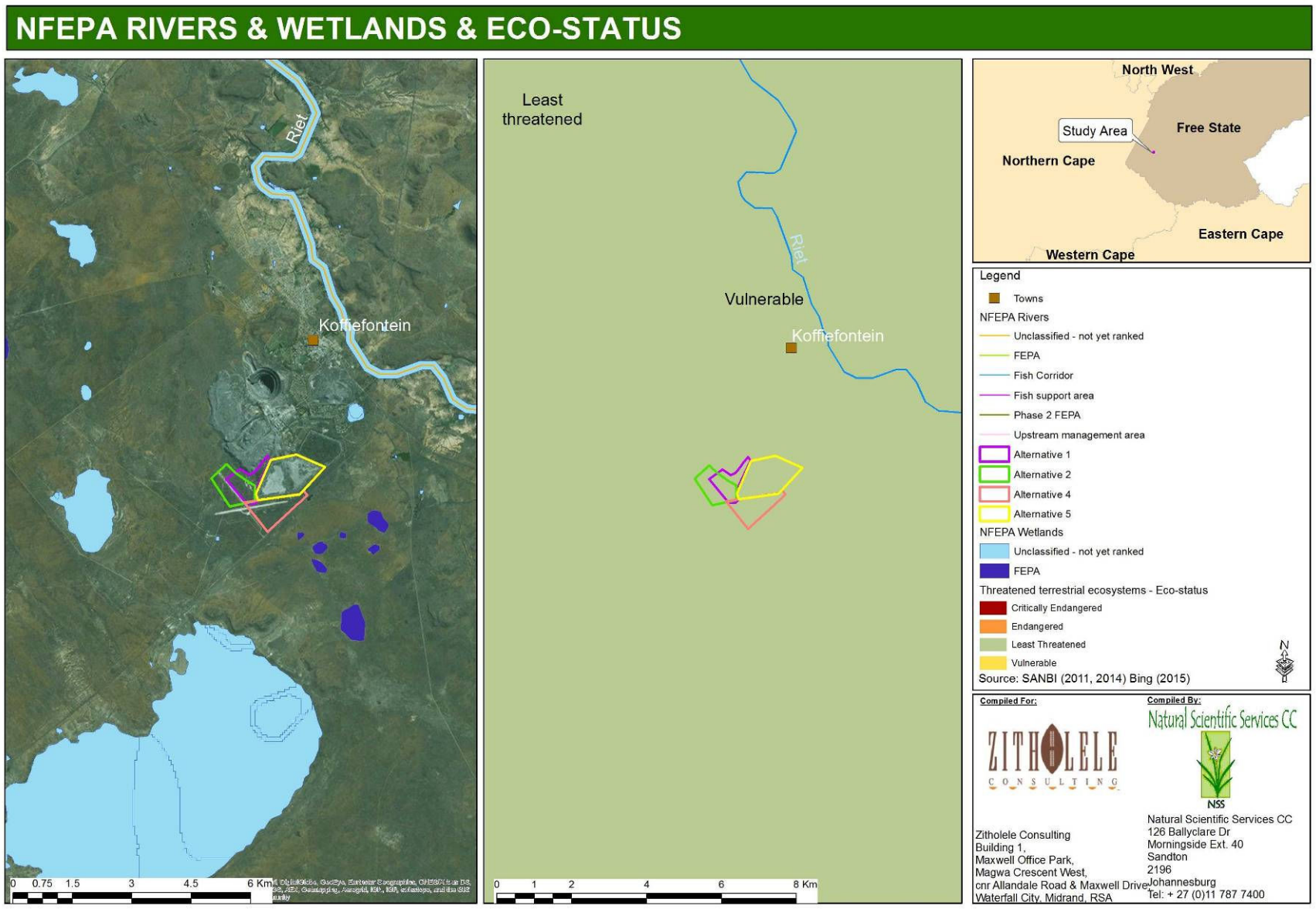


Figure 5-8 Study Region Freshwater Ecosystem Priority Areas and Eco-status

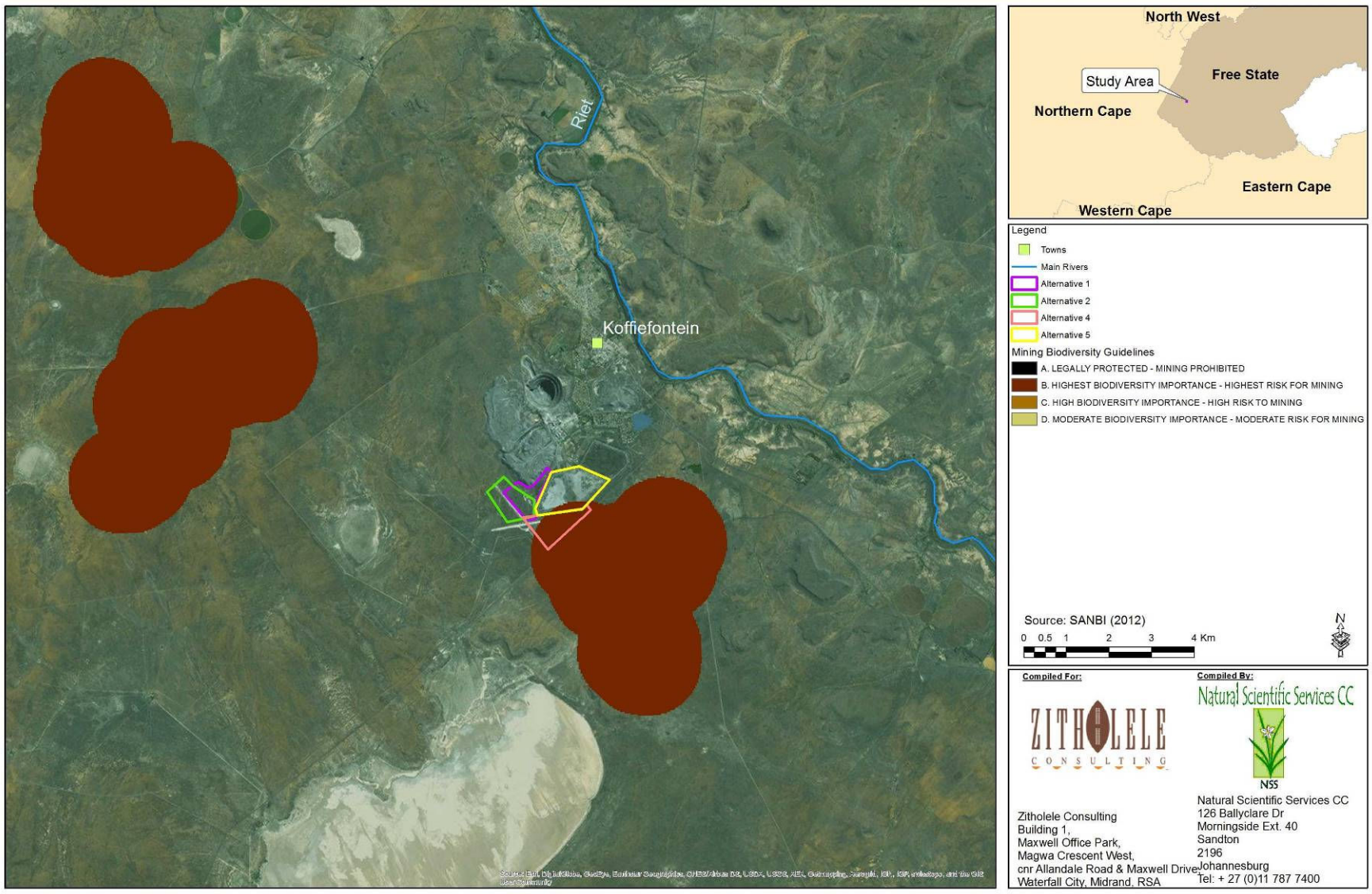


Figure 5-9 Mining and Biodiversity Guideline atlas data for the Study Region

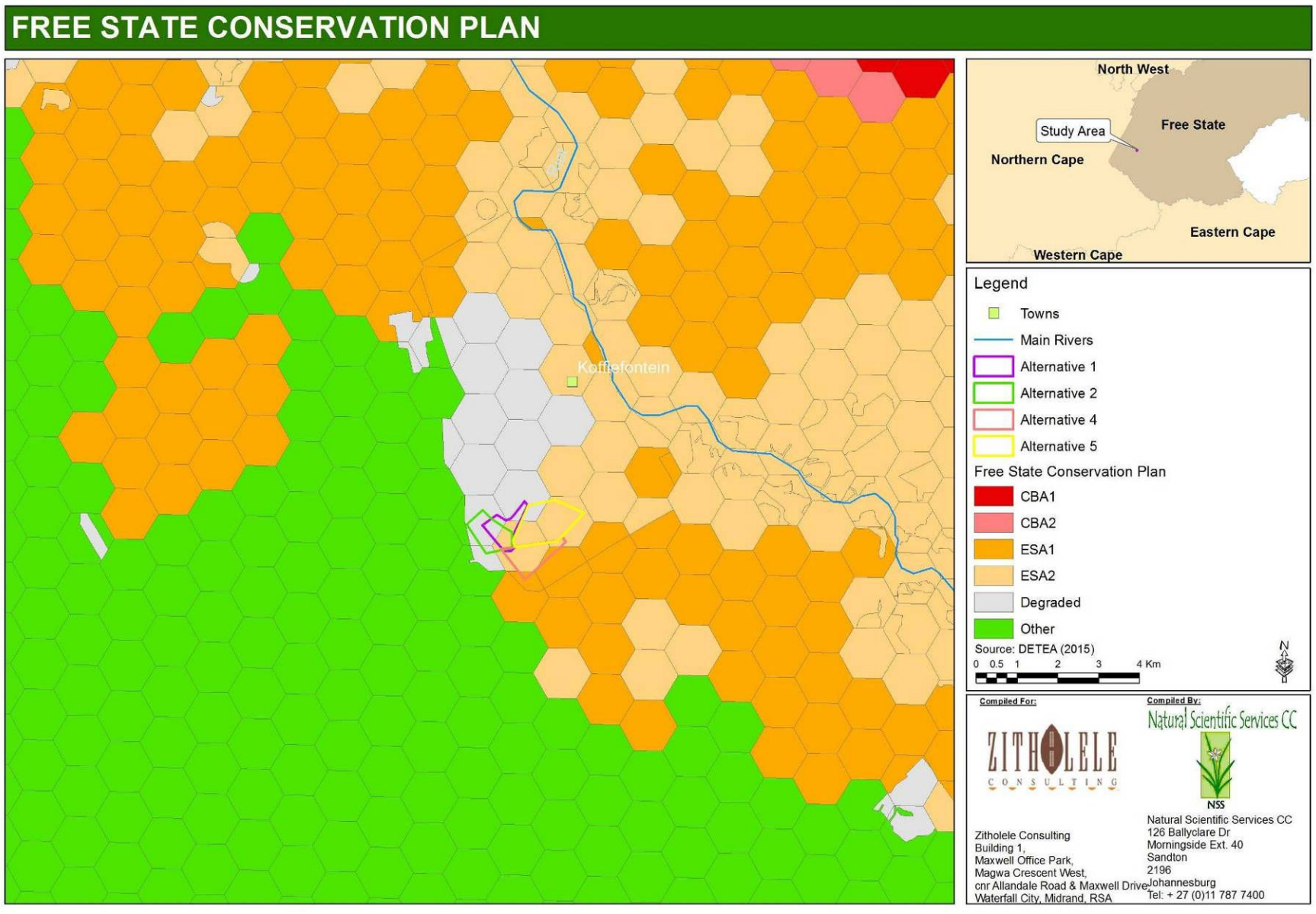


Figure 5-10 Free State Conservation Plan for the Study Region and surrounds

6. Methodology

6.1. Flora

5.6.6. Desktop Research

Desktop research included the following:

- Aerial Imagery from 1944 (Chief Directorate: National Geo-spatial Information Cape Town).
- 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) 2924BD and 2925AC (This database in currently in revision).
- CI plant species records in the study region.
- Reports within the area including:
- the EIA For the proposed Oryx Photovoltaic Energy Facility near Koffiefontein, Environamics 2014
- Ecological Assessment Report Proposed Blackwood Solar Energy Facility Near Kimberley Free State, Savannah, 2014
- 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 (NEM:BA; Act 10 of 2004).

5.6.7. Fieldwork

Floral fieldwork was performed during mid-March and late October 2015, 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.**
- 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.

5.6.8. 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.
- An ordination using a DCA of the same Braun Blanquet data was used to determine the proximity of relationships between sample entities, and to confirm the vegetation assemblages (floral communities) identified in the TWINSPAN 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 or No Habitat available.

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

5.6.9. 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 March and October 2015 visits may be due to:

- The small, fragmented nature of the Site and disturbances from past agricultural activities on site. The majority of the site was worked or used for the mine and is therefore in a recovery phase (**Figure 5-2**).
- The duration of each fieldwork session.
- 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.
- The three site alternatives (Alternatives 1,2 and 4) were relatively homogeneous in nature making it difficult to assess using vegetation sampling methods such as Braun-Blanquet cover-abundance scale. They had also been affected historically through the construction and removal of a slimes dam.
- A number of the grasses and shrubs contained no flowerheads or even fruiting bodies. The veld showed signs of moving towards winter dormancy (March 2015). The October 2015 assessment had some rains, but not sufficient enough to promote growth and excessive flowering.

- As an alternative to other vegetation cover methods (such as the Domin method), the Braun-Blanquet cover-abundance scale was used to analyze vegetation. It is reported that the Braun-Blanquet method requires only one third to one fifth the field time required to other similar methods (Wikum & Shanholtzer, 1978). Furthermore, cover-abundance ratings are better suited than density values to elucidate graphically species-environment relationships. For extensive surveys this method provides sufficiently accurate baseline data to allow environmental impact assessment as required by regulatory agencies. However, there are a couple of problems that have been detected with such sampling methods (Hurford & Schneider, 2007). These are as follows:
- It can be seen as subjective and dependent upon the experience and knowledge of the vegetation type by the surveyor. The cover estimate may vary from observer to observer.
- There also may be a problem when the cover estimate is very close to two different classes (on the border so to speak) and then it is for the observer to decide which class it should be allocated to. In Hurford & Schneider's (2007) experience, in marginal situations, where the cover of a species is close to a boundary between two classes, the chance of two observers allocating the species to the same cover class is no better than 50:50. However, when comparing to other sampling methods such as Domin, Braun-Blanquet scale is better adapted for monitoring (less cover classes and fewer boundaries).

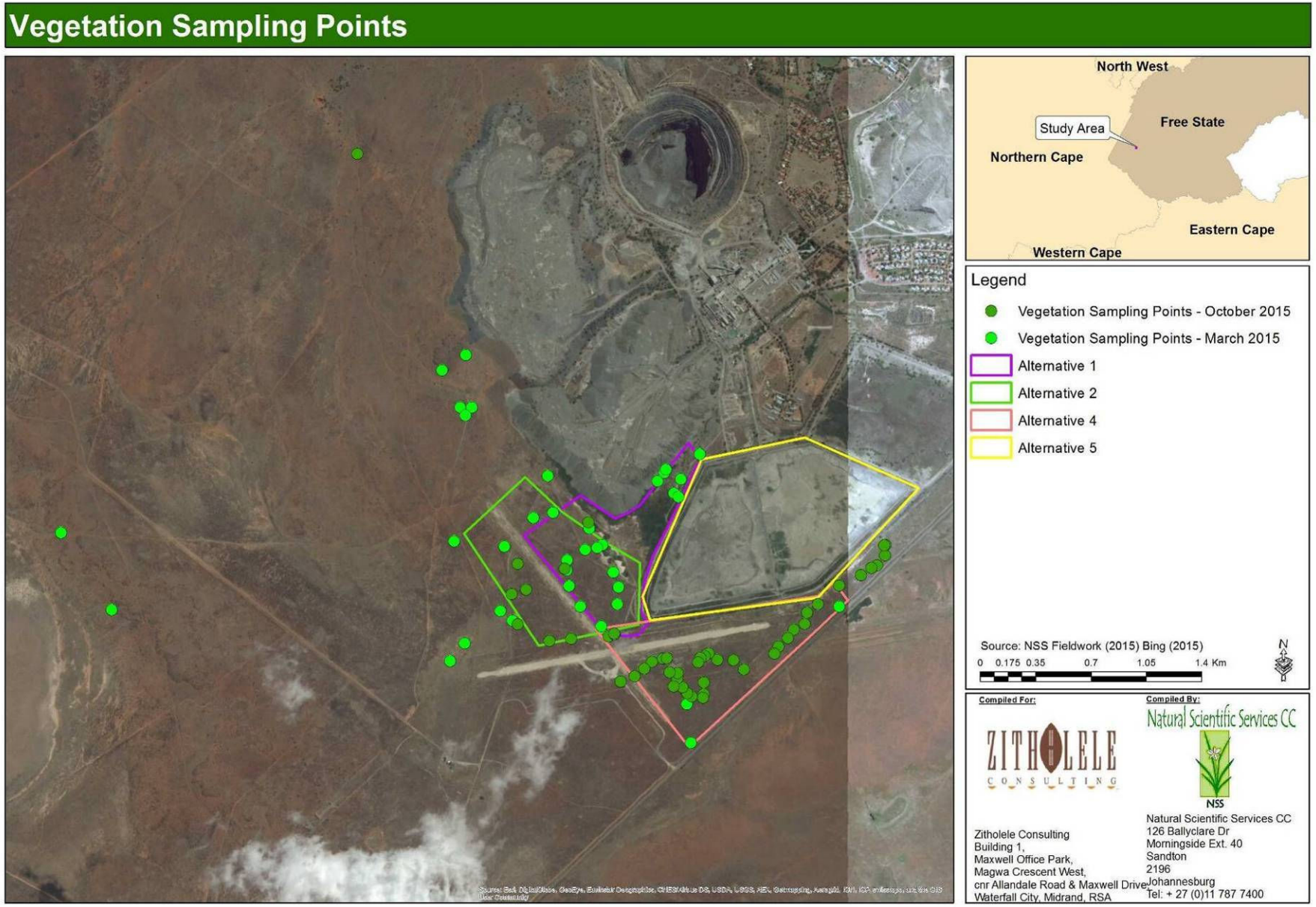


Figure 6-1 Main Vegetation Sampling Points

6.2. Fauna

5.6.10. Desktop Research

Lists of potentially occurring fauna were compiled for:

- Mammals, including bats, using the published species distribution maps in Friedmann & Daly (2004) and Stuart & Stuart (2007), and Monadjem *et al*. (2010), respectively, and online species distribution data from MammalMAP (2015).
- Birds, using the online species distribution maps from the first and second Southern African Bird Atlas Projects (SABAP 1 & 2, 2013), and the latest online list of bird species for the Study Region, which included relatively recent SABAP 2 records for pentad 2925_2455 and older SABAP 1 records for QDS 2924BD. Bird species were classified according to a modified version of Newman's (2002) 12 bird categories, which are described under **Appendix 12.2**.
- Reptiles, using the published species distribution maps in Bates *et al.* (2014), and online species distribution data from ReptileMAP (2015). The 2013 report on a local herpetological survey by the North-West University (NWU, 2013) was also consulted.
- Frogs, using the published species distribution maps in Minter *et al*. (2004) and online species distribution data from FrogMAP (2015). The NWU (2013) report on a local herpetological survey was also consulted.
- Butterflies, using the published species distribution maps in Mecenero *et al.* (2013), and online species distribution data from LepiMAP (2015).
- Scorpions, using the published species distribution maps in Leeming (2003), and online species distribution data from ScorpionMAP (2015) – although currently ScopionMAP has no records of scorpions from the Study Area.
- Odonata, using the published distribution maps in Samways (2008), and online species distribution data from OdonataMAP (2015) – although currently OdonataMAP has no records of odonata from the Study Area.

The lists were refined based on our field observations, where the Likelihood of Occurrence (LoO) of each species was rated using the following scale:

- Present: the species, or signs of its presence, was observed on Site (i.e. within the boundaries of one or more of the project alternatives) or in the Study Area (i.e. within a 3km radius of the Site).
- High: the species is highly likely to occur, based on available distribution data, and observed habitats.
- Moderate: the species may occur, based on available distribution data, and observed habitats and disturbances.
- Low: the species is unlikely to occur, based on available distribution data, lack of suitable habitat and/or disturbances.
- Managed: the observed species occurs as a managed population.

5.6.11. Fieldwork

Fieldwork was performed over two periods 9-11 March 2015 (late summer) and 19-21 October 2015 and involved (day and night-time) visual observations, grab-sampling, camera- and live-trapping of fauna, as well as a driven acoustic survey (transect) for bats.

Visual observations & grab-sampling

Faunal observations were made while driving, walking, and inspecting different habitats in the Study Area. Taxa were identified based on observations of dead or live specimens, spoor, droppings, burrows (burrow scopes included) and other evidence. Rocks and logs were turned to find reptiles, scorpions, frogs and invertebrates. Sweep nets were used to catch butterflies and odonata. A SASS net was used to collect tadpoles. At night a spotlight and torches were used to search for nocturnal vertebrates, and a UV torch was used to detect scorpions.

Camera-trapping

Motion-sensitive cameras (**Figure 6-2**) were installed at 10 locations in the Study Area, where vertebrate activity seemed likely (**Figure 6-3**). Some of the cameras were baited with tinned pilchards to purposefully attract carnivorous mammals.

Camera trap

Sherman trap

Camera trap

Figure 6-2 Faunal trap types

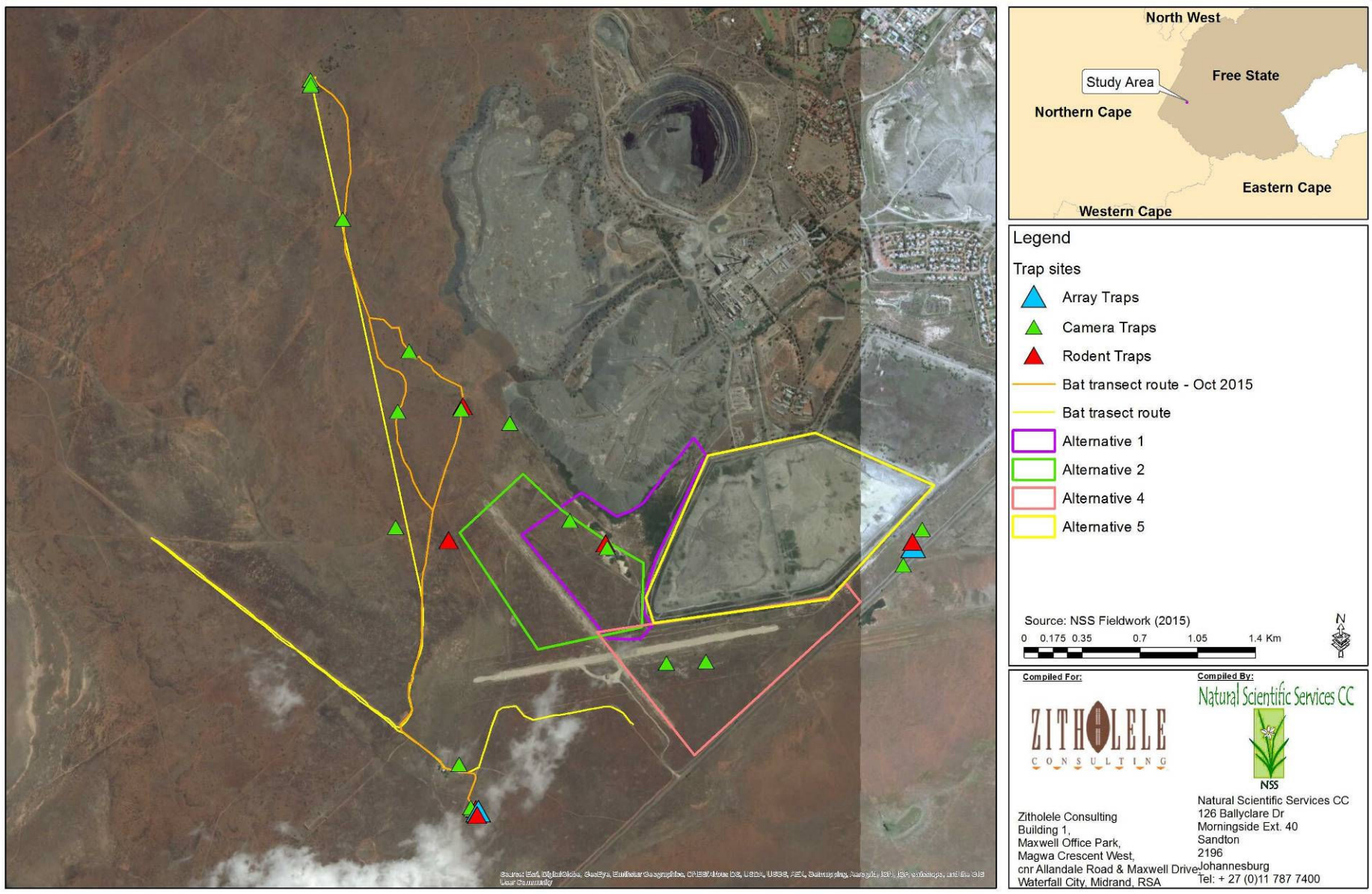


Figure 6-3 Faunal trapping localities and bat transect route

Figure 6-4 Burrow Scope

Live-trapping

During the first site visit a series of metal rodent traps were installed, and operated for three days and two nights at four localities. Each series of rodent traps comprised two multi-entry traps and 6-10 Sherman traps (**Figure 6-2**). Each rodent 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.

During the second site visit, in a similar fashion, a series of rodent traps were deployed at two localities (one new). Additionally during the second site visit two array traps were set aimed at sampling herpetofauna and terrestrial macro-invertebrates (Campbell & Christman, 1982). A schematic layout of one of these array traps is presented in **Figure 6-2**. Each array trap consists 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. The locations of the various trap sites, types and motion cameras are shown in (**Figure 6-3**).

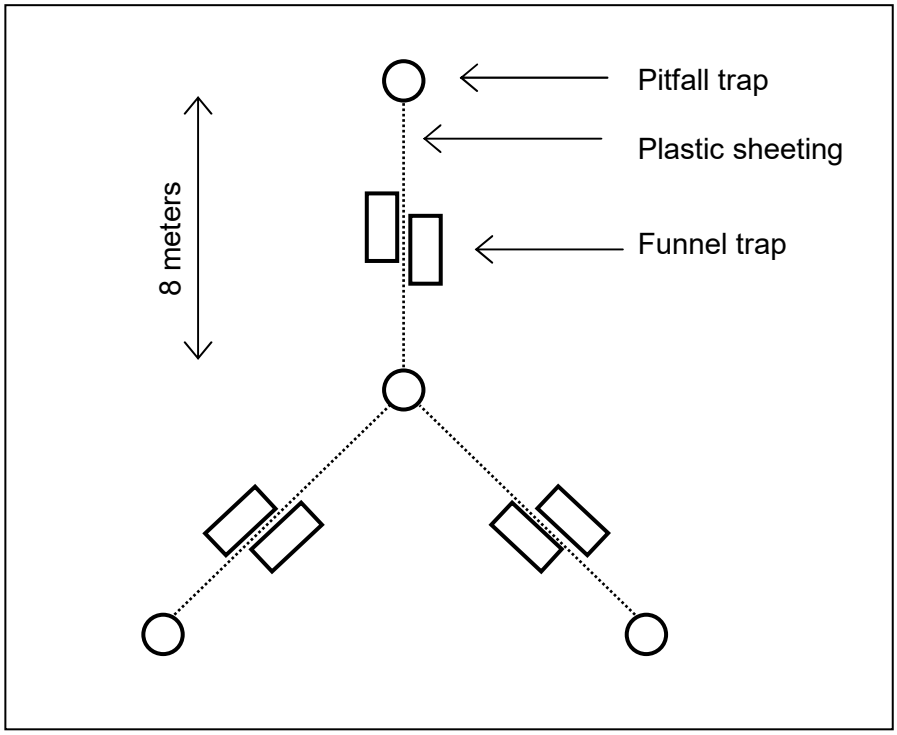


Figure 6-5 Schematic layout of a faunal array trap including drift fences, pitfall and funnel traps

Acoustic survey for bats

An ultra-sonic Echo Meter 3 (EM3) detector (Wildlife Acoustics, Inc., USA) was used to record bat calls at night while driving "transects" through Study Area on 9 March and 19-20 October 2015. Wildlife Acoustics Compressed (.wac) files of bat calls recorded by the EM3 detector were converted to wave (.wav) and zero crossing (.zc) files using the Kaleidoscope programme (Wildlife Acoustics Inc., USA). The converted data were subsequently processed using the Anallok BatSound Pro (Pettersson Elektronik, Sweden) programme to identify bat taxa from detailed examination of the peak frequency, duration and band width of calls.

5.6.12. Data Analysis

To permit a rough comparison of terrestrial vertebrate and butterfly diversity between different habitats in the Study Area, each detected faunal species was assigned, depending on where it was encountered, to one or more of the following habitat types:

- Rocky outcrops.
- Open karoid scrub.
- Wetlands (including small, seasonal depressions or dams, or permanent water holes).
- Man-made (including buildings, roads, powerlines, mine slimes dams, etc.).

5.6.13. Conservation Status of Species

Where available, the global (i.e. IUCN 2013.1 Red List) and national conservation status of each potentially occurring and observed faunal species is indicated in the appended species lists. National faunal atlases and Red Data books for mammals, birds, reptiles, frogs, butterflies

and odonata have been published, respectively, by Friedmann & Daly (2004), Barnes (2000), Bates *et al.* (2014), Minter *et al*. (2004) and Measey (2011), Henning *et al.* (2009) and Mecenero *et al.* (2013), and Samways (2006). The South African Red Data book for birds is currently being revised, and an update is expected soon. An atlas and Red Data book for South African scorpion species has not yet been published.

Apart from the IUCN Red List and the national faunal atlases and Red Data books, a legally-binding national list of Threatened or Protected Species (ToPS 2007) is provided under the National Environmental Management: Biodiversity Act (NEM:BA 2004). Observed or potentially occurring ToPS are discussed in text. As there is often spatio-temporal variation in human disturbances, the conservation status of some species differs between the IUCN global, national Red Data book, and ToPS listings. Unless otherwise stated, the most threatened status of a species is provided in text, whether this is at a global, national or provincial level.

5.6.14. Limitations

Not all potentially occurring species were likely to be detected, as this would require intensive long-term survey work. Some species, which are uncommon, small, migratory, secretive or otherwise difficult to detect may not have been detected even though they were potentially present on Site. Certainly several CI species particularly those with sporadic movements (e.g. Blue Crane) or highly limited activity windows (e.g. Giant Bullfrog) which may occur (or are reported to occur on site by mine staff) would be missed given the brief nature of the surveys.
Our assessment should, however, provide a good basic understanding of local biodiversity considering that the <400ha Study Area was surveyed by five NSS personnel in two periods collectively amounting to 6 days and 4 nights.

6.3. Wetlands

Prior to any field investigations being undertaken, the area was surveyed at a desktop level using 1:50 000 topographical maps, Google Earth™ Imagery, historical imagery (1949 imagery) and available contour data to determine the layout of potential wetlands within the study site and immediate surrounds. The wetland field investigations were undertaken in March 2015, with some confirmations in October 2015.

5.6.15. Wetland Classification

Wetlands were defined using the recently-published “Classification system for Wetlands and other Aquatic Ecosystems in South Africa” by Ollis *et al*. (2013), hereafter referred to as “the Classification System.” Ecosystems included by the Classification System encompass all those that are listed under the Ramsar Convention as “wetlands,” and include all freshwater (non-marine) systems. The Classification System recognizes three broad inland systems: rivers, wetlands and open waterbodies. 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 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 (**Figure 6-6**):
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)

5.6.16. Wetland Extent

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.
- 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).
- 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 facultative wetland plants (helophytes) that needed to be identified as wetland indicators, as opposed to only hydrophytes. (Day *et al*, 2010).

In addition to the above indicators, biotic and abiotic indicators discussed by Day *et al*; (2010) were also used to identify temporary wetland systems within the arid environment.

The study site was traversed, on foot, with soil samples, within the top 50cm and deeper where necessary, of the soil profile, taken using a hand auger along transects across the property and within select areas where wetland vegetation indicators were present or soil anomalies such as surface cracking. 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).

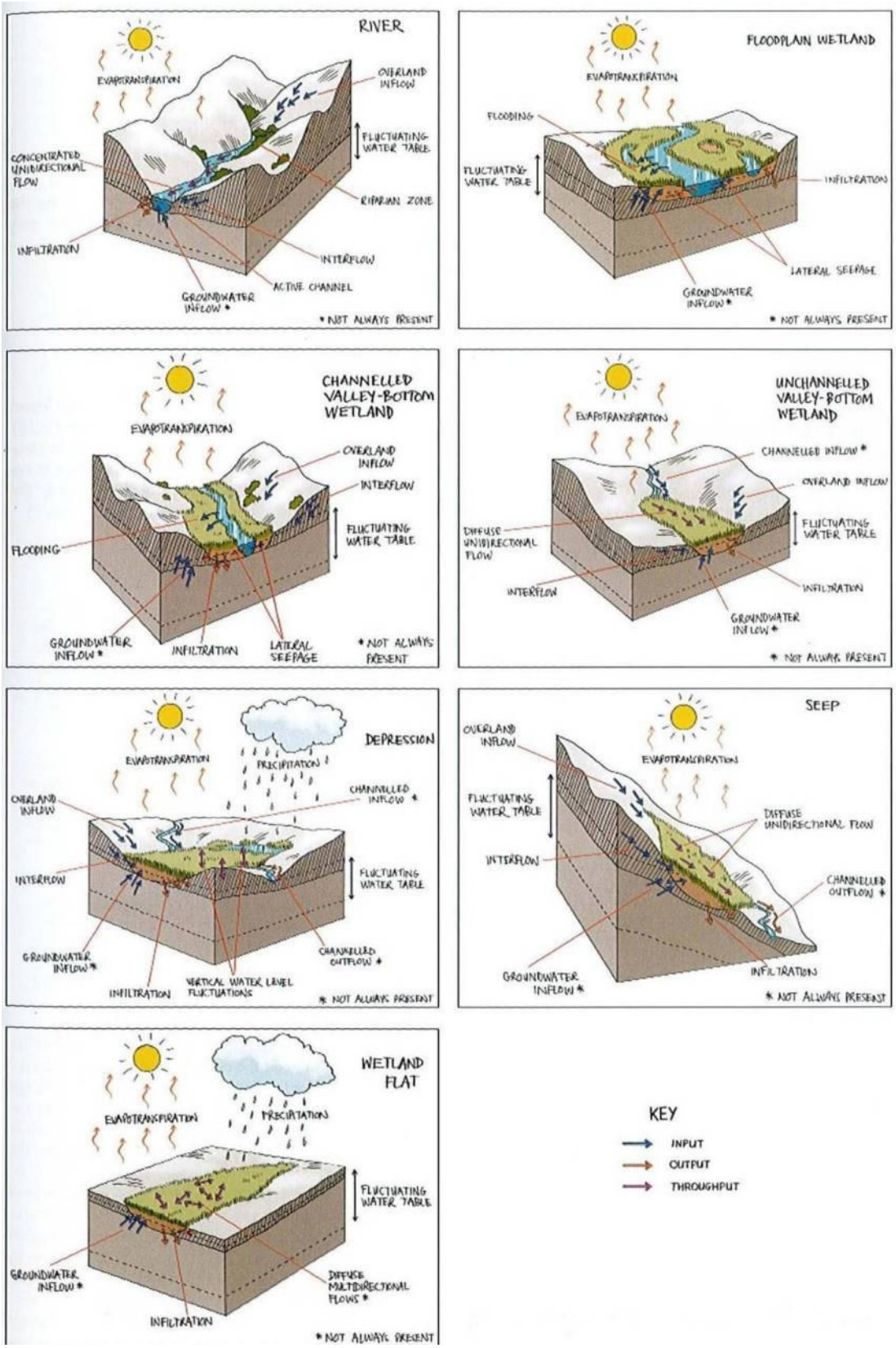


Figure 6-6 Primary HGM types, highlighting dominant water inputs, throughputs & outputs (Ollis et al. 2013)

7. Results

7.1. Flora

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 quarter degree squares (QDSs). For this study, the Site falls with 2924BD and 2925AC QDGS. Species within the POSA database for this QDS do not exceed 142 species (Date extracted May 2015) and represent 43 Families. The dominant families being, POACEAE, ASTERACEAE and CHENOPODIACEAE (**Table 7-1**), with the herbs representing 35.25%, graminoids and dwarf shrubs representing 18.31% equally and shrub species representing over 9.15% of the total species listed for the area. This is a typical representation of vegetation structure for Nama Karoo Shrubveld communities and for that found in the study area (**Table 7-1**).

Table 7-1 Top ten dominant families and most dominant growth forms obtained from the POSA website for the QDS 2924BD and 2925AC on Site

IMPORTANT FAMILIES	No. OF SPP	GROWTH FORMS	% TOTAL SPP	ON SITE
POACEAE	26	Herb	35.21	20.21
ASTERACEAE	22	Dwarf shrub	18.31	11.7
CHENOPODIACEAE	12	Graminoid	18.31	25.23
APOCYNACEAE	6	Shrub	9.15	11.7
FABACEAE	6	Succulent	6.34	4.26
MALVACEAE	6	Geophyte	4.93	7.45
CONVOLVULACEAE	4	Cyperoid, helophyte, herb	2.11	2.13
CUCURBITACEAE	4	Climber, herb, succulent	1.41	1.06
SCROPHULARIACEAE	4	Hydrophyte	1.41	-
AIZOACEAE	3	Bryophyte / Lichens	0.7	1.06

5.6.17. Vegetation Communities

For more detailed sampling, 32 sample points were investigated in various natural and semi natural habitats on Site, and in the immediate surrounding Study Area, but due to the transformed homogenous nature of the Site only 24 points were analysed using TWINSPAN. The homogenous shrubveld habitat made it difficult to use a sampling method that would yield different communities. In support of this, there were limited species detected with only 95 recorded during the survey. The site was also in recovery from the previous slimes dam as evident within the 1944 aerial imagery. Results of an ordination analysis of the phytosociological data are presented in **Figure 7-2** and **Figure 7-2**. At the time of the survey, the conditions of the veld was indicating a movement towards winter dormancy. Numerous species did not contain flower heads and even fruiting bodies were lacking. Phase 1 set the scene for the vegetation communities with two (2) main plant communities been identified (Units A, B) within the Site

boundaries based on coverage and disturbances with sub-community distinctions being made within Unit A (**Table 7-2** and **Figure 7-3)**. Unit C represents extremely transformed habitats where historical vegetation structure has been completely altered. Unit D is on the edge of this forming in areas such as excavations where some shrubveld encroaches of an otherwise transformed area.

Shrubveld – in recovery (March 2015)

Shrubveld-Grassland transitional area (forming part of a cryptic wetland zone)

Slimes Dam Habitat – Site 5

Shrubveld – (Alternative 4) showing some grass cover – October 2015

Figure 7-1 Photographs of the different vegetation communities

Table 7-2 Preliminary Vegetation communities

UNIT	HABITAT & VEGETATION COMMUNITIES	% COVERAGE
	Shrubveld	
A	Pentzia lanata - Eragrostis x pseud-obtusa Recovery Shrubveld	20.5%
B	Lycium cinereum- Eriocephalus decussatus Shrubveld	16.62%
	B1 Lycium - Sporobolus Transitional Area	0.81%
	Transformed Vegetation Areas	
C	*Phragmites* Dominated Transformed Habitat	3.22%
D	Phragmites – Tamarisk Excavations	0.78%

UNIT	HABITAT & VEGETATION COMMUNITIES	% COVERAGE
C	Transformed (Including Site 5)	
	All other transformed areas – including Waste Rock, Slimes etc	53.00%

Descriptions and photographic evidence of the two main vegetation communities are provided in **Table 7-3**, **Table 7-4**, and **Table 7-5**. Severely transformed areas such as the *Phragmites* dominated area between the WRD and the TSF or the quarries/borrow pits is described in **Table 7-6**.

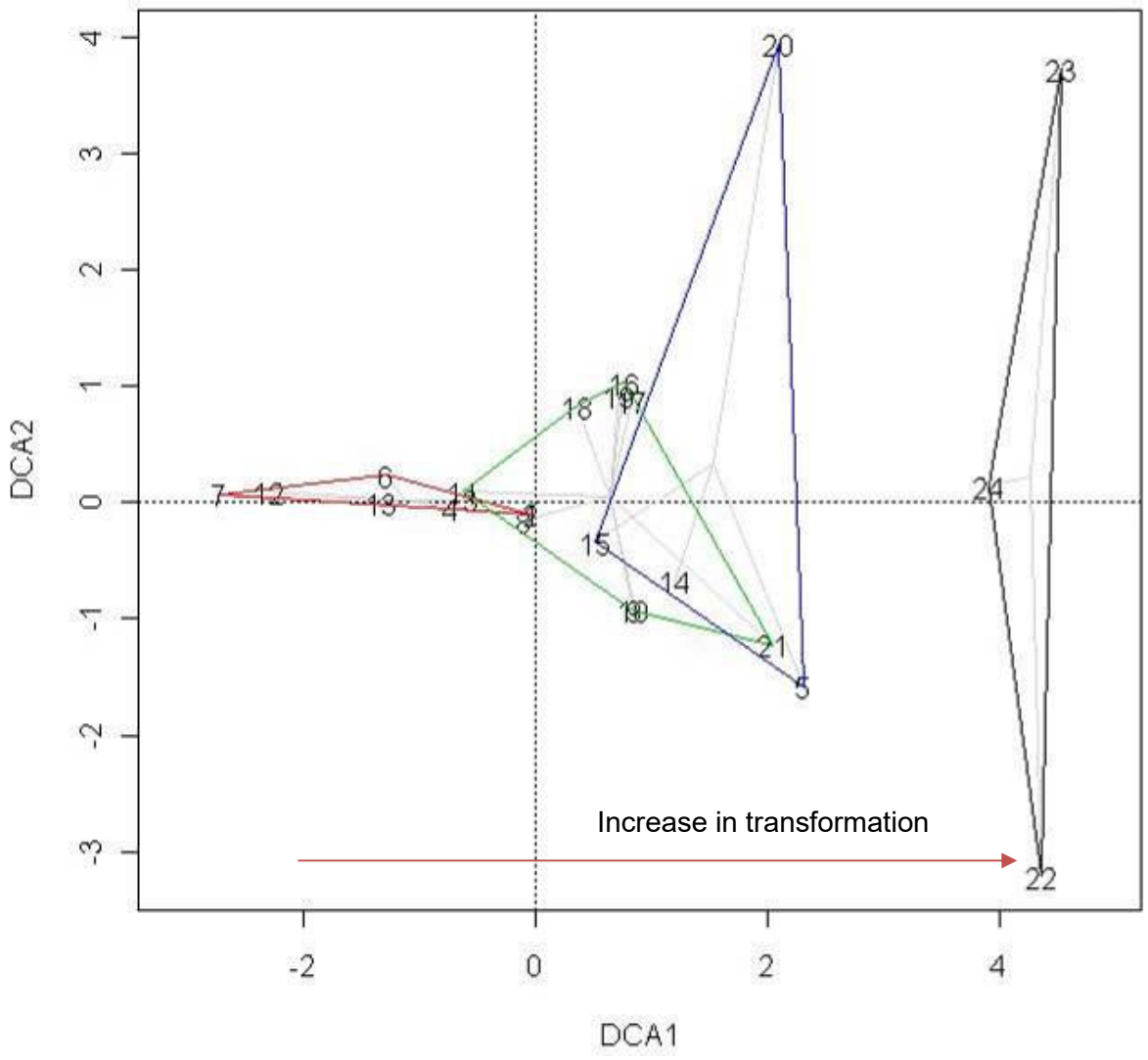


Figure 7-2 **DCA basic ordination of phytosociological data from 24 main sampling plots**

Table 7-3 Unit A Pentzia lanata - Eragrostis x pseud-obtusa Recovery Shrubveld

Pentzia lanata - Eragrostis x pseud-obtusa Recovery Shrubveld	
Photographic representation	 
National Zones:	Northern Upper Karoo; Highest Biodiversity Area (M&BG)
Veg Structure	Average Height: 25-30cm Approximate Herbaceous Cover: 15-20%
% Coverage	20.5%
Condition:	This area contains limited top soil with exposed rock evident – High calcrete evident. The lichen *Buellia cf rinodinea* was evident.  Grass cover was limited and grazed showing no flowerheads. The October 2015 visit yielded little difference. Numerous berms present throughout the area with grass cover slightly higher in the depressions created by the berms. Thsi was also evident in Alternative 4. Alien species include Salsola kali, and Atriplex lindleyi
CI Species:	*Nananthus vittatus* (N.E.Br.) Schwantes (DDT) (Site 1) *Orbea* species
Common species:	Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter Chaetacanthus cf costatus Nees Cotula anthemoides L. Eragrostis bicolor Eragrostis superba Peyr. Indigofera cf. alternans Lycium cinereum Thunb. Nidorella resedifolia DC. subsp. Resedifolia Panicum coloratum L. var. coloratum Pentzia lanata Hutch. Salsola cf aphylla

Pentzia lanata - Eragrostis x pseud-obtusa Recovery Shrubveld		
	Eragrostis x pseud-obtusa De Winter Eriocephalus decussatus Burch Felicia spp Fingerhuthia africana Lehm. Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus	Salvia stenophylla Burch. ex Benth. Selago geniculata L.f. Tribulus terrestris L. Zygophyllum incrustatum E.Mey. ex Sond.
Species Examples:		
	Nidorella resedifolia	Eragrostis x pseud-obtusa
Current Conservation Status		Medium

* Alien Species; *[1] Category 1 Alien Invasive; DDT -Data Deficient Taxonomically (DDT) TSP listing; M&BG – Mining and Biodiversity Guidelines

Table 7-4 Unit B Lycium cinereum- Eriocephalus decussatus Shrubveld

Unit BLycium cinereum- Eriocephalus decussatus Shrubveld		
Photographic representation		
National Zones:	Northern Upper Karoo; Highest Biodiversity Area (M&BG)	
Veg Structure	Average Height: 35-40cm Approximate Herbaceous Cover: 30-35%	
% Coverage	Evidence of Banded Vegetation: 0.87% Small Pan: 0.04% Edge of Rock outcrop: 0.27% Remaining Shrubveld: 16.62%	
Condition:	Reddish soils evident with reduced calcrete exposure. Increase in grass cover with the presence of species such as *Themeda triandra*	

<table>
<tr><th colspan="3">Unit BLycium cinereum- Eriocephalus decussatus Shrubveld</th></tr>
<tr><td></td><td colspan="2">and Fingerhuthia africana both climax stable perrenial species.
Some disturbances evident including small excavations and berms.
Some vegetation banding evident to the west. Banded vegetation is often associated with xeric habitats where soil moisture is too limited to support stable continuous vegetation cover. According to Tongway & Hindley (2004), these exposed soils feed runoff and therefore nutrients to the bands of vegetation, thereby increasing moisture availability.
Limited alien species</td></tr>
<tr><td>CI Species:</td><td colspan="2">Myrothamnus flabellifolius Welw. (DDT)
Haemanthus cf humilis Jacq. (P)</td></tr>
<tr><td>Common species:</td><td>Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter
Aristida diffusa Trin. subsp. diffusa
Asparagus spp
Chaetacanthus cf costatus Nees
Chenopodium album L.
Cyperus spp
Ehretia rigida (Thunb.) Druce subsp. rigida
Enneapogon scoparius Stapf
Felicia ovata (Thunb.) Compton
Fingerhuthia africana Lehm.
Heteropogon contortus (L.) Roem. & Schult.</td><td>Lycium cinereum Thunb.
Lycium spp
Mestoklema arboriforme (Burch.) N.E.Br. ex Glen
Myrothamnus flabellifolius Welw.
Salvia stenophylla Burch. ex Benth.
Searsia cf dregeana (Sond.) Moffett
Tarchonanthus camphoratus L.
Tenaxia (Merxmuellera) dura (Stapf) N.P.Barker & H.P.Linder
Themeda triandra Forssk.
Trachyandra spp
Ziziphus mucronata Willd. subsp. mucronata</td></tr>
<tr><td>Species Examples:</td><td>  </td><td>  </td></tr>
<tr><td></td><td>Wahlenbergia nodosa</td><td>Peliostomum leucorrhizum</td></tr>
<tr><td colspan="2">Current Conservation Status</td><td>Medium</td></tr>
</table>

* Alien Species; *[1] Category 1 Alien Invasive; P – Protected under Ordinance; DDT -Data Deficient Taxonomically (DDT) TSP listing; M&BG – Mining and Biodiversity Guidelines

Table 7-5 Unit B1 Lycium - Sporobolus Transitional Area

Lycium - Sporobolus Transitional Area		
Photographic representation		
National Zones:	Northern Upper Karoo	
Veg Structure	Average Height: 10-15cm Approximate Herbaceous Cover: 30-35%	
% Coverage	0.81%	
Condition:	A transitional zone between a cryptic wetland and the surrounding shrubveld with more grass species present. Limited cover is still evident with the presence of mat forming grasses - Probability of accumulation of solutes presenting a more sodic soil than surrounding areas – thereby increasing mat forming species but also limited cover in shrub species. This larger area surrounds a cryptic wetland inner zone where evidence of pooling in high rainfall occurs. This was witnessed during the October field visit (see image below).  Category 1 species evident: *Cuscuta campestris*	
CI Species:	No species detected	
Common species:	Berkheya cf onopordifolia (DC.) O.Hoffm. ex Burtt Davy Convolvulus boedeckerianus Peter Cynodon dactylon (L.) Pers. Eragrostis bicolor Eragrostis chloromelas Steud. Eragrostis spp	Lycium cinereum Thunb. Lycium spp Nidorella resedifolia DC. subsp. Resedifolia Pentzia lanata Hutch. Salvia stenophylla Burch. ex Benth. Seriphium plumosum L.

Lycium - Sporobolus Transitional Area		
	Eragrostis superba Peyr. Eragrostis x pseud-obtusa De Winter Hyparrhenia hirta (L.) Stapf	Sporobolus africanus (Poir.) Robyns & Tournay Sporobolus ioclados Zygophyllum incrustatum E.Mey. ex Sond.
Species Examples:		
	Sporobolus ioclados	Convolvulus boedeckerianus
Current Conservation Status		Medium-High

* Alien Species; *[1] Category 1 Alien Invasive; M&BG – Mining and Biodiversity Guidelines

Table 7-6 Unit C and D Transformed Areas

Unit C and D Transformed Areas		
Photographic representation		
National Zones:	Northern Upper Karoo Vegetaion Type	
Veg Structure	Average Height: 1-2m Approximate Herbaceous Cover: varying between transformed areas up to 80-90% between slimes dams	
% Coverage	4.25%	
Condition:	These areas are completely transformed and dominated in most areas by *Phragmites australis,* This is due to the seep and run off from the slimes dams creating artificial wetland habitat.	
CI Species:	No species detected	
Common species:	Aristida congesta Roem. & Schult. subsp. congesta	Nicotiana glauca Graham*[1] Panicum coloratum L. var. coloratum

Unit C and D Transformed Areas		
	Asparagus cf burchellii Baker Atriplex lindleyi Moq. subsp. inflata (F.Muell.) Paul G.Wilson Cynodon dactylon (L.) Pers. Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus Jamesbrittenia aurantiaca (Burch.) Hilliard Flaveria bidentis (L.) Kuntze	Phragmites australis (Cav.) Steud. Salvia stenophylla Burch. ex Benth. Salsola kali L. Sporobolus africanus (Poir.) Robyns & Tournay Tribulus terrestris L. Tamarix ramosissima Ledeb.
Species Examples:		
	Phragmites within trenches	Datura ferox
Current Conservation Status		Low

* Alien Species; *[1] Category 1 Alien Invasive; M&BG – Mining and Biodiversity Guidelines

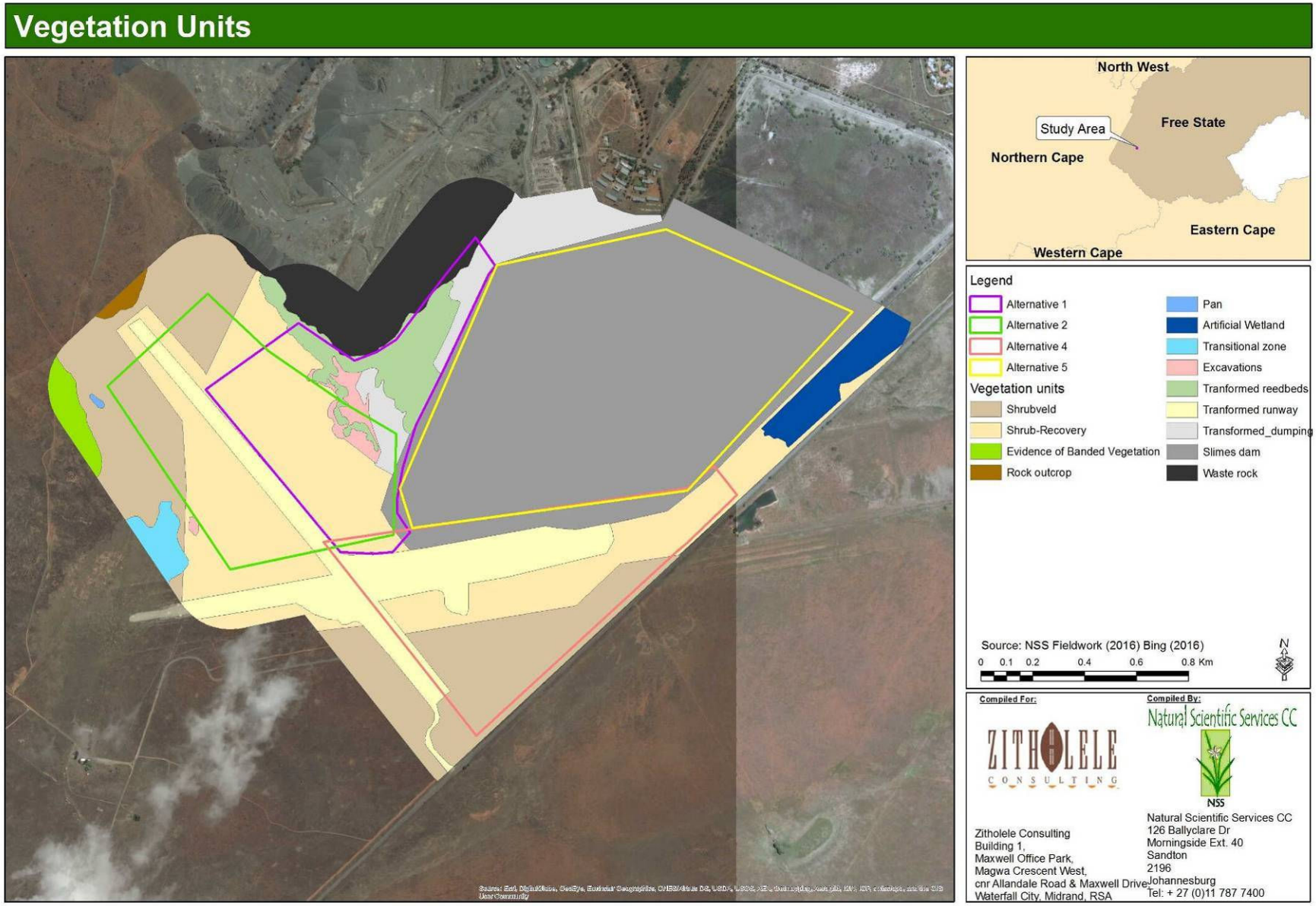


Figure 7-3 Vegetation units identified on Site

5.6.18. Conservation Important Species

It is well documented that heterogeneous landscapes, diverse geology and a range of environmental conditions, provide a diverse number of habitats for plant species (Pickett, *et.al*. 1997; O'Farrell, 2006; KNNCS, 1999). These areas are normally associated with high levels of species endemism and richness. For example, at least 74% of the 23 threatened Highveld plant taxa occur on the crests and slopes of ridges and hills (Pfab & Victor 2002). However, homogenous landscapes, either natural or that have been transformed through historical farming practices and infrastructural development contain minimal diversity and endemism. The current site has been affected historically by mining practices with the majority of the area being under slimes and therefore are considered transformed and within a recovery phase.

Within this section the Conservation Important (CI) species are discussed. These include the National Threatened Plant Species Programme (TSP) lists, the Protected species according to the Nature Conservation Ordinance (12 of 1983) and any specific Endemic or Rare species. 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 77 Red Data listed species (**Table 7-7**) within Free State Province (including Data Deficient species) of which 3 species are Endangered (EN), 7 are Vulnerable (VU) and 11 are Near Threatened (NT). In addition to this a number of species are considered Data Deficient (23 species);

Table 7-7 Numbers of CI plant species per Red Data category within South Africa and Gauteng (updated May 2015)

Threat Status	South Africa	FREE STATE	2924BD 2925AC
EX (Extinct)	28	0	0
EW (Extinct in the wild)	7	0	0
CR PE (Critically Endangered, Possibly Extinct)	57	0	0
CR (Critically Endangered)	332	0	0
EN (Endangered)	716	3	0
VU (Vulnerable)	1 217	7	0
NT (Near Threatened)	402	11	0
Critically Rare (known to occur only at a single site)	153	1	0
Rare (Limited population but not exposed to any direct or potential threat)	1 212	13	0
Declining (not threatened but processes are causing a continuing decline in the population)	47	9	0
LC (Least Concern)	13 856	2266	127
DDD (Data Deficient - Insufficient Information)	348	8	0
DDT (Data Deficient - Taxonomically Problematic)	904	15	1
Total spp (including those not evaluated)	23 399	2333	128

**Date accessed – May 2015

From the POSA website (QDS 2924BD and 2925AC) only one (1) TSP listed CI species has been recorded in the Study Region (not flowering during both field investigations). This species is considered Data Deficient –Taxonomically (DDT) and is known as *Nananthus vittatus*. It was found in an area that would have been disturbed during the operations of the historical slimes dam. *Nananthus vittatus* is found in fine loamy soils that are rich in iron (**Figure 7-4 and Figure 7-6**). In terms of its status the following are applicable:

- It is seen as a popular species among those that collect succulents;
- The identification of the genus but specifically *N vittatus* plants in habitat show different growth phases and its appearance can change dramatically through the year; and
- Dispersal of this species is very restricted and localised. It's mechanism of seed dispersal is through its higrochastic (dependant on rain) fruit and the seed is only dispersed a short distance which results in localised small communities.

In addition to this species NSS also detected another DDT species in the rocky outcrops just north of the site (not within the boundaries of the site alternatives). This is the species *Myrothamnus flabellifolius (*resurrection plant). It usually forms large stands in shallow soil on sunny rocky hills or along cracks and crevices in rocks (**Figure 7-6**).

Identified Protected species (also considered CI species) under the Nature Conservation Ordinance, 12 of 1983 included *Orbea* species and *Haemanthus cf humilis* (**Figure 7-4).**

Nananthus vittatus

Haemanthus cf humilis

Orbea – possibly O cooperi

Orbea – possibly O cooperi (Fruiting Body)

Figure 7-4 Photographs evidence of Conservation Important plant species on Site

Buffer Zones for Flora

No specific Red Data Plant Policy is available for Free State Province, however, GDARD's Policy (2001) followed a systematic and researched approach to buffer zones for rare and threatened species. This approach has been used successfully and is supported by the Threatened Plant Programme (D Raimondo *pers comm.*). Priority ranking of Red Data plant species for the province of Gauteng was performed by creating a priority profile for each species, which was indicated in terms of the scoring of all species against eight criteria. These eight criteria included:

- Endemic to southern Africa
- Distribution within southern Africa
- Red Data status in South Africa
- Critically Endangered
- Endangered
- Vulnerable
- Data Deficient
- Distribution within the Northern Provinces (Retief and Herman 1997)
- Distribution within Gauteng
- Occurrence in conservation areas
- Urbanization threat
- Utilization

The priority ranking categories that emerged were A1, A2, A3 and B rated species. Buffer zones were applied to each category as follows for species recorded outside of the Urban edge:

- A1: 600m
- A2: 500m
- A3: 400m
- B: 300m

If one was to apply a similar ranking to species within the Free State Province, then for a species such as the DDT listed *Nananthus vittatus* and *Myrothamnus flabellifolius,* a buffer of 300m should apply.

5.6.19. 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 (Category 1-3). The protection of our natural systems from invasive species is further strengthened within Sections 70-77 of NEM: BA. Chapter 5 of this Act specifically deals with Species and Organisms Posing Potential Threats to Biodiversity. To summarise, the purpose of Chapter 5 is to:

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

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

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

The regulations for this Act were promulgated in August 2014. Section 21 of the regulations lists the categories for alien and listed invasive species. These are:

- Exempted species being alien species listed in List 1 of the Notice
- Prohibited species being alien species listed in List 2 of the Notice

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

According to POSA, 15 species of Aliens have been recorded within the two QDS's for the study area. Of these 5 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). Within the boundaries of the Site, alien species did not dominate the landscape but were prevalent around the Waste Rock Dump (WRD) and the existing Slimes dams. The Category 1 species *Tamarix ramosissima, Argemone ochroleuca* and *Datura ferox* were found scattered within the borrow pit area and the side walls of the WRD and TSF within Alternative 1 and 5 (**Figure 7-5** and **Table 7-8**). *Datura* species was located in the disturbed areas were soils have been scraped or stockpiled. *Cuscuta campestris* (Category 1b) was located within the transitional zone (*Unit B1*) just on the outskirts of Alternative 2. These species will need to be controlled by the EO and team as part Petra Diamonds Alien Invasive Management Plan. A list of species recorded during the field visits is supplied in **Table 7-8**.

Table 7-8 The main observed alien invasive plant species

Family	Species	Growth forms	CARA	NEMBA
ANACARDIACEAE	Schinus molle	Tree		
ASTERACEAE	Flaveria bidentis (L.) Kuntze	Herb	Weed	
CHENOPODIACEAE	Atriplex lindleyi Moq. subsp. inflata (F.Muell.) Paul G.Wilson	Herb	3	
CHENOPODIACEAE	Salsola kali L.	Herb	Weed	1b
CONVOLVULACEAE	Cuscuta campestris Yunck.	Herb	1	1b
LAMIACEAE	Salvia stenophylla Burch. ex Benth.	Herb	Weed	
PAPAVERACEAE	Argemone ochroleuca	Herb, shrub	1	1b
SOLANACEAE	Datura ferox L.	Herb, shrub	1	1b
TAMARICACEAE	Tamarix ramosissima Ledeb.	Shrub, tree	3	1b

Tamarix ramosissima

Schinus molle (young plant)

Datura ferox

Argemone ochroleuca

Cuscuta campestris

Atriplex lindleyi

Figure 7-5 Photographs of alien invasive plant species on Site (mainly within Alternative 1 and 5)

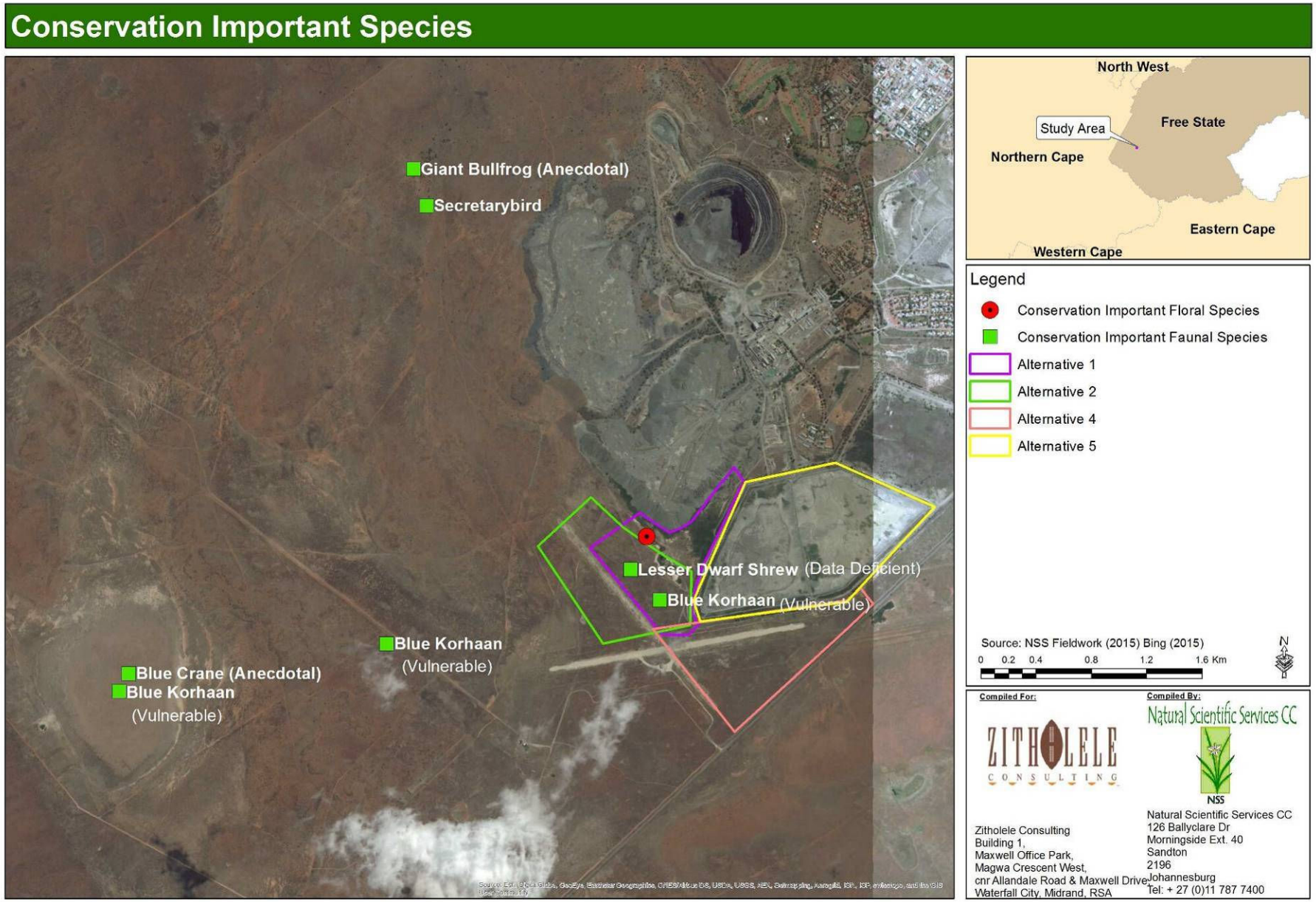


Figure 7-6 Conservation Important Species

7.2. Fauna

Provided in **Appendices 12.5-12.11** are the scientific and common names, the global, national Red Data and where relevant, the ToPS conservation status, and the observed habitat associations of indigenous mammal, bird, reptile, frog, butterfly, scorpion and odonata species that are listed for the Study Area, and more specifically the Site (i.e. the three combined project alternatives).

It was expected that the Study Area would be inhabited primarily by arid-adapted, fossorial (burrowing), rupicolous (rock-dwelling), and adaptable generalist faunal species due to the local semi-arid climate, limited availability of surface water, and prevalence of thick sand and scattered rocky outcrops. Although we observed a significant proportion of the fauna that are expected to occur in the Study Area, certain species were not detected, but which could very well be present. Several alien faunal species were detected, which have either spread to, or have been introduced by humans in the area. The observed alien species are mentioned in text, but have not been included in tables or the appended species lists. Observed and potentially occurring Conservation Important (CI) faunal species are discussed in more detail.

5.6.20. Mammals

Some 58 mammal species are expected to occur naturally in the Study Area. During the first (late summer) visit 28 (48%) species were detected. An additional six species *viz.* African Wild Cat (*Felis silvestris*), Black-backed Jackal (Canis mesomelas), Water Mongoose (Atilax paludinosus), Striped Mouse (*Rhabdomys pumilio*), Hairy-footed Gerbil (*Gerbillurus paeba*) and Common Duiker (*Sylvicapra grimmia*), bringing the total species observed to 34 or 59% of the expected diversity (**Table 7-9**). Of these five indigenous ungulate species (i.e. Impala, Red Hartebeest, Springbok, Blue Wildebeest and Eland) occur it seems, as managed populations. A skull of the alien Fallow Deer (*Dama dama*) was also found, but no live specimens were seen (**Figure 7-7**). Domestic cats and dogs were seen in proximity to houses, and donkeys were also seen in the Study Area. Furthermore, the majority of bat calls that we recorded in the Study Area appear to be those of Cape Serotine (*Neoromicia capensis*) and Rusty Pipistrelle (*Pipistrellus rusticus*). The latter is not expected to occur in the region and was not recorded on the second early summer visit (October 2015).

Mammal species that were not detected (**Appendix 12.5**), but which are considered highly likely to occur, include mainly nocturnal carnivore species such as Caracal, African Weasel and Cape Fox, and various rodents. Mammal species with a moderate LoO in the Study Area include e.g. Brown Hyaena and Chacma Baboon, which are vulnerable to conflict with humans, and the cave-dependent Natal Long-fingered and Geoffroy's Horseshoe bats.

African Wild Cat
(*Felis silvestris*)

Yellow Mongoose
(*Cynictis penicillata*)

Aardwolf
(*Proteles cristatus*)

Black-backed Jackal
(Canis mesomelas)

Suricate
(*Suricata suricatta*)

Red Hartebeest
(*Alcelaphus buselaphus*)

Springbok
(*Antidorcas marsupialis*)

Impala
(*Aepyceros melampus*)

Eland
(*Tragelaphus oryx*)

Blue Wildebeest
(*Connochaetes taurinus*)

Cape Ground Squirrel
(*Xerus inauris*)

Pygmy Mouse
(*Mus minutoides*)

Porcupine
(*Hystrix africaeaustralis*)

Rock Elephant-shrew
(*Elephantulus myurus*)

Cape Serotine
(*Neoromicia capensis*)

Aardvark
(*Orycteropus afer*)

Figure 7-7 Evidence of mammals in the Study Area

Most (54%) of the recorded mammal species were associated with open karoid scrub (**Figure 7-8**), which predominates the Site and Study Area. Across this habitat type, Aardvark and other animal burrows were abundant, and provide important shelter for numerous fauna. Scattered rocky outcrops in the Study Area provide habitat upon which the observed Rock Elephant-shrew, Rock Hyrax and Namaqua Rock Mouse, and the potentially occurring Smith's Red Rock Rabbit depend. Bat activity was typically concentrated around permanent waterholes and buildings in the Study Area.

The Data Deficient (DD) Lesser Dwarf Shrew was found twice on Site (once in a termite mound and later under bushy vegetation; **Figure 7-7**). As its status implies, little is known about this species, except that termite mounds provide shelter and probably food for these shrews (Stuart & Stuart 2000). As termite mounds are common and can be locally abundant such as on Site and in the Study Area, the Lesser Dwarf Shrew is unlikely to be highly threatened.

Eleven other CI mammal species potentially occur in the Study Area (**Table 7-10**). The Vulnerable (VU) Black-footed Cat, Near Threatened (NT) Southern African Hedgehog, Protected (PS) Cape Fox and the DD African Weasel are considered highly likely to occur due to favourable prevailing ecological conditions including grassy karoid scrub with a high abundance of animal burrows, termite mounds and rodent prey. The NT Brown Hyaena may occur, while suitable habitat for the Endangered (EN) White-tailed Rat and NT Spotted-necked Otter might occur further afield, such as along the Rietspruit.

Table 7-9 Mammal diversity

ORDER	COMMON NAMES	No. OF SPECIES POTENTIALLY PRESENT	No. OF SPECIES DETECTED	PERCENTAGE OF SPECIES DETECTED
ARTIODACTYLA	Even-toed ungulates	7	7	100%
CARNIVORA	Carnivores	18	9	50%
CHIROPTERA	Bats	6	3	50%
HYRACOIDEA	Hyraxes	1	1	100%
INSECTIVORA	Insectivores	4	1	25%
LAGOMORPHA	Hares & rabbits	2	1	50%
MACROSCELIDEA	Elephant-shrews	1	1	100%
PRIMATES	Primates	1	0	0%
RODENTIA	Rodents	17	10	59%
TUBULIDENTATA	Aardvark	1	1	100%
TOTAL		**58**	**34**	**59%**

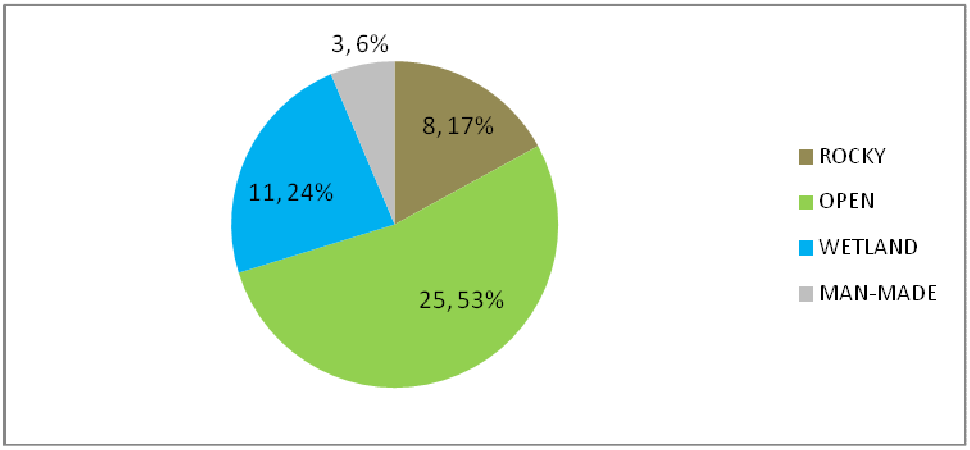


Figure 7-8 **Number and percentage of detected mammal species per habitat type**

Table 7-10 **Conservation Important mammal species**

SCIENTIFIC NAME	COMMON NAME	STATUS GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	LoO SITE	LoO AREA
Mystromys albicaudatus	White-tailed Rat	EN (D)	EN	-	4	3
Felis nigripes	Black-footed Cat	VU (D)	LC	PS	2	2
Hyaena brunnea	Brown Hyaena	NT (D)	NT	PS	3	3
Lutra maculicollis	Spotted-necked Otter	LC (D)	NT	PS	4	4
Atelerix frontalis	Southern African Hedgehog	LC (S)	NT	PS	2	2
Miniopterus natalensis	Natal Long-fingered Bat	LC (U)	NT	-	3	3
Vulpes chama	Cape Fox	LC (S)	LC	PS	2	2
Poecilogale albinucha	African Weasel	LC (U)	DD	-	2	2
Crocidura cyanea	Reddish-grey Musk Shrew	LC (S)	DD	-	3	2
Crocidura fuscomurina	Tiny Musk Shrew	LC (U)	DD	-	3	2
Suncus varilla	Lesser Dwarf Shrew	LC (U)	DD	-	1a	2
Tatera leucogaster	Bushveld Gerbil	LC (S)	DD	-	3	2

5.6.21. Birds

Of an estimated 212 potentially occurring indigenous bird species, 86 species (41%) were detected in the Study Area during both NSS surveys (**Table 7-11**), and over the past few years collectively 109 species (51%) have been recorded in QDS 2924BD during the SABAP 1 and/or in pentad 2925_2455 during the SABAP 2 (**Appendix 12.6**). To a large degree these apparently low detection rates reflect the scarce or vagrant occurrence of many bird species due to the semi-arid climate and limited availability of certain resources in the region.

Double-banded Courser (*Rhinoptilus africanus*)

Spotted Eagle-owl (*Bubo africanus*)

Greater Kestrel (*Falco rupicoloides*)

Common Ostriche (*Struthio camelus*)

Anteating Chat (*Myrmecocichla formicivora*)

Mountain Wheatear (*Oenanthe monticola*)

Northern Black Korhaan (*Afrotis afraoides*)

Spotted Eagle-owl (*Bubo africanus*) roost

Spike-heeled Lark (*Chersomanes albofasciata*)

Secretarybird (*Sagittarius serpentarius*)

Southern Pale Chanting Goshawk (*Melierax canorus*)

Yellow-billed Duck (*Anas undulata*)

Figure 7-9 Evidence of birds in the Study Area

In particular, due to the limited availability of inundated wetland habitat, few waterbird species (in categories 1, 2 and 3) are expected to reside in the Study Area. More waterbird species may be expected to occur after significant rainfall at the large pan situated ~2.5km west of the Site. If or when this pan is inundated, various lapwing, sandpiper, ibis, duck, egret, tern and other waterbird species are considered highly likely to occur in the Study Area. Similarly, due to a limited availability of large trees and high cliff faces, tree- and cliff-nesting raptor and other bird species may visit the Study Area only to forage.

More species in bird categories 8-12 would likely be recorded if more time was spent surveying the Study Area. However, NSS detected nine bird species that have not yet been recorded in the region by SABAP observers. These included Jackal Buzzard, Amur Falcon, Spotted Eagle-owl (**Figure 7-9**), Barn Owl, White-rumped Swift, White-fronted Bee-eater, Karoo Prinia, Chestnut-vented Titbabbler and Pin-tailed Whydah. In addition to the 212 potentially occurring indigenous bird species, the alien House Sparrow was observed, and the alien Rock Dove and Common Myna are considered highly likely to occur.

Approximately half (47%) of the detected bird species were associated with the predominant open karoid scrub habitat type (**Figure 7-11**). A third (33%) of the detected bird species was associated with man-made habitat including buildings, gardens and power lines. A few wetland-associated bird species were recorded at (artificially) permanent water bodies in the Study Area. Bird species that were recorded on rocky outcrops were using bushes and trees on those outcrops, and are not strictly rupiculous.

In terms of CI bird species two species namely the VU Blue Korhaan and NT Secretary bird were observed in the study area but Blue Crane is also reported to occur particularly near the large north-western pan following rain (E. van der Westhuizen-Coetzer pers. comm.). Blue Korhaan were most often encountered in small groups of up to four birds in the north-western regions of the study area particularly at the large pan ~2.5km west of the Site. The species has previously been recorded in pentad 2925_2455 during the SABAP 2 (2015). The Blue Korhaan is endemic to the grassland biome in South Africa and Lesotho, and is threatened primarily by habitat transformation (BirdLife, 2015). Blue Korhaans typically feed and nest in areas with short grass and, therefore, the Site could provide suitable habitat conditions for this species.

Fifteen other CI bird species potentially occur in the Study Area (**Table 7-12**). The Endangered (EN) White-backed Vulture has previously been recorded in the region by SABAP observers, and may visit the Study Area to forage. The species is, however, unlikely to reside in the Study Area as it requires tall trees for nesting (BirdLife 2015). The EN Ludwig's Bustard inhabits semi-arid grassland and shrubveld where it nests on bare ground, and is considered highly likely to occur in the Study Area. Ludwig's Bustards are extremely vulnerable to collision with power lines as they have limited frontal vision (BirdLife 2015).

The VU Secretarybird, Tawny Eagle, Lesser Kestrel and Black Stork have also previously been recorded in the region by SABAP observers, and are considered highly likely to visit the Study Area to forage. Secretarybird, Tawny Eagle and Black Stork are, however, unlikely to reside in the Study Area as they require tall trees for nesting (BirdLife 2015). The migratory Lesser Kestrel does not breed in South Africa, but could roost in the Study Area during winter.

Two NT bird species are considered highly likely to occur, including the Caspian Tern and Greater Flamingo (which has previously been recorded in the region by SABAP observers). Both these NT bird species are likely to visit the large, nearby pan (when water is present), but are not expected to occur on Site.

Table 7-11 Bird diversity

CATEGORY	No. OF SPECIES POTENTIALLY PRESENT	No. OF SPECIES DETECTED	PERCENTAGE OF SPECIES DETECTED
1. Ocean birds	1	0	0%
2. Inland water birds	18	4	22%
3. Ducks & wading birds	28	1	4%
4. Large terrestrial birds	14	6	43%
5. Raptors	16	4	25%
6. Owls & nightjars	3	2	67%
7. Sandgrouse, doves etc	8	4	50%
8. Aerial feeders, etc	31	11	35%
9. Cryptic & elusive insect-eaters	32	9	28%
10. Regular insect-eaters	35	10	29%
11. Oxpeckers & nectar feeders	3	1	33%
12. Seed-eaters	23	8	35%
TOTAL	**212**	**60**	**28%**

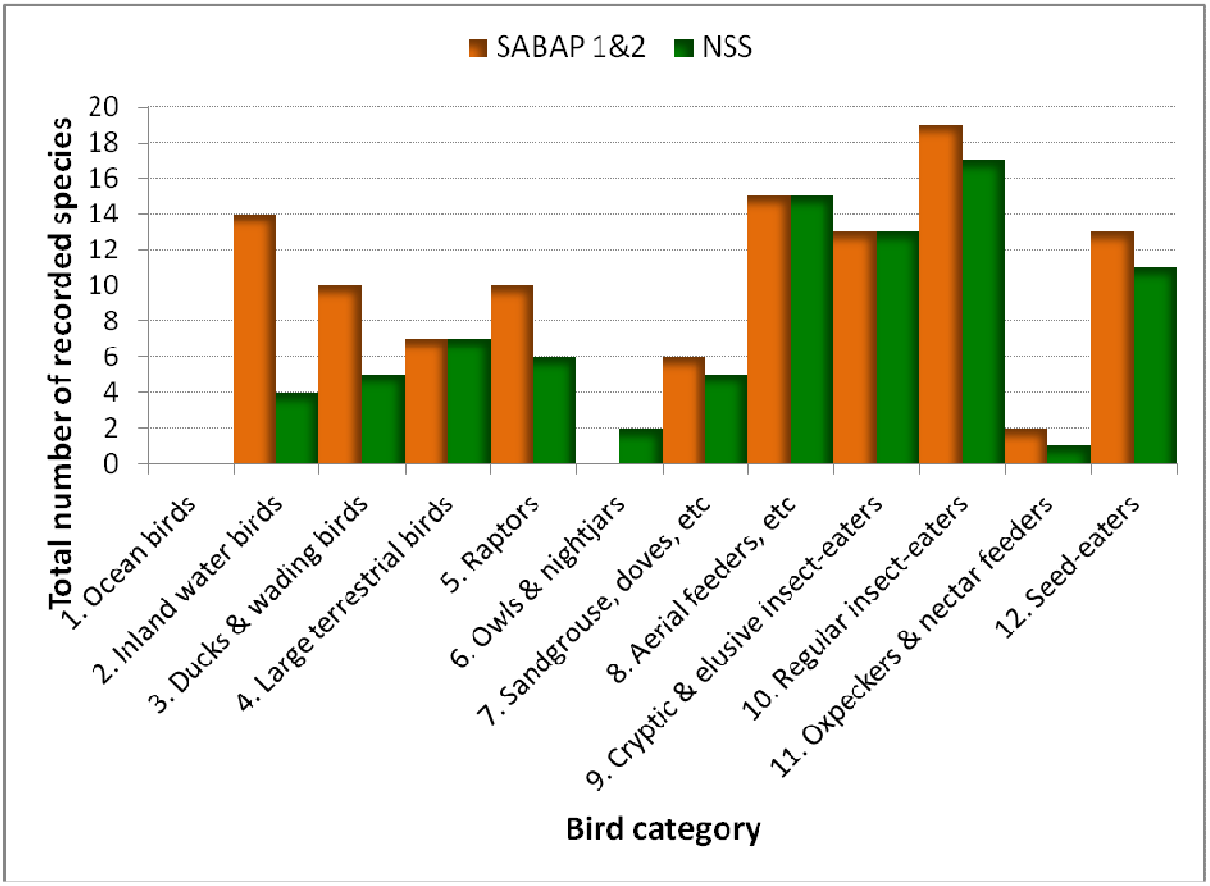


Figure 7-10 Total numbers of bird species with different feeding habits (modified from Newman 2002), which were observed in the Study Area by NSS, and in the Study Region by observers during the SABAP 1 and 2 (2015).

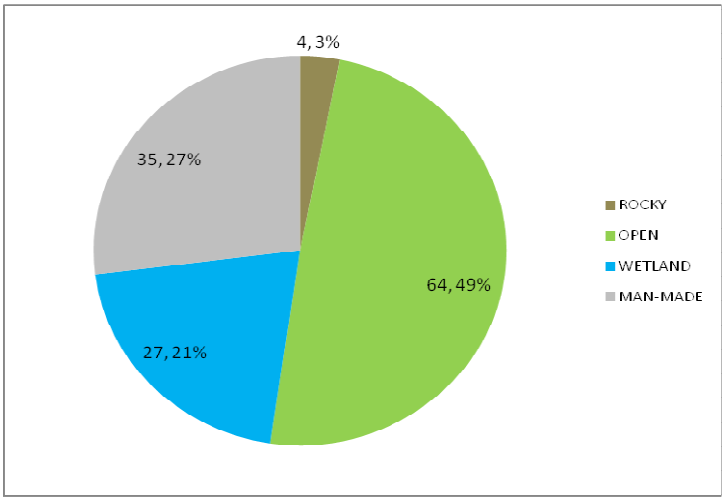


Figure 7-11 Number and percentage of detected bird species per habitat type

Table 7-12 Conservation Important bird species

SCIENTIFIC NAME	COMMON NAME	STATUS GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	LoO SABAP1&2	LoO AREA	LoO SITE
Balearica regulorum	Grey Crowned-crane	EN (D)	VU	EN		3	3
Gyps africanus	White-backed Vulture	EN (D)	VU	EN	1	2	3
Neotis ludwigii	Ludwig's Bustard	EN (D)	VU	VU		2	3
Anthropoides paradiseus	Blue Crane	VU (S)	VU	EN		3	3
Polemaetus bellicosus	Martial Eagle	VU (D)	VU	VU		3	4
Sagittarius serpentarius	Secretarybird	VU (D)	NT	-	1	1c	2
Circus maurus	Black Harrier	VU (S)	NT (N-End)	-		3	3
Ardeotis kori	Kori Bustard	NT (D)	VU	VU		3	3
Eupodotis caerulescens	Blue Korhaan	NT (S)	NT (N-End)	VU	1	1	2
Coracias garrulus	European Roller	NT (D)	LC (NB)	-		3	3
Aquila rapax	Tawny Eagle	LC (S)	VU	VU	1	2	3
Falco naumanni	Lesser Kestrel	LC (S)	VU (NB)	VU	1	2	3
Ciconia nigra	Black Stork	LC (U)	NT	VU	1	2	4
Sterna caspia	Caspian Tern	LC (I)	NT	-		2	4
Phoenicopterus roseus	Greater Flamingo	LC (I)	NT	-	1	2	4
Falco biarmicus	Lanner Falcon	LC (I)	NT	-		3	3

5.6.22. Reptiles

At least forty-seven indigenous reptile species are expected to occur in the Study Area (**Table 7-13**), of which 13 species have been recorded. These include eight species that were detected by NWU (2013) and an additional five species that were detected NSS surveys, including Bibron's Gecko, Holub's Sandveld Lizard, Cape Skink, Western Ground Agama and Fork-marked Sand Snake (**Figure 7-12**). NWU (2013) also reportedly detected Striped Skink (*Trachylepis striata*) in the Study Area. However, as the Striped Skink is limited to the subtropical eastern escarpment of South Africa (Bates *et al.* 2014), the observed specimen(s) was more likely the similar-looking Speckled Rock Skink (*T. punctatissima*).

Southern Rock Agama
(*Agama atra*)

Western Rock Skink
(*Trachylepis sulcate sulcata*) female

Western Ground Agama
(*Agama aculeata aculeata*)

Leopard Tortoise
(*Stigmochelys pardalis*)

Spotted Sand Lizard
(*Pedioplanis lineoocellata lineoocellata*)

Holub's Sandveld Lizard
(*Nucras holubi*)

Cape Skink
(*Trachylepis capensis*)

Western Rock Skink
(*Trachylepis sulcate sulcata*) female

Marsh Terrapin
(*Pelumodusa subrufa*)

Fork-marked Sand Snake
(*Psammophis trinasalis*)

Bibron's Gecko
(*Chondrodactylus bibronii*)

Southern Karusa Lizard
(*Karusasaurus polyzonus*)

Figure 7-12 Evidence of reptiles in the Study Area

Reptile species that neither NWU nor NSS has detected in the Study Area (**Appendix 12.7**), but which are considered highly likely to occur on Site, include the Serrated Tent Tortoise, Cape Gecko, Common Banded Gecko, Cape Spade-snouted Worm Lizard, Spotted Sandveld Lizard, Namaqua Sand Lizard and 12 snake species including e.g. Karoo Sand Snake (which has previously been recorded in QDS 2924BD; ReptileMAP 2015), Mole Snake and Cape Cobra. Live-trapping using drift fencing with funnel and pitfall traps would increase the probability of detecting more lizard and snake species.

In contrast to mammals and birds, a significant proportion (39%) of the recorded reptile species was detected in rocky outcrops (**Figure 7-13**), which provide important habitat for rupiculous reptile species such as the observed Bibron's Gecko, Karoo Girdled Lizard, Western Rock Skink and Southern Rock Agama. In open karoid scrub habitat, such as on Site, Leopard Tortoise, sand and lacertid lizards, and the Western Ground Agama were common. Certain reptile species, such as the observed Marsh Terrapin and Nile Monitor (NWU 2013), are more or less dependent on wetland habitat. Buildings and other man-made infrastructure (e.g. fence poles) could provide suitable habitat for some potentially occurring gecko and snake species. In addition, the numerous animal burrows and termite mounds in the Study Area provide important shelter for various reptiles including tortoises and various snake species.

No detected or potentially occurring reptile species has a known threatened or protected status. Several potentially occurring reptile species are, however, endemic to South Africa (**Appendix 12.7**). These include the Greater Dwarf Tortoise, Common Banded Gecko, Thin-tailed Legless Skink and the Aurora Snake, which is declining with increasing loss and transformation of grasslands.

Table 7-13 Reptile diversity

FAMILY	COMMON NAME	No. OF SPECIES POTENTIALLY PRESENT	No. OF SPECIES DETECTED	PERCENTAGE OF SPECIES DETECTED
PELOMEDUSIDAE	Freshwater side-necked terrapins	1	1	100%
TESTUDINIDAE	Tortoises	3	1	33%
GEKKONIDAE	Geckos	4	1	25%
AMPHISBAENIDAE	Worm lizards	2	0	0%
LACERTIDAE	Typical lizards	4	2	50%
CORDYLIDAE	Girdled lizards & relatives	1	1	100%
SCINCIDAE	Skinks	8	2	25%
VARANIDAE	Monitors	2	1	50%
AGAMIDAE	Agamas	2	2	100%
TYPHLOPIDAE	Blind snakes	1	0	0%
LEPTOTYPHLOPIDAE	Thread snakes	1	0	0%
VIPERIDAE	Adders	1	0	0%
LAMPROPHIDAE	Advanced snakes	10	2	20%
ELAPIDAE	Cobras & relatives	2	0	0%
COLUBRIDAE	Typical snakes	4	0	0%
TOTAL		47	13	28%

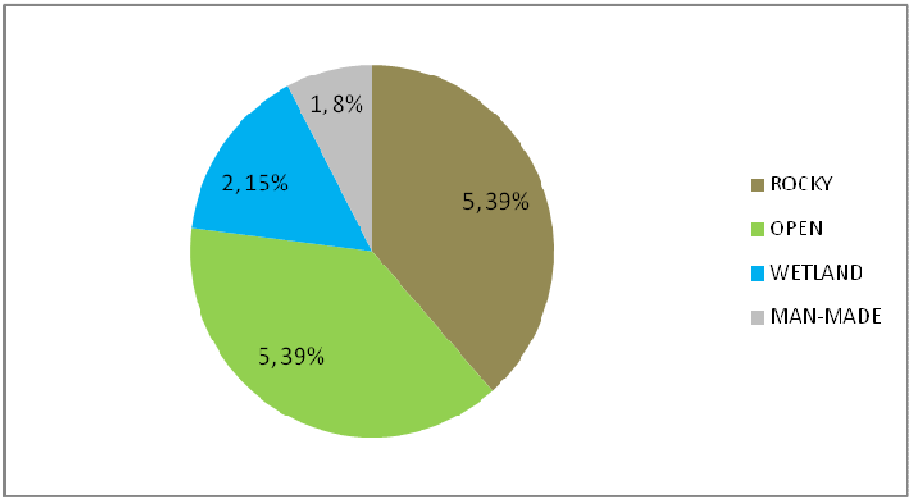


Figure 7-13 Number and percentage of detected reptile species per habitat type

5.6.23. Frogs

Fourteen indigenous frog species potentially occur in the Study Area (**Table 7-14**), seven (54%) of which were detected in mid-summer by NWU (2013) and nine (64%) by NSS over two surveys in early and late summer. Two additional frog species were added to the inventory established by NWU (2013) *viz*. Bushveld Rain Frog and Southern Pygmy Toad.

Southern Pygmy Toads (*Poyntonophrynus vertebralis*)

Bushveld Rain Frog (*Breviceps adspersus adspersus*)

Tremolo/Tandy's Sand Frog (*Tomopterna cryptotis/tandyi*)

Common Platanna (*Xenopus laevis*) tadpole

Figure 7-14 Evidence of frogs in the Study Area

Frog species that neither NWU nor NSS has detected in the Study Area (**Appendix 12.8**), but which are considered highly likely to occur, include the Guttural Toad, Giant Bullfrog and Tandy's Sand Frog. Survey work after heavy rain in early summer (November) would more likely reveal the presence of these species. Although we found numerous sand frogs during our survey (**Figure 7-14**), it is difficult to distinguish between the Tremolo and Tandy's sand frogs based on morphology alone and as such call analysis was used for confirmation (Du Preez & Carruthers 2009). The distribution ranges of the Karoo Toad and Western Olive Toad are marginal to the Study Area.

Except for the terrestrial-breeding Bushveld Rain Frog all specimens observed by NSS or NWU were found at or near wetland habitat. This includes a depression, which was dry during our March 2015 survey, where Southern Pygmy Toads emerged after we spilt some water in the depression (**Figure 7-14**).

The only potentially occurring CI frog species is the NT Giant Bullfrog (**Table 7-15**). Despite that the nearest official records for this species are from ca. 80km north, east, south-east and south-west of the Site, predictive distribution modelling indicates that local climatic conditions are highly suitable for this species (Yetman 2012) and indeed mine staff report having seen Giant Bullfrog at the northern most dam during a high rainfall event (E. van der Westhuizen-Coetzer *pers comm*.). Giant Bullfrogs are extremely difficult to detect due to their brief, sporadic and mainly nocturnal activity aboveground following heavy summer rainfall, which is often difficult to predict (Yetman 2012). In this regard NWU might be able to provide a sniffer dog, which has been trained to detect buried Giant Bullfrogs, to determine the extent of occurrence of this species on site.

Table 7-14 Frog diversity

FAMILY	COMMON NAMES	No. OF SPECIES POTENTIALLY PRESENT	No. OF SPECIES DETECTED	PERCENTAGE OF SPECIES DETECTED
BREVICIPITIDAE	Rain frogs	1	1	100%
BUFONIDAE	True toads	5	2	40%
HYPEROLIIDAE	Leaf-folding & reed frogs	1	1	100%
PIPIDAE	Platannas (African clawed frogs)	1	1	100%
PYXICEPHALIDAE	River, stream, moss & sand frogs	6	4	67%
TOTAL		**14**	**9**	**64%**

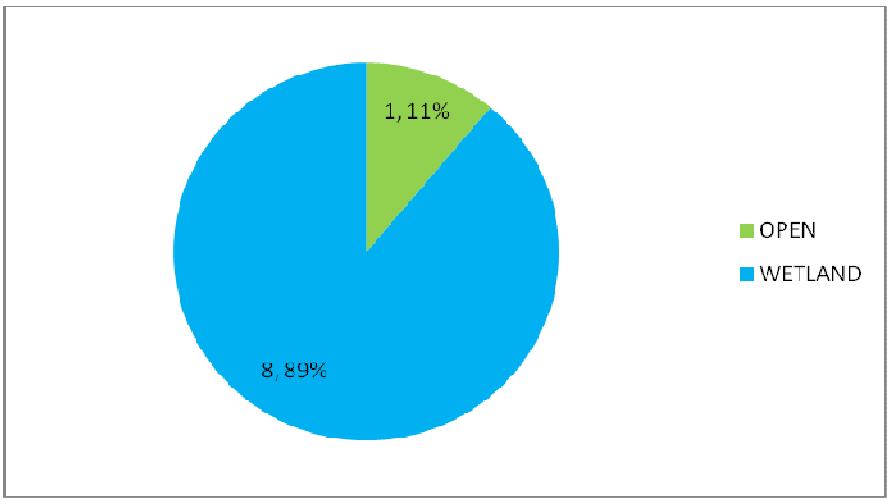


Figure 7-15 Number and percentage of detected frog species per habitat type

Table 7-15 Conservation Important frog species

SCIENTIFIC NAME	COMMON NAME	STATUS GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	LoO SITE	LoO AREA
Pyxicephalus adspersus	Giant Bullfrog	LC (D)	NT	PS	3	2

5.6.24. Butterflies

An estimated 43 indigenous butterfly species potentially occur in the Study Area (**Table 7-16**), seven of which have been recorded in QDS 2924BD (LepiMAP 2015). During NSS surveys seven species were observed in the study area (**Figure 7-16**). Certainly more butterfly species occur in the Study Area, and would likely be recorded if baited trapping and active searching were performed for longer periods during different times of the year. None of the observed species have a known threatened or protected status (**Appendix 0**), and most are widespread or locally common. Except for the Citrus Swallowtail, which was seen near suburban gardens, all the other observed butterfly species were associated with the predominant open karoid scrub habitat (**Figure 7-16**).

Brown-veined White (*Belenois aurota*)

African Ringlet (*Ypthima asterope hereroica*)

Twin-spot Blue (*Lepidochrysops plebeian plebeia*)

Free State Blue (*Lepidochrysops letsea*)

Tinktinkie Blue (*Brephidium metophis*)

Molomo Copper (*Aloeides molomo molomo*)

Twin-spot Blue (*Lepidochrysops plebeian plebeia*)

Free State Blue (*Lepidochrysops letsea*)

Figure 7-16 Evidence of butterflies in the Study Area

Table 7-16 Butterfly diversity

FAMILY	COMMON NAME	No. OF SPECIES POTENTIALLY PRESENT	No. OF SPECIES DETECTED	PERCENTAGE OF SPECIES DETECTED
HESPERIDAE	Skippers & relatives	3	0	0%
PAPILIONIDAE	Swallowtails & relatives	1	1	100%
PIERIDAE	Whites, Yellows & relatives	8	1	13%
NYMPHALIDAE	Acraeas, Browns, Charaxes & relatives	8	1	13%
LYCAENIDAE	Blues, Coppers, Opals & relatives	23	4	13%
TOTAL		**43**	**7**	**14%**

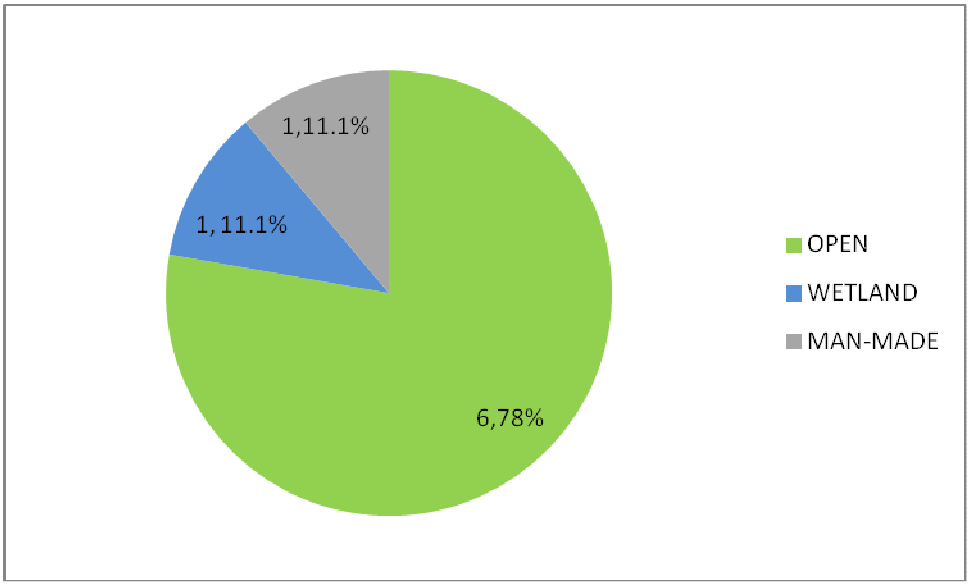


Figure 7-17 Number and percentage of detected butterfly species per habitat type

5.6.25. Scorpions

Potentially six scorpion species occur (**Table 7-17**), including two *Parabuthus,* two *Uroplectes* and two *Opistophthalmus* species (**Appendix 0**). Five of the six species are considered highly likely to occur, while the distribution range of the remaining species, *P. mossambicensis* is marginal to the Study Area. *P. granulatus* digs burrows in consolidated sandy soils at the base of shrubs, and is an active-foraging species. It is also regarded as South Africa's most venomous scorpion (Leeming, 2003). Active searching which involved rock-turning by day and shining a UV torch on tree trunks and on the ground at night yielded one scorpion species *Opistophthalmus carinatus*. This species typically inhabits burrows under large stones and boulders. *Opistophthalmus* scorpions are listed as national Protected Species under the NEM:BA (**Table 7-18**). Other species which are highly likely to occur include *U. carinatus* and *U. triangulifer* which occupy scrapes under rocks and surface debris in open, grassy areas whereas *O. pictus* constructs burrows in the open in very hard substrate (such as in the Study Site), and can be locally abundant (Leeming 2003).

Table 7-17 Scorpion diversity

FAMILY	COMMON NAMES	No. OF SPECIES POTENTIALLY PRESENT	No. OF SPECIES DETECTED	PERCENTAGE OF SPECIES DETECTED
BOTHURIDAE	Namibian scorpions	0	0	n.a.
BUTHIDAE	Thick-tailed scorpions & relatives	4	0	0%
ISCHNURIDAE	Rock scorpions & relatives	0	0	n.a.
SCORPIONIDAE	Burrowing scorpions & relatives	2	1	50%
TOTAL		**6**	**1**	**17%**

Table 7-18 Conservation Important scorpion species

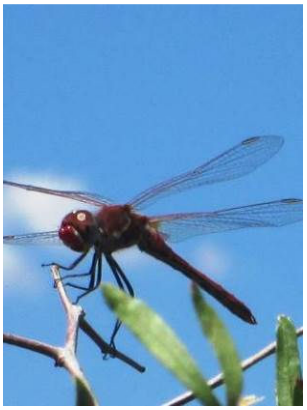
SCIENTIFIC NAME	COMMON NAME	STATUS	LoO	
		S.A. NEM:BA	SITE	AREA
Opistophthalmus carinatus		PS	1c	2
Opistophthalmus pictus		PS	2	2

5.6.26. Odonata

An estimated 12 indigenous odonata species potentially occur in the Study Area, of which four species were observed during NSS surveys in the study area (**Table 7-19**). Swamp Bluet and Blue Emperor were observed at only one location each namely the small, artificial waterhole near the reserve accommodation area and the waterhole in the far north respectively. Marsh Bluetail and Broad Scarlet were found at both these locations (**Figure 7-18**). According to Samways (2008), the former two species have a Biotic Index score of 1 while the latter have a score of 0. The Index is “based on three criteria: geographical distribution, conservation status and sensitivity to change in habitat. It ranges from a minimum of 0 to a maximum of 9. A very common, widespread species which is highly tolerant of human disturbance scores 0. In contrast, a range-restricted, threatened and sensitive endemic species scores 9.”

Of the potentially occurring odonata species that were not detected (**Appendix 12.11**), three are considered highly likely to occur on Site, and include the Nomad and the Red-veined Dropwing (both with a biotic index score of 0) and the Black-tailed Skimmer (with a biotic score of 1). The Nomad typically inhabits reedy and grassy margins of dams and pools (such as those on Site), but can also be found in grassland far from water. The Red-veined Dropwing and Black-tailed Skimmer inhabit pools, dams, marshes and the sluggish reaches of rivers. No potentially occurring odonata species has a known threatened or protected status.

Broad Scarlet (*Crocothemis erythraea)* female



Broad Scarlet (*Crocothemis erythraea)* male

Marsh Bluetail (*Ischnura senegalensis*) male

Swamp Bluet (Africallagma glaucum)

Figure 7-18 Evidence of odonata in the Study Area

Table 7-19 Odonata diversity

FAMILY	COMMON NAME	No. OF SPECIES POTENTIALLY PRESENT	No. OF SPECIES DETECTED	PERCENTAGE OF SPECIES DETECTED
LESTIDAE	Spreadwings	1	0	0%
PROTONEURIDAE	Threadtails	1	0	0%
COENAGRIONIDAE	Citrils, Sprites & relatives	3	2	67%
AESHNIDAE	Hawkers, Emperors & relatives	1	1	100%
GOMPHIDAE	Tails	1	0	0%
LIBELLULIDAE	Skimmers, Dropwings & relatives	5	1	0.20%
TOTAL		**12**	**4**	**33%**

7.3. Wetlands

The wetland assessment was undertaken within the Site itself and within the immediate surrounds. No natural wetlands were found within the Site. Within the Site itself (the footprint of the 3 alternatives assessed – in field during the Scoping Phase) only a number of artificial wetlands, created by seepage and runoff from the existing slimes dams as well as excavations, were identified (**Figure 7-19**). Within the immediate surrounds NSS identified one small ephemeral endorheic depression (pan) and what is referred to by Day *et al* (2010) as a "cryptic" wetland. In the broader area (over 1km from the study area) a number of larger pans, of National Importance, were identified, with the buffers of these systems extending over the study site (**Section 5.6**). The findings of the wetland assessment are summarised in **Table 7-20**, **Table 7-21** and **Table 7-22**, with a description of the wetland types found given below.

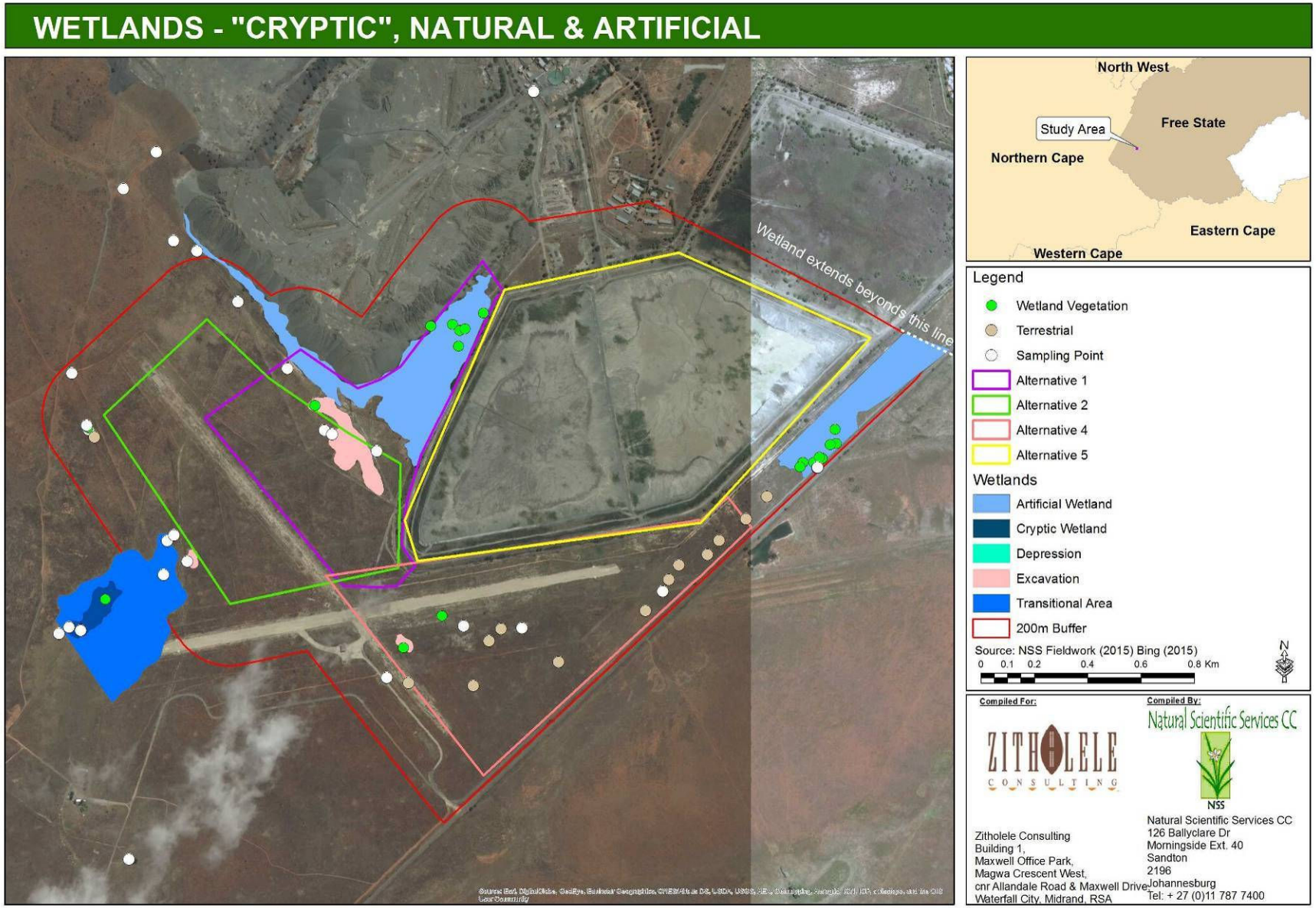
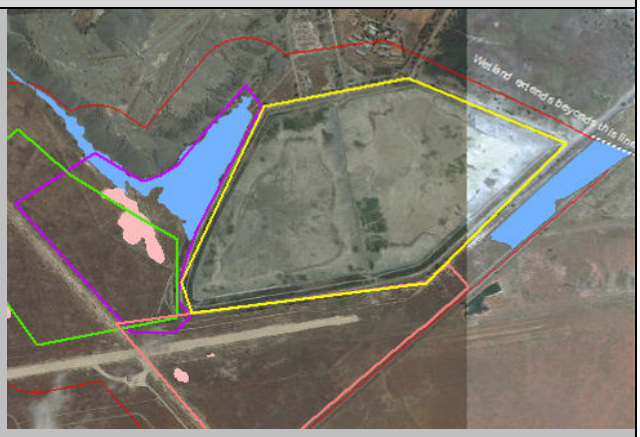


Figure 7-19 Artificial, Natural and "Cryptic" Wetlands identified within the study site and immediate surrounds

Artificial Wetlands

Artificial wetlands are classified by Ollis *et al* (2013) as wetlands produced by human beings, not naturally occurring. The artificial wetlands identified on site have formed as a result of seepage and run off from the adjacent slimes dams. The wetlands are colonised by *Phragmites australis*. The substratum of these wetlands is covered by slimes (minimum 20cm in depth). Based on the aerial imagery from 1949 these areas have been disturbed for a number of years, with the old slimes dams covering the now called artificial wetlands in the 1940's.

Table 7-20 Artificial Wetlands

ARTIFICIAL WETLANDS - KOFFIEFONTEIN			
Artificial Wetland Area (including excavations)		22.5 ha	
			
2049 Aerial Imagery		2013 Aerial Imagery	
			
Artificial wetland downslope of the slimes dam		Dirty Water Collection trench	
WETLAND CLASSIFICATION (Ollis *et al*, 2013)		CONSERVATION STATUS	
Level 1: System	Inland	FEPA	The southern artificial wetlands are located within the buffer of the FEPA pans systems
Level 2: Ecoregion	26.02		
Level 2: NFEPA – WetVeg	Dry Highveld Grassland Group 2		
Level 3: Landscape Unit	Plain	Mining and Biodiversity Guidelines (2012)	N/A
Level 6: Descriptor	Artificial		

ARTIFICIAL WETLANDS - KOFFIEFONTEIN			
SETTING			
Quaternary catchment	C51K	Land Type & Geology	AE279. Shale of the Ecca Group, Karoo Sequence with occasional dolerite intrusions
Hydrology	Artificial – fed by runoff from adjacent slimes dam	Substratum & Soil Form	Slimes overlaying red soils (potentially the Hutton Soil Form)
WETLAND INDICATORS			
 Phragmites australis dominated		 No soil wetness indicators present. Slimes layer overlaying red soils	
IMPACTS			
Current Impacts Artificial wetlands created by runoff and seep from the adjacent simes dam Substratum consists of slimes a minimum of 20 cm thick (in both the central wetland area and the dirty water collection trenches) Water contamination (Sodium chloride and sulphates) associated with water source and slimes dams as the substratum Mono-specific with *Phragmites australis* dominating Evidence of historic excavations, assumed to collect slimes after a spill event			

ARTIFICIAL WETLANDS - KOFFIEFONTEIN	
	
Slimes lining the dirty water collection trench	Slimes removed from trench and dumped adjacent
	
Evidence of erosion off the Slimes dam	Areas excavated downstream of Slimes dam

Endorheic Depressions

Pans (depressions) within South Africa are characteristic of the drier parts of the country and are concentrated in the Northern Cape, Western Free State and North West Province (Allan *et al*, 1995). The conditions within the study site are all conclusive with the formation of pans, the area is arid (i.e. receives less that 550mm of rainfall, with evapotranspiration higher than rainfall), the area is underlain by shales, the slope is less than 1 degree. The depression identified within the study area was small in extent, 0.1 ha, and is ephemeral in nature. Depressions are defined by Ollis *et al* (2013) as “a wetland or aquatic ecosystem with closed (or near closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water accumulates.” Due to the large number of depressions within the Dry Highveld Grassland Group 2 vegetation type, they are classified as Least Threatened. In terms of delineating the systems, it is the catchment of the depression that should be demarcated as sensitive. The available contour data was used to demarcate the pan, however due to the flat terrain the scale of the contours was not fine enough for an accurate delineation.

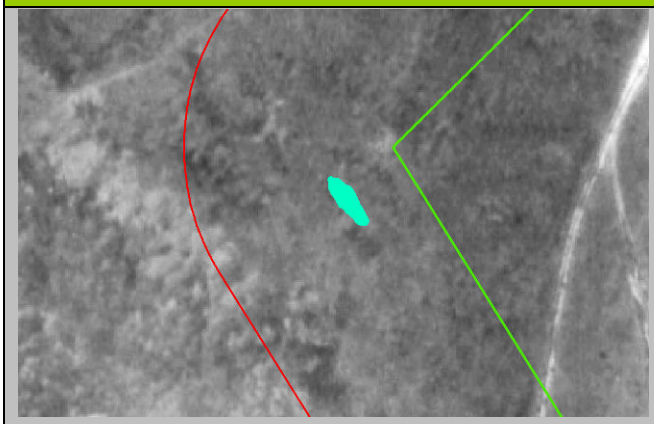
Present Ecological State

Historically there has been little research done in South Africa on pans, especially when compared to palustrine[1] 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. The main impacts have therefore been listed in **Table 7-21**.

Ecosystem Services

Despite their recognised importance, the scientific understanding of the functioning of wetlands in arid environments and their associated ecosystem services is incomplete (Tooth, 2015). The presence of pans within the moisture stressed environment of the study area means that these wetlands are key providers ('hotspots') of ecosystem services, including water and food supply (Tooth, 2015). The Millennium Ecosystem Assessment (2005) and the UNEP's Global Deserts Outlook (Ezcurra, 2006) both highlighted that in moisture stressed environments such as the study area wetland ecosystem services are unbalanced and may provide the only supply of fundamental water and food resources. The concern with pans is that they perform few of the functions normally associated with wetlands and could therefore be seen as less important systems (Ferreira, 2012), which is not the case. In addition to the provision of water, these depressions provide a unique habitat in terms of biodiversity maintenance, precipitation of minerals and the distribution of accumulated salts and nutrients during the dry months.

Table 7-21 Ephemeral Endorheic Depression

EPHEMERAL ENDORHEIC DEPRESSION	
Wetland Area	0.1 ha
	
1949 Aerial Imagery	2013 Aerial Imagery

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

EPHEMERAL ENDORHEIC DEPRESSION			
			
LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)		CONSERVATION STATUS	
Level 1: System	Inland	Mining and Biodiversity Guidelines (2012)	Highest Biodiversity and Importance over 1km to the east
Level 2: Ecoregion	26.02		
Level 2: NFEPA – WetVeg (WVG) and Threat Status	Dry Highveld Grassland Group 2, Critically Endangered		
Level 3: Landscape Unit	Plain	FEPA	Wetland FEPA cluster over 1km to the east
Level 4: Wetland HGM Type (WT) and Ecological Threat Status	Depression, Endorheic, Without Channelled Outflow; Least Threatened	Protection Level WT	Not Protected
SETTING			
Quaternary catchment	C51K	Land Type & Geology	AE279. Shale of the Ecca Group, Karoo Sequence with occasional dolerite intrusions
Hydrology	Surface water dependant	Soil Form	Potentially Mispah
ECOSYSTEM SERVICES			
Biodiversity Maintenance, for example habitat for the Southern Pygmy Toads Provision of water, mainly after rainfall events, in an otherwise arid environment Temporary wetlands allow for the precipitation of minerals, including phosphate minerals due to the concentrating effects of evaporation. In temporary wetlands some of the accumulated salts and nutrients can be transported out of the system by wind and deposited in surrounding landscape			
WETLAND INDICATORS			

EPHEMERAL ENDORHEIC DEPRESSION			
		 Surface calcrete	 Soils underlain by shale
IMPACTS			
Impacts were limited but included: Adjacent road Evidence of trampling by wildlife (very limited)			
			

Cryptic Wetland

In addition to the ephemeral endorheic depression and artificial wetlands identified, there was also a "cryptic" wetland flat identified immediately to the south west of Alternative 2. This area was distinctively different to the adjacent areas, with a central area consisting of calcrete present on the surface, cracking surfaces, and the presence of halophytic species that are typically found in salt and/or pan type environments. These wetlands are defined by Day *et al* (2010) as "cryptic" wetlands. This "cryptic" wetland occurs due to the presence suitable substrate that contains water for a period of a few days. This occurs due to rain falling unevenly over time so that for a short period in time the rainfall will exceed evaporation, whilst for the rest of the time evaporation exceeds rainfall and the wetlands dry up.

"Cryptic" wetlands cannot be reliably identified as wetlands during the dry season on the basis of standard wetland identification and delineation tools. The report undertaken by Day *et al* (2010) highlights a number of other indicators that can be used to assess wetland presence in these dry arid conditions: biotic indicators (invertebrates and plants) and abiotic indicators

(topographic indicators and indicators of inundation and saturation). In these "cryptic" wetlands however no one indicator provides adequate information and rather a suite of indicators is required to build up even a conceptual understanding of wetland ecosystem structure and function.

Biotic Indicators

The scope and timing of this assessment did not allow for the assessment of invertebrates, or algae as biotic indicators. The only additional biotic indicator that can be used is that of macrophytes. Plants in infrequently and ephemerally inundated temporary wetlands consist essentially of terrestrial, often ruderal species although during periods of inundation may include annual macrophytes and algae (Day *et al*, 2010). These vegetation indicators are not typical of those discussed in the standard wetland identification and delineation tools (DWAF, 2005) or in a wide range of publications available that provide list of wetland indicator species (Day *et al*, 2010). "Cryptic" wetlands form a special case as the conditions that usually give rise to the establishment of wetland indicator species are either absent from the wetland altogether, or present for such limited periods of time that there is only a small window of opportunity for the establishment of true wetland plants (Day *et al*, 2010). Within the "cryptic" wetland identified within the broader study area at Koffiefontein the only vegetation indicator identified was *Sporobolus iocladus* (**Table 7-22**). This plant species is defined as a Halophyte[2] – a salt tolerant plant species (Bennett *et al*, 2013), which falls under the group of Helophytes[3]. The use of Halophytes as wetland indicators must be used with caution as they can dominate areas that are highly saline but lack wetland hydrology (Day *et al*, 2010). Since evapo-concentration is usually a characteristic of these "cryptic" wetlands, salt-loving halophytes are also often associated with these habitats. The presence of halophytes alone provides a low confidence in the presence of a "cryptic" wetland. *Sporobolus iocladus* is however listed by Day *et al* (2010) as an indicator of temporary wetlands in the Free State, which has a Low to Medium confidence in the identification of "cryptic" wetland. Day *et al* (2010), highlights how the presence of these individuals should be viewed as a likely indication of wetland conditions.

Abiotic Indicators

Topography: In terms of the landscape setting the "cryptic" wetland identified within the study area is located on a plain – an extensive area of low relief (Ollis *et al*, 2013). This topographic setting would indicate that the wetland would be inundated during the wet season conditions as opposed to saturated (Day *et al*, 2010). This indicator can only provide a useful dry season indication of wetland type and cannot confirm the presence or absence of a cryptic wetland unless water is actually present, in this case it was not. In terms of the HGM Unit, the "cryptic" wetland would be a flat – "a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or bench. Closed elevation contours are not

[2] Haloophyte: Species that can complete their life cycle in soil with an electrical conductivity equivalent to ~80mM NaCl at saturation (Bennett *et al* 2013).

[3] Helophyte: Terrestrial plants of which the photosynthetically active parts tolerate long periods of submergence or floating on water – facultative wetland plants (Day *et al*, 2010)

evident around the edge of a wetland flat", (Ollis *et al*, 2013). Wetland flats within the Dry Highveld Grassland Group 2 are classified as Critically Endangered (Nel & Driver, 2012). Day *et al* (2010) explains the CR endangered status of these temporary systems may due to the difficulty in identifying (and thus managing and conserving) such systems, coupled with the ease in which they can be filled in or otherwise destroyed as a result of various anthropogenic activities.

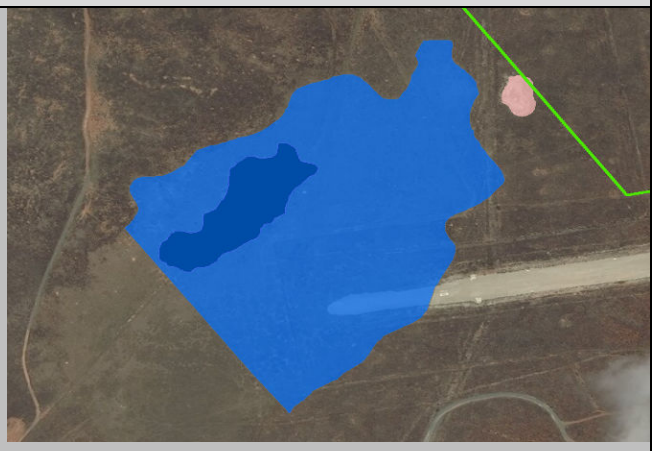
Indicators of Inundation and Saturation

Soil Wetness. In terms of the wetland indicators, defined by DWAF (2005), no soil wetness indicators were present in these areas. Of all abiotic indicators, soil wetness is usually the least useful for identifying cryptic wetlands as the soils of temporary wetlands in very arid areas are often too shallow, too saline or too temporarily inundated to exhibit typical wetland features in terms of soils (Day *et al*, 2010).

In terms of abiotic factors the "presence of thin, curled polygons of inorganic fines, which collect on the surface of the substratum" is considered one abiotic indicator. Evidence of this on site can be seen in **Table 7-22**.

The identification and detailed delineation of cryptic wetlands is unlikely to be achievable with any useful degree of confidence based on a dry season assessment only. Based on the presence of a couple of indicators the area identified on site within the "transition zone" may be classified as a "cryptic" wetland. The broader area of this transitional zone was characterised by more vegetation than the "cryptic" wetland and an abundance of termite mounds. When assessing the aerial imagery it appears as if this transitional zones inks to the pans to the south.

Table 7-22 "Cryptic" Wetland

TEMPORARY WETLAND FLAT "CRYPTIC WETLAND"	
Cryptic wetland area & greater transitional zone	1.4 ha & 11.4 ha
	
1949 Aerial Imagery	2013 Aerial Imagery

<table>
<tr><th colspan="4">TEMPORARY WETLAND FLAT “CRYPTIC WETLAND”</th></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><th colspan="2">LEVEL 1 TO 4 CLASSIFICATION (Ollis et al, 2013)</th><th colspan="2">CONSERVATION STATUS</th></tr>
<tr><td>Level 1: System</td><td>Inland</td><td rowspan="2">Mining and Biodiversity Guidelines (2012)</td><td rowspan="2">Highest Biodiversity and Importance over 1km to the east</td></tr>
<tr><td>Level 2: Ecoregion</td><td>26.02</td></tr>
<tr><td>Level 2: NFEPA – WetVeg (WVG) and Threat Status</td><td>Dry Highveld Grassland Group 2, Critically Endangered</td><td></td><td></td></tr>
<tr><td>Level 3: Landscape Unit</td><td>Plain</td><td>FEPA</td><td>Wetland FEPA cluster over 1km to the east</td></tr>
<tr><td>Level 4: Wetland HGM Type (WT) and Ecological Threat Status</td><td>Wetland Flat; Critically Endangered</td><td>Protection Level WT</td><td>Not Protected</td></tr>
<tr><th colspan="4">SETTING</th></tr>
<tr><td>Quaternary catchment</td><td>C51K</td><td>Land Type & Geology</td><td>AE279. Shale of the Ecca Group, Karoo Sequence with occasional dolerite intrusions</td></tr>
<tr><td>Hydrology</td><td>Surface water dependant</td><td>Soil Form</td><td>Potentially Oakleaf</td></tr>
<tr><th colspan="4">ECOSYSTEM SERVICES</th></tr>
<tr><td colspan="4">Biodiversity Maintenance: Provision of a unique habitat
Provision of water, mainly after rainfall events, in an otherwise arid environment
Temporary wetlands allow for the precipitation of minerals, including phosphate minerals due to the concentrating effects of evaporation.
In temporary wetlands some of the accumulated salts and nutrients can be transported out of the system by wind and deposited in surrounding landscape</td></tr>
<tr><th colspan="4">“CRYPTIC” WETLAND INDICATORS</th></tr>
</table>

TEMPORARY WETLAND FLAT "CRYPTIC WETLAND"			
			
Sporobolus iocladus – Halophyte	Thin, curled polygons of inorganic fines	Surface calcrete – evaporation exceeds rainfall – brining salts to the surface	Topography - Plain
IMPACTS			
Impacts include: Roads transecting the area Adjacent borrow pits - excavations Airfield to the immediate east of the area			

8. Significance Mapping

Areas of local significance or Areas of Concern are those areas within the study area that have been highlighted because of their:

- Ecological Sensitivity (including renewability/success for rehabilitation);
- Level/Extent of Disturbance.
- Presence of CI species, (identified at the vegetation unit/habitat level); and
- Conservation Value (at a regional, national, provincial and local scale);

The identified vegetation/habitat units within the study site were qualitatively assigned Low to High biodiversity conservation importance or significance. This was based on results of the March and October 2015 sampling (floral, faunal and wetland components), NSS's collective professional experience with ecological systems and processes, and relevant national biodiversity conservation planning initiatives (**Figure 8-1**). Ratings were as follows:

High rated areas include:

- The ephemeral endorheic depression.
- Rock outcrops to the north of Alternatives 1 and 2.

Moderate-High rated areas include:

- The identified transitional zone "cryptic wetland". This area provides a unique habitat for faunal species in relation to the surrounding vegetation units.
- A minimum buffer of 50m on the ephemeral endorheic depression.
- A minimum buffer of 50m on rocky outcrops.

- A buffer of 300m around the DDT CI plant species (refer to **Section 5.6.18**).

Moderate rated areas include:

- Evidence of banded vegetation. Banded vegetation aids in resilience and stability where it has the potential to increase soil porosity and facilitate retention of moisture and nutrients in the system.
- The 1km buffer on the wetland FEPAs, as recommended under the NFEPA, and incorporated in the atlas of the Mining and Biodiversity Guideline. This is rated in the Moderate category due to disturbances and as this section of the buffer is fragmented from the Wetland Cluster by a road network.
- Recovered shrubveld.
- Shrubveld.

Low sensitive areas include the following transformed areas:

- Reed beds.
- Runway.
- Excavations.
- Dumps.

Low-None sensitive areas include the following highly transformed areas:

- Slimes dams.
- Waste rock.

The significance map should guide the proposed development where:

- Disturbances should preferentially occur in **Low-None** sensitive areas.
- **High** sensitive areas should be subject to limited disturbance and rigorous mitigation.
- **Moderate-High** sensitive areas may be disturbed with rigorous mitigation.
- **Moderate** sensitive areas may be disturbed with some appropriate mitigation.
- **Low** sensitive areas may be disturbed with minimal mitigation, or rehabilitated if not developed.

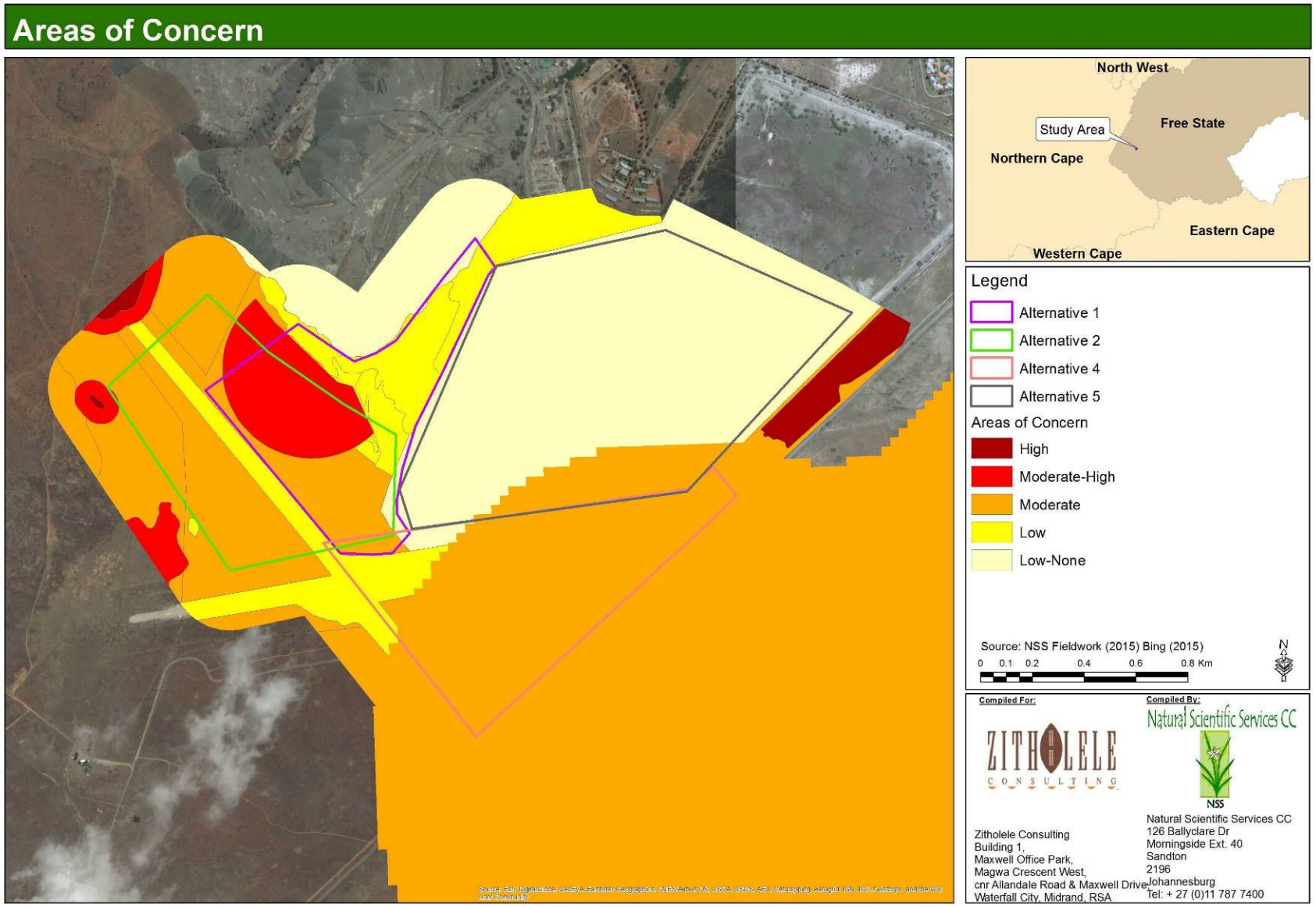


Figure 8-1 Significance (Areas of Concern) Map

9. Impacts & Mitigation

Our assessment of potential impacts of the proposed project on flora, fauna and wetlands was completed according to the methodology prescribed by Zitholele, and in the context of:
Relevant international, national and provincial legislation and policies.
Results from the desktop and field based investigations of flora, fauna and wetlands, including observations of CI species.
The national and provincial significance of local biodiversity, as highlighted e.g. by the NFEPA, the Mining and Biodiversity Guideline, BirdLife, etc.
Significance Rating for the vegetation / habitats, CI species and associated buffer zones.

NOTE: The methodologies for this impact assessment require that impacts are grouped according to activities. Therefore the most conservative risk rating for each activity has been provided.


Light pollution


Erosion off the slimes dam


Erosion


Sediment deposition


slimes runoff


Excavations


Artificial slimes induced wetland


Alien species –such as *Schinus molle*


Berm

Figure 9-1 Evidence of impacts in the Study Area

9.1. Activity: Clearing of Vegetation (Table 9-1)

5.6.27. Associated Impacts

Clearing of vegetation can result in the destruction of Conservation Important (CI) and other species, habitats and ecosystem services. Although it is evident that vegetation was cleared for the historical slimes dams, the affected areas have to a large extent recovered to form new habitats. The existing overall impact risk of the historical clearing of vegetation was, therefore, rated as **Moderate**. Without mitigation, the overall additive and cumulative impact risk of clearing vegetation for the new slimes dam was rated as **Moderate** for Alternative 2 and 4, **High** for Alternative 1 and **Low** for Alternative 5:

Alternative 1:

- Three quarters were covered by historical slimes dams;
- Current habitat significance rating of Moderate and Low;
- Destruction of the *Nananthus vittatus* small population and its recommended buffer;
- Loss of artificial wetlands emanating from seepage and run-off from the existing slimes dam;
- Habitat loss (foraging and breeding area) for Threatened species such as the identified Blue Korhaan

Alternative 2:

- Half covered by historical slimes dams;
- Destruction of habitat that supports *Nananthus vittatus* (within it's buffer);
- Current habitat significance rating of largely Moderate.
- Loss of artificial wetlands emanating from seepage and run-off from the existing slimes dam.
- Adjacent to the transitional zone "cryptic wetland".
- Bordering the buffer of the identified ephemeral endorheic depression
- Habitat loss (foraging area) for Threatened species such as the identified Blue Korhaan

Alternative 4:

- Approximately a third covered by historical slimes dams;
- Disturbance within the 1km buffer around the southern wetland FEPAs;
- Destruction of habitat with Moderate, Low, and Low-None significance.
- Relocation of the airfield and thus further disturbance to vegetation communities outside of the existing study area.
- Habitat loss (foraging area) for Threatened species such as the identified Blue Korhaan.
- Alternative 5:
- No natural vegetation within this site
- An existing slimes dam;
- Current habitat significance rating of Low-None;

5.6.28. Mitigation

With effective mitigation, the overall cumulative impact risk of clearing vegetation for each of the three alternative dam locations could be reduced to **Low** and remain **Low** for Site 5.

For Alternatives 1 and 2 this would require, among other things:

- Successful relocation of the *Nananthus vittatus* population.

For Alternative 4:

- Stockpile what remains of topsoil in the southern section (not covered historically by slimes) to retain viability of the seed bank.
- To most effectively mitigate the impacts of clearing vegetation for Alternative 4, Alternatives 1 or 2 should instead be selected.
- Investigate the NFEPA status assigned to the pans to the south as this will affect the integrity of the buffer.

For Alternative 5:

- No natural vegetation remains, no mitigation required for vegetation clearing..

General Mitigation:

- Petra Diamonds EO to be on site regularly and to monitor progress and implementation of mitigation measures.
- Vegetation should preferably be cleared during winter, when many fauna are less active or have migrated.
- It is recommended that a walk down of the site be conducted by herpetologist, to intensively search for and oversee the relocation of reptiles and amphibians within the proposed footprint area. NSS has seen that this mitigation has been successful in other projects.
- Demarcate and restrict anthropogenic disturbances to the construction area;
- Where possible in the removal process, species such as geophytes should be collected and stored for future rehabilitative efforts around the mine in a nursery. Grass seeds can also be collected and stored and used during operation in a number or rehabilitation exercises, such as dam wall coverage.
- Construction crews should be informed about the importance of biodiversity through an induction process. Awareness of potentially harmful animals such as snakes should also be raised. The appointed EO on site should be trained to handle snakes.

9.2. Activity: Earth Works (associated with construction) (Table 9-2)

5.6.29. Associated Impacts

Current impacts associated with the earth works of the historical and current slimes dams and the airfield include:

- Areas excavated downstream of the existing slimes dam (potentially to clear slimes from a historical spill) have resulted in an artificial wetland with erosion, mono-specific *Phragmites australis* reed beds and alien flora.

- Excavation of borrow pits within Alternative 1 and 2 and associated growth of alien species such as *Tamarix* spp. Small excavations also occur within Alternative 4.
- Compaction of the airfield has led to sparse vegetation cover
- Berms created from rock fragmenting the landscape, although also supplying additional habitat for fauna
- Dirty water trenches and berms adjacent to the existing slimes dam (Site 5) with mono-specific vegetation

The current impact risk from earth works was rated as **Moderate** for Alternatives 1, 2 and 4, and **High** for Alternative 5.

Future impacts from excavating, levelling, compacting and dumping material can cause:

- Destruction and displacement of fossorial fauna, specifically herpetofauna
- Excessive dust
- Erosion and sedimentation
- Proliferation of alien flora
- Creation of artificial wetlands in areas of excavation

All of the above will result in edge effects such as vegetation structural changes, changes in faunal population dynamics. The overall additive impact risk of earthworks for Alternative 1 was rated as **Moderate** because, the eastern half of this alternative is located between or adjacent to the current slimes dam, where many of the afore-mentioned impacts are already evident. The overall additive impact risk due to earth works for Alternative 2 was rated as **High** considering that this alternative does not adjoin the current slimes dams, and is in relatively close proximity to rocky outcrops. The overall additive impact risk due to earth works for Alternative 4 was also rated as **High**, primarily due to the relatively natural state of the area in the south in terms of berms, trenches etc. and the potential impacts on the nearby wetland FEPAs (such as increased sedimentation and proliferation of unwanted flora). The overall additive impact risk due to earth works for Alternative 5 was rated as **Low.**

5.6.30. Mitigation

With effective mitigation, the overall cumulative impact risk due to earth works for each of the alternative dam locations could be reduced to **Low** (remain **Low** for Site 5).

- Petra Diamonds EO to be on site regularly and to monitor progress and implementation of mitigation measures.
- Petra Diamonds is required by law to remove Category 1 species, therefore an alien and invasive plan needs to be compiled and implemented
- Daily wetting of exposed surfaces during earth works to control dust (refer to Air Quality IA for further mitigation measures)
- Erosion Management Plan to be compiled and implemented (refer to Soils IA for further mitigation measures). Measures that could be assessed include:

- Placing biodegradable sand bags around stockpiles, construction footprint etc. As the topography is flat these are recommended as opposed to berms
- Rehabilitation of areas disturbed outside of the slimes dam footprint, for example borrow pits.
- Rehabilitation of existing impacts, for example removal of berms, infill and re-vegetation of borrow pits (Only locally indigenous and *weed-free* flora should be used for re-vegetation of disturbed areas).

- During earthworks a faunal specialist should be on hand for any species that will require translocation during the construction phase.
- Construction crews should be informed about the importance of biodiversity through an induction process. Awareness of potentially harmful animals such as snakes should also be raised. The appointed EO on site should be trained to handle snakes.
- The new dam should be designed according to the Waste Classification and Management Regulations and Supporting Norms and Standards 2013.

9.3. Activity: Increased Traffic, Machinery & Human Activity (Table 9-3)

5.6.31. Associated Impacts

Current impacts in the study area include:

- Minimal traffic, due to limited access to the site. However, the airfield services flights frequently.
- Current traffic activities on the mine properties associated with fence patrols, dumping on the WRD.
- Light pollution emanating from the current activities.
- Noise pollution from machinery.

For all alternatives the existing overall impact risk from traffic and human activity was rated as **Moderate**.

Increased traffic, machinery and human activity, especially during construction of the new slimes dam, will likely cause increased noise, light, chemical and other forms of pollution, faunal disturbance and roadkill (displacement of species such as the Blue Korhaan), dust and erosion, proliferation of alien flora and thus, degradation of habitats and ecosystem services. Impacts from increased traffic, machinery and human activity will be of greatest magnitude during the short-term construction phase and, therefore, the overall additive impact risk for alternatives 1,2 and 4 was rated as **Moderate** (**Low** for Alternative 5). The overall cumulative impact risk from traffic and human activity on biodiversity was rated as **Moderate** for Alternatives 1, 2 and 5, and **High** for Alternative 4 due to the proximity of Alternative 4 to the R48, and Koffiefontein town, as well as the nearby cluster of wetland FEPAs.

5.6.32. Mitigation

With effective mitigation, the overall cumulative impact risk from increased traffic and human activity for each of the alternative dam locations could be reduced from High or Moderate, to Low. To most effectively mitigate impacts from traffic and human activity for Alternative 4, Alternatives 1 or 2 should instead be selected. To mitigate impacts from traffic and human activity the following should be applied:

- Noise should be minimized as far as practicably possible:
- Service and maintain vehicles regularly;
- Traffic and construction activities should be limited to daylight hours.
- Demarcate and restrict anthropogenic disturbances to the construction area.
- Measures such as speed humps, signage and fines should be implemented to reduce speeding and off-road driving.
- Off-road driving is prohibited in all surrounding natural areas.
- Lights should be minimized, hooded and orientated downwards.
- Effective and environmentally-friendly measures should be implemented to minimize dust, erosion and sedimentation. Vehicles and machinery should be checked regularly for leaks.

9.4. Activity: Operation of the New Slimes Dam (Table 9-4)

5.6.33. Associated Impacts

The current impacts relating to biodiversity and wetlands from the existing slimes dam includes:

- Dust pollution;
- Presence of alien invasives including Category 1 species;
- Artificial wetland areas and the growth of monospecific stands of *Phragmites;*
- Slimes deposited within these artificial wetlands are at least 20cm deep (**Figure 9-1**).
- Spillage and clearing of slimes just west of the current slimes dam.
- Surface and Groundwater reporting in the vicinity indicate high levels of sodium chloride and sulphates (AGES, 2013). The potential impacts from this on the adjacent pan systems has not been reported;

Many of these impacts are evident in the Study Area where historical practices (e.g. slimes dam containing no lining, toe drains etc.) were adopted and no corrective management measures implemented. However, the vegetation in these areas is in a state of recovery. These impacts are most extensive where Alternatives 1 and 4 are located and, therefore, for these alternatives, the existing impact risk was rated as **Moderate** – compared to **Low** for Alternative 2, and **High** for Alternative 5 (slimes dam in operation).

- Poor operation and maintenance of the new slimes dam could lead to:
- Further erosion and sedimentation,
- Further surface and groundwater contamination and potential impacts on the NFEPAs south of the site,
- Creation of new artificial wetland habitats,

- Edge effects altering vegetation structure such as the proliferation of alien or other unwanted flora.

The overall additive impact risk of poor operation of the proposed slimes dam at Alternative 5 was rated as **Low** and for Alternative 1 was rated as **Moderate** considering that the eastern half of this alternative is located between or adjacent to the current slimes dams, where many of the afore-mentioned impacts are already evident. The overall additive impact risk from poor operation of the proposed slimes dam at Alternative 2 was rated as **High** considering that this alternative does not adjoin the current slimes dams. The overall additive impact risk from poor "operation" of the proposed slimes dam at Alternative 4 was also rated as **High** due to the proximity of this alternative to the nearby cluster of wetland FEPAs.

5.6.34. Mitigation

With effective mitigation, the overall residual impact risk for the operation of a new slimes dam for each of the alternative dam locations could be reduced to **Moderate** (**Low** for Site 5**)**. To most effectively mitigate impacts the following applies:

- Petra Diamonds EO to be on site regularly and to monitor implementation of mitigation measures.
- The new dam should be designed according to the Waste Classification and Management Regulations and Supporting Norms and Standards 2013.
- Regular water surface and ground water monitoring is required (refer to the Water Management Plan for the Mine) – Investigate remediation options for current and potential future surface and groundwater contamination e.g. Phytoremediation.
- Erosion Management Plan to be compiled and implemented (refer to Soils IA for further mitigation measures).
- Petra Diamonds is required by law to remove Category 1 species, therefore an alien and invasive plan needs to be compiled and implemented
- Management and operational staff should be informed about the importance of biodiversity through an induction process. Awareness of potentially harmful animals such as snakes should also be raised. The appointed EO on site should be trained to handle snakes.
- Pamphlets should be designed and included into induction processes. These should include as a minimum:
    - Snake Awareness;
    - Alien Invasives;
    - Conservation Important Species;
    - The role of the NFEPA systems and surrounding habitat;
    - General environmental management processes such as recycling; littering, species harvesting etc.
- Investigate the NFEPA status assigned to the pans to the south as this will affect the integrity of the buffer. This must include an investigation into the potential groundwater link between the new slimes dam and the NFEPAs south of the Site.

- Research opportunities to be investigated include:
  - Vegetation cover trials on the walls for the existing and future slimes dams.
  - MSc studies on species located within the area including the population dynamics of Red Listed species such as the Blue Korhaan, DD Shrew species and the DDT *Nananthus* plant.
  - It is evident that the vegetation communities re-established with a degree of success after the removal of the historical slime dam. A long-term monitoring programme should be implemented to determine changes in structure and banding within these communities.

Table 9-1 Impact ratings and mitigation for clearing vegetation

	CONSTRUCTION								
ALTERNATIVE 1	**Activity**	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**
	Clearing of vegetation	Direct	Existing	LOW	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**
		Destruction of CI & other species specimens, habitats & ecosystem services		2	*2*	4	*5*		**2.67**
			Additive	LOW	*Regional / Provincial*	Long term	*It's going to happen / has occurred*	**Definite**	**High**
				2	*4*	4	*5*		**3.33**
			Cumulative	LOW	*Regional / Provincial*	Long term	*It's going to happen / has occurred*	**Definite**	**High**
				2	*4*	4	*5*		**3.33**
			Residual	LOW	*Regional / Provincial*	Short-term	*It's going to happen / has occurred*	**Definite**	**Moderate**
				2	*4*	2	*5*		**2.67**
ALTERNATIVE 2	CONSTRUCTION								
	Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**
	Clearing of vegetation	Direct	Existing	LOW	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**
		Destruction of CI & other species specimens, habitats & ecosystem services		2	*2*	4	*5*		**2.67**
			Additive	LOW	*Local*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**
				2	*3*	4	*5*		**3.00**
			Cumulative	LOW	*Local*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**
				2	*3*	4	*5*		**3.00**
			Residual	LOW	*Isolated Sites / Proposed Site*	Short-term	*It's going to happen / has occurred*	**Definite**	**Low**
				2	*1*	2	*5*		**1.67**
ALTERNATIVE 3	CONSTRUCTION								
	Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**
	Clearing of vegetation	Direct	Existing	LOW	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**
		Destruction of CI & other species specimens, habitats & ecosystem services		2	*2*	4	*5*		**2.67**
			Additive	MODERATE	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**
				3	*1*	4	*5*		**2.67**
			Cumulative	MODERATE	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**
				3	*1*	4	*5*		**2.67**
			Residual	LOW	*Isolated Sites / Proposed Site*	Short-term	*It's going to happen / has occurred*	**Definite**	**Low**
				2	*1*	2	*5*		**1.67**
ALTERNATIVE 4	CONSTRUCTION								
	Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**
	Clearing of vegetation	Direct	Existing	VERY HIGH	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	**Definite**	**High**
		Destruction of CI & other species specimens, habitats & ecosystem services		5	*1*	4	*5*		**3.33**
			Additive	VERY LOW	*Isolated Sites / Proposed Site*	Long term	*Practically Impossible*	**Definite**	**Very Low**
				1	*1*	4	*1*		**0.40**
			Cumulative	VERY LOW	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	**Definite**	**Low**
				1	*1*	4	*5*		**2.00**
			Residual	LOW	*Isolated Sites / Proposed Site*	Short-term	*It's going to happen / has occurred*	**Definite**	**Low**
				2	*1*	2	*5*		**1.67**
ALTERNATIVE 5	CONSTRUCTION								
	Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**
	Clearing of vegetation	Direct	Existing	VERY HIGH	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	**Definite**	**High**
		Destruction of CI & other species specimens, habitats & ecosystem services		5	*1*	4	*5*		**3.33**
			Additive	VERY LOW	*Isolated Sites / Proposed Site*	Long term	*Practically Impossible*	**Definite**	**Very Low**
				1	*1*	4	*1*		**0.40**
			Cumulative	VERY LOW	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	**Definite**	**Low**
				1	*1*	4	*5*		**2.00**
			Residual	LOW	*Isolated Sites / Proposed Site*	Short-term	*It's going to happen / has occurred*	**Definite**	**Low**
				2	*1*	2	*5*		**1.67**

Mitigation
For Alternatives 1 and 2 this would require, among other things: Successful relocation of the *Nananthus vittatus* population. For Alternative 4: Stockpile what remains of topsoil in the southern section (not covered historically by slimes) to retain viability of the seed bank. To most effectively mitigate the impacts of clearing vegetation for Alternative 4, Alternatives 5 or 1 should instead be selected. Investigate the NFEPA status assigned to the pans to the south as this will affect the integrity of the buffer. For all alternatives: Petra Diamonds EO to be on site regularly and to monitor progress and implementation of mitigation measures. Vegetation should preferably be cleared during winter, when many fauna are less active or have migrated. It is recommended that a walk down of the site be conducted by herpetologist, to intensively search for and oversee the relocation of reptiles and amphibians within the proposed footprint area. NSS has seen that this mitigation has been successful in other projects. Demarcate and restrict anthropogenic disturbances to the construction area; Where possible in the removal process, species such as geophytes should be collected and stored for future rehabilitative efforts around the mine in a nursery. Grass seeds can also be collected and stored and used during operation in a number or rehabilitation exercises, such as dam wall coverage. Construction crews should be informed about the importance of biodiversity through an induction process. Awareness of potentially harmful animals such as snakes should also be raised. The appointed EO on site should be trained to handle snakes.

Table 9-2 Impact ratings and mitigation for the earthworks associated with construction

CONSTRUCTION, OPERATION & DE-COMMISSION									
Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**	**Mitigation**
ALTERNATIVE 1 / ALTERNATIVE 2	Direct & Indirect	Existing	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**	▯ Petra Diamonds EO to be on site regularly and to monitor progress and implementation of mitigation measures. ▯ Petra Diamonds is required by law to remove Category 1 species, therefore an alien and invasive plan needs to be compiled and implemented ▯ Daily wetting of exposed surfaces during earth works to control dust (refer to Air Quality IA for further mitigation measures) ▯ Erosion Management Plan to be compiled and implemented (refer to Soils IA for further mitigation measures). Measures that could be assessed include: o Placing biodegradable sand bags around stockpiles, construction footprint etc. As the topography is flat these are recommended as opposed to berms ▯ Rehabilitation of areas disturbed outside of the slimes dam footprint, for example borrow pits. ▯ Rehabilitation of existing impacts, for example removal of berms, infill and re-vegetation of borrow pits (Only locally indigenous and weed-free flora should be used for re-vegetation of disturbed areas). ▯ During earthworks a faunal specialist should be on hand for any species that will require translocation during the construction phase. ▯ Construction crews should be informed about the importance of biodiversity through an induction process. Awareness of potentially harmful animals such as snakes should also be raised. The appointed EO on site should be trained to handle snakes. ▯ The new dam should be designed according to the Waste Classification and Management Regulations and Supporting Norms and Standards 2013.
Ground excavations, levelling, compaction, deposition, etc.	Destruction of fossorial fauna; Dust; Erosion; Sedimentation; Creation of artificial wetlands; Proliferation of alien flora; Degradation of habitat & ecosystem services		3	*2*	4	*5*		**3.00**	
		Additive	LOW	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**	
			2	*2*	4	*5*		**2.67**	
		Cumulative	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**	
			3	*2*	4	*5*		**3.00**	
		Residual	LOW	*Study Area*	Short-term	*It's going to happen / has occurred*	**Definite**	**Low**	
			2	*2*	2	*5*		**2.00**	
CONSTRUCTION, OPERATION & DE-COMMISSION									
Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**	
ALTERNATIVE 2 / ALTERNATIVE 3	Direct & Indirect	Existing	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**	
Ground excavations, levelling, compaction, deposition, etc.	Destruction of fossorial fauna; Dust; Erosion; Sedimentation; Creation of artificial wetlands; Proliferation of alien flora; Degradation of habitat & ecosystem services		3	*2*	4	*5*		**3.00**	
		Additive	HIGH	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**High**	
			4	*2*	4	*5*		**3.33**	
		Cumulative	HIGH	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**High**	
			4	*2*	4	*5*		**3.33**	
		Residual	MODERATE	*Study Area*	Short-term	*It's going to happen / has occurred*	**Definite**	**Moderate**	
			3	*2*	2	*5*		**2.33**	
CONSTRUCTION, OPERATION & DE-COMMISSION									
Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**	
ALTERNATIVE 4	Direct & Indirect	Existing	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**Moderate**	
Ground excavations, levelling, compaction, deposition, etc.	Destruction of fossorial fauna; Dust; Erosion; Sedimentation; Creation of artificial wetlands; Proliferation of alien flora; Degradation of habitat & ecosystem services		3	*2*	4	*5*		**3.00**	
		Additive	HIGH	*Local*	Long term	*It's going to happen / has occurred*	**Definite**	**High**	
			4	*3*	4	*5*		**3.67**	
		Cumulative	HIGH	*Local*	Long term	*It's going to happen / has occurred*	**Definite**	**High**	
			4	*3*	4	*5*		**3.67**	
		Residual	MODERATE	*Study Area*	Short-term	*It's going to happen / has occurred*	**Definite**	**Moderate**	
			3	*2*	2	*5*		**2.33**	
CONSTRUCTION, OPERATION & DE-COMMISSION									
Activity	**Nature of impact**	**Impact type**	**Magnitude**	**Spatial scale**	**Temporal scale**	**Probability**	**Certainty**	**Risk**	
ALTERNATIVE 5	Direct & Indirect	Existing	HIGH	*Study Area*	Long term	*It's going to happen / has occurred*	**Definite**	**High**	
Ground excavations, levelling, compaction, deposition, etc.	Destruction of fossorial fauna; Dust; Erosion; Sedimentation; Creation of artificial wetlands; Proliferation of alien flora; Degradation of habitat & ecosystem services		4	*2*	4	*5*		**3.33**	
		Additive	VERY LOW	*Isolated Sites / Proposed Site*	Long term	*Very Likely*	**Definite**	**Low**	
			1	*1*	4	*4*		**1.60**	
		Cumulative	MODERATE	*Study Area*	Long term	*Very Likely*	**Definite**	**Moderate**	
			3	*2*	4	*4*		**2.40**	
		Residual	LOW	*Study Area*	Short-term	*It's going to happen / has occurred*	**Definite**	**Low**	
			2	*2*	2	*5*		**2.00**	

Table 9-3 Impact ratings and mitigation for increased traffic, machinery and human activity

CONSTRUCTION, OPERATION & DECOMMISSION

	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk
ALTERNATIVE 1	Increased traffic, machinery & human activity	Direct & Indirect	Existing	VERY LOW	*Local*	Medium term	*It's going to happen / has occurred*	Definite	Moderate
		Increased noise, light, chemical & other forms of pollution; Increased faunal disturbance & roadkill; Increased dust & erosion; Proliferation of alien flora; Degradation of habitats &		1	*3*	3	*5*		2.33
			Additive	MODERATE	*Local*	Medium term	*It's going to happen / has occurred*	Definite	Moderate
				3	*3*	3	*5*		3.00
			Cumulative	MODERATE	*Local*	Medium term	*It's going to happen / has occurred*	Definite	Moderate
				3	*3*	3	*5*		3.00
			Residual	LOW	*Study Area*	Short-term	*It's going to happen / has occurred*	Definite	Low
				2	*2*	2	*5*		2.00
ALTERNATIVE 2									

CONSTRUCTION, OPERATION & DECOMMISSION

	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk
ALTERNATIVE 2	Increased traffic, machinery & human activity	Direct & Indirect	Existing	VERY LOW	*Local*	Medium term	*It's going to happen / has occurred*	Definite	Moderate
		Increased noise, light, chemical & other forms of pollution; Increased faunal disturbance & roadkill; Increased dust & erosion; Proliferation of alien flora; Degradation of habitats &		1	*3*	3	*5*		2.33
			Additive	MODERATE	*Local*	Medium term	*It's going to happen / has occurred*	Definite	Moderate
				3	*3*	3	*5*		3.00
			Cumulative	MODERATE	*Local*	Medium term	*It's going to happen / has occurred*	Definite	Moderate
				3	*3*	3	*5*		3.00
			Residual	LOW	*Study Area*	Short-term	*It's going to happen / has occurred*	Definite	Low
				2	*2*	2	*5*		2.00
ALTERNATIVE 3									

CONSTRUCTION, OPERATION & DECOMMISSION

	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk
ALTERNATIVE 4	Increased traffic, machinery & human activity	Direct & Indirect	Existing	LOW	*Local*	Long term	*It's going to happen / has occurred*	Definite	Moderate
		Increased noise, light, chemical & other forms of pollution; Increased faunal disturbance & roadkill; Increased dust & erosion; Proliferation of alien flora; Degradation of habitats &		2	*3*	4	*5*		3.00
			Additive	MODERATE	*Local*	Medium term	*It's going to happen / has occurred*	Definite	Moderate
				3	*3*	3	*5*		3.00
			Cumulative	MODERATE	*Local*	Long term	*It's going to happen / has occurred*	Definite	High
				3	*3*	4	*5*		3.33
			Residual	LOW	*Study Area*	Short-term	*It's going to happen / has occurred*	Definite	Low
				2	*2*	2	*5*		2.00
ALTERNATIVE 4									

CONSTRUCTION, OPERATION & DECOMMISSION

	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk
ALTERNATIVE 5	Increased traffic, machinery & human activity	Direct & Indirect	Existing	LOW	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate
		Increased noise, light, chemical & other forms of pollution; Increased faunal disturbance & roadkill; Increased dust & erosion; Proliferation of alien flora; Degradation of habitats &		2	*2*	4	*5*		2.67
			Additive	LOW	*Isolated Sites / Proposed Site*	Medium term	*It's going to happen / has occurred*	Definite	Low
				2	*1*	3	*5*		2.00
			Cumulative	LOW	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate
				2	*2*	4	*5*		2.67
			Residual	LOW	*Study Area*	Short-term	*It's going to happen / has occurred*	Definite	Low
				2	*2*	2	*5*		2.00
ALTERNATIVE 4									

Mitigation
Noise should be minimized as far as practicably possible: o Service and maintain vehicles regularly; o Traffic and construction activities should be limited to daylight hours. Demarcate and restrict anthropogenic disturbances to the construction area. Measures such as speed humps, signage and fines should be implemented to reduce speeding and off-road driving. Off-road driving is prohibited in all surrounding natural areas. Lights should be minimized, hooded and orientated downwards. Effective and environmentally-friendly measures should be implemented to minimize dust, erosion and sedimentation. Vehicles and machinery should be checked regularly for leaks.

Table 9-4 Impact ratings and mitigation for operation of the new slimes dam

	OPERATION									
ALTERNATIVE 1	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk	ALTERNATIVE 2
	Operation & maintenance of the new slimes dam	Direct & Indirect; Erosion; Sedimentation; surface and groundwater contamination; creation of artificial wetlands; Proliferation of alien flora; Transformation of habitat & ecosystem services; Dust	Existing	LOW	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				2	*1*	4	*5*		2.33	
			Additive	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				3	*2*	4	*5*		3.00	
			Cumulative	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				3	*2*	4	*5*		3.00	
			Residual	LOW	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				2	*2*	4	*5*		2.67	

	OPERATION									
ALTERNATIVE 2	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk	ALTERNATIVE 3
	Operation & maintenance of the new slimes dam	Direct & Indirect; Erosion; Sedimentation; surface and groundwater contamination; creation of artificial wetlands; Proliferation of alien flora; Transformation of habitat & ecosystem services; Dust	Existing	VERY LOW	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	Definite	Low	
				1	*1*	4	*5*		2.00	
			Additive	HIGH	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	High	
				4	*2*	4	*5*		3.33	
			Cumulative	HIGH	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	High	
				4	*2*	4	*5*		3.33	
			Residual	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				3	*2*	4	*5*		3.00	

	OPERATION									
ALTERNATIVE 4	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk	ALTERNATIVE 4
	Operation & maintenance of the new slimes dam	Direct & Indirect; Erosion; Sedimentation; surface and groundwater contamination; creation of artificial wetlands; Proliferation of alien flora; Transformation of habitat & ecosystem services; Dust	Existing	LOW	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				2	*1*	4	*5*		2.33	
			Additive	HIGH	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	High	
				4	*2*	4	*5*		3.33	
			Cumulative	HIGH	*Local*	Long term	*It's going to happen / has occurred*	Definite	High	
				4	*3*	4	*5*		3.67	
			Residual	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				3	*2*	4	*5*		3.00	

	OPERATION									
ALTERNATIVE 5	Activity	Nature of impact	Impact type	Magnitude	Spatial scale	Temporal scale	Probability	Certainty	Risk	ALTERNATIVE 4
	Operation & maintenance of the new slimes dam	Direct & Indirect; Erosion; Sedimentation; surface and groundwater contamination; creation of artificial wetlands; Proliferation of alien flora; Transformation of habitat & ecosystem services; Dust	Existing	HIGH	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	High	
				4	*2*	4	*5*		3.33	
			Additive	VERY LOW	*Isolated Sites / Proposed Site*	Long term	*It's going to happen / has occurred*	Definite	Low	
				1	*1*	4	*5*		2.00	
			Cumulative	MODERATE	*Study Area*	Long term	*It's going to happen / has occurred*	Definite	Moderate	
				3	*2*	4	*5*		3.00	
			Residual	VERY LOW	*Study Area*	Long term	*Very likely*	Definite	Low	
				1	*2*	4	*4*		1.87	

Mitigation
⍰ Petra Diamonds EO to be on site regularly and to monitor implementation of mitigation measures. ⍰ The new dam should be designed according to the Waste Classification and Management Regulations and Supporting Norms and Standards 2013. ⍰ Regular water surface and ground water monitoring is required (refer to the Water Management Plan for the Mine) – Investigate remediation options for current and potential future surface and groundwater contamination e.g. Phytoremediation. ⍰ Erosion Management Plan to be compiled and implemented (refer to Soils IA for further mitigation measures). ⍰ Petra Diamonds is required by law to remove Category 1 species, therefore an alien and invasive plan needs to be compiled and implemented ⍰ Management and operational staff should be informed about the importance of biodiversity through an induction process. Awareness of potentially harmful animals such as snakes should also be raised. The appointed EO on site should be trained to handle snakes. ⍰ Pamphlets should be designed and included into induction processes. These should include as a minimum: o Snake Awareness; o Alien Invasives; o Conservation Important Species; o The role of the NFEPA systems and surrounding habitat; o General environmental management processes such as recycling; littering, species harvesting etc. ⍰ Investigate the NFEPA status assigned to the pans to the south as this will affect the integrity of the buffer. This must include an investigation into the potential groundwater link between the new slimes dam and the NFEPAs south of the Site. ⍰ Research opportunities to be investigated include: o Vegetation cover trials on the walls for the existing tailings and future slimes dams. o MSc studies on species located within the area including the population dynamics of Red Listed species such as the Blue Korhaan, DD Shrew species and the DDT Nananthus plant. o It is evident that the vegetation communities re-established with a degree of success after the removal of the historical slime dam. A long-term monitoring programme should be implemented to determine changes in structure and banding within these communities.

10. Concludng Remarks

In summary, Site Alternative 5 is the most preferred due to the existing disturbances. Alternatives 1, 2 and 4 are very simillar in habitat and disturbances. However, Alternative 1 contains the DDT CI species. If this site alternative is used, investigations on the CI species removal would need to be conducted. In terms of less fragmentation on the habitats towards the north and west, Alternative 4 would be suitable. Alternative 2 is the least preffered from a biodiversity perspective.

Table 10-1 A summary of the Cumulative and Residual Impact ratings for the four alternatives

	Clearing of Vegetation		Ground excavations, levelling, compaction, deposition, etc.		Increased traffic, machinery & human activity		Operation & maintenance of the new slimes dam	
	Cumulative	Residual	Cumulative	Residual	Cumulative	Residual	Cumulative	Residual
Alternative 1	High	Moderate	Moderate	Low	Moderate	Low	Moderate	Moderate
Alternative 2	Moderate	Low	High	Moderate	Moderate	Low	High	Moderate
Alternative 4	Moderate	Low	High	Moderate	High	Low	High	Moderate
Alternative 5	Low	Low	Moderate	Low	Moderate	Low	Moderate	Low

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12. Appendices

12.1. NSS assessment methodology proposed to Zitholele on 14 April 2014

The study area is an approximate size of 100 hectares in extent. As a requirement from a number of provincial authorities two surveys will be required and are included into the proposal, this will not include trapping for 4/5 nights. NSS will therefore follow the following methodology which includes a detailed desktop review and a terrestrial ecological assessment within the summer months:

An **initial desktop review** of available literature including:

- Latest available Northern Cape Province Biodiversity data (no C-Plan available as yet);
- Descriptions of Regional Vegetation types;
- Relevant Legislation and Policies;
- National Spatial Biodiversity Assessments;
- NSS's previous studies in the region
- Communications with Mpumalanga Province and NBI;
- Recent Red Data Floral Listings [Produced by the Threatened Species
- Programme (TSP) in collaboration with SANBI (PRECIS and SIBIS databases)];
- Recent Red Data Faunal Listings as per the SANBI website;
- Existing databases and atlases,
- Other studies performed within the area that are available and of relevance; and
- Aerial imagery, if no aerial photographs are available Google Earth or Bing imagery will be used.

An **ecological investigation** in early and late summer (dependant on rains), which will include the following:

- An assessment of the major habitat types present in the study area and identification of vegetation communities using approved sampling methods;
- Identification of faunal species using the following methodologies
- *Visual observations*. This is performed by walking the site and noting habitat types and the visual presence of animals or evidence of animals in the form of faeces, pellets, spoor, nests, burrows, feathers etc.
- *Motion Cameras* – Depending on the habitat, NSS will place motion cameras out for additional faunal sampling (one field night per trip).
- *Night Observations*. – In terms of the night surveys a lot of faunal activity occurs during this time for all taxa. We would need to try and obtain as much information on species presence as possible. For example, one group, which we completely miss in the day are the bat species and we would like to put out mist nests and use a Bat Detector if possible. Avifaunal species such as owls and nightjars can only really be recorded at

night as well as certain rodent and mammal species. Further to this, snakes are more active during dusk and chances of seeing them are heightened.

- A list of common or dominant floral and faunal species within the vegetation communities will be compiled;
- Potential occurrence of Conservation Important Species (CIS) such as Red Data listed, Endemic of Medicinally important will be highlighted. Any species found on site will be recorded and details provided to the relevant Conservation Authorities.
- Alien and Invasive species will also be recorded, where possible.
- Any additional information will be recorded for any other features that may have ecological significance – GPS points will be documented.
- Wetlands / ephemeral rivers etc within the boundaries of the area will be identified and **where possible** (depending on the system) the methods will include:
- *Desktop Mapping:* Prior to any field investigations being undertaken, the area will be surveyed at a desktop level using 1:50,000 topographical maps, previous reports (if any) and Google / Bing imagery as reference material to determine the layout of potential wetlands on the site.
- *Wetland Classification*: The most popular wetland classification method used in South Africa is the classification of wetlands into hydro-geomorphic units developed by Kotze *et al*. (2008) in WET-EcoServices. The system excludes artificial wetlands from the classification.
- *Present Ecological State* (PES): The PES of the wetlands in the boundary will be assessed using the Level 1 WET-Health tool, as described by Macfarlane *et al* (2008). WET-Health is a tool designed to assess the health or integrity of a wetland. In assessing the health of the wetlands, the tool uses indicators based on the main wetland drivers: geomorphology, hydrology and vegetation.
- *Wetland Functionality:* The wetlands will be assessed in terms of their functionality (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

A **report** detailing the following:

- An introduction on the site and its locality;
- A broad description of the biophysical attributes of the area;
- A list of any applicable legislation, guidelines, standards and criteria to be considered in project planning (e.g. whether permits required for removal of certain species);
- An assessment of the different habitat and vegetation types found, including structure, dominant plant and animal composition and condition;
- Species of Conservation Concern, if any, (Red Data/endemics/medicinal value) that could potentially occur in the site and surrounds.

- PES of the wetland systems including the Ecological Importance and Sensitivity (EIS) assessment according to the guidelines by DWAF, (1999b).
- Identification of Impacts and possible mitigatory measures.

12.2. PRECIS Species List for the relevant QDGs

FAMILY	SPECIES	THREAT STATUS	LIFECYCLE	GROWTH FORMS
ASPHODELACEAE	*Aloe claviflora Burch.*	LC	Perennial	Herb, succulent
POACEAE	*Anthephora pubescens Nees*	LC	Perennial	Graminoid
POACEAE	*Aristida meridionalis Henrard*	LC	Perennial	Graminoid
POACEAE	*Aristida vestita Thunb.*	LC	Perennial	Graminoid
CHENOPODIACEAE	*Atriplex lindleyi Moq. subsp. inflata (F.Muell.) Paul G.Wilson*	NE	Annual	Herb
CHENOPODIACEAE	*Atriplex semibaccata R.Br. var. appendiculata Aellen*	LC	Annual (occ. perennial)	Dwarf shrub
POACEAE	*Bromus catharticus Vahl*	NE	Annual (occ. perennial)	Graminoid
PHYSCIACEAE	*Buellia rinodinea A.Massal.*		[No lifecycle defined]	Lichen
POACEAE	*Cenchrus incertus M.A.Curtis*	NE	Annual	Graminoid
VERBENACEAE	*Chascanum pinnatifidum (L.f.) E.Mey. var. pinnatifidum*	LC	Perennial	Herb
CHENOPODIACEAE	*Chenopodium album L.*	NE	Annual	Herb
ASTERACEAE	*Chrysocoma ciliata L.*	LC	Perennial	Shrub
CUCURBITACEAE	*Citrullus lanatus (Thunb.) Matsum. & Nakai*	LC	Annual	Climber, herb, succulent
CAPPARACEAE	*Cleome rubella Burch.*	LC	Annual	Herb
COLCHICACEAE	*Colchicum melanthoides (Willd.) J.C.Manning & Vinn. subsp. melanthoides*	LC	Perennial	Geophyte
COMMELINACEAE	*Commelina africana L. var. lancispatha C.B.Clarke*	LC	Perennial	Herb
NYCTAGINACEAE	*Commicarpus pentandrus (Burch.) Heimerl*	LC	Perennial	Herb, scrambler
CONVOLVULACEAE	*Convolvulus boedeckerianus Peter*	LC	Perennial	Herb
CONVOLVULACEAE	*Convolvulus multifidus Thunb.*	LC	Perennial	Herb
CONVOLVULACEAE	*Convolvulus sagittatus Thunb.*	LC	Perennial	Herb

FAMILY	SPECIES	THREAT STATUS	LIFECYCLE	GROWTH FORMS
ASTERACEAE	*Cotula anthemoides L.*	LC	Annual	Herb
ASTERACEAE	*Cotula burchellii DC.*	NE	Annual (occ. perennial)	Herb
CUCURBITACEAE	*Cucumis heptadactylus Naudin*	LC	Perennial	Herb
CUCURBITACEAE	*Cucumis myriocarpus Naudin subsp. leptodermis (Schweick.) C.Jeffrey & P.Halliday*	LC	Annual	Herb
CUCURBITACEAE	*Cucumis zeyheri Sond.*	LC	Perennial	Herb
FABACEAE	*Cullen tomentosum (Thunb.) J.W.Grimes*	LC	Perennial	Herb
CONVOLVULACEAE	*Cuscuta campestris Yunck.*	NE	Annual	Herb, parasite
POACEAE	*Cymbopogon pospischilii (K.Schum.) C.E.Hubb.*	NE	Perennial	Graminoid
CYPERACEAE	*Cyperus longus L. var. tenuiflorus (Rottb.) Boeck.*	LC	Perennial	Cyperoid, helophyte, herb
APIACEAE	*Deverra burchellii (DC.) Eckl. & Zeyh.*	LC	Perennial	Shrub
ASTERACEAE	*Dicoma schinzii O.Hoffm.*	LC	Perennial	Herb
EBENACEAE	*Diospyros lycioides Desf. subsp. lycioides*	LC	Perennial	Shrub
HYACINTHACEAE	*Dipcadi glaucum (Burch. ex Ker Gawl.) Baker*	LC	Perennial	Geophyte
HYACINTHACEAE	*Dipcadi marlothii Engl.*	LC	Perennial	Geophyte
POLYGONACEAE	*Emex australis Steinh.*		Annual	Herb
POACEAE	*Enneapogon cenchroides (Licht. ex Roem. & Schult.) C.E.Hubb.*	LC	Annual (occ. perennial)	Graminoid
POACEAE	*Eragrostis barrelieri Daveau*	NE	Annual	Graminoid
POACEAE	*Eragrostis curvula (Schrad.) Nees*	LC	Perennial	Graminoid
POACEAE	*Eragrostis lehmanniana Nees var. lehmanniana*	LC	Perennial	Graminoid
POACEAE	*Eragrostis mexicana (Hornem.) Link subsp. virescens (J.Presl.) S.D.Koch & Sánchez Vega*	NE	Annual	Graminoid
POACEAE	*Eragrostis micrantha Hack.*	LC	Perennial	Graminoid

FAMILY	SPECIES	THREAT STATUS	LIFECYCLE	GROWTH FORMS
POACEAE	*Eragrostis procumbens Nees*	LC	Annual	Graminoid
POACEAE	*Eragrostis superba Peyr.*	LC	Perennial	Graminoid
POACEAE	*Eragrostis trichophora Coss. & Durieu*	LC	Perennial	Graminoid
EUPHORBIACEAE	*Euphorbia bergii A.C.White, R.A.Dyer & B.Sloane*	LC	Perennial	Shrub, succulent
EUPHORBIACEAE	*Euphorbia duseimata R.A.Dyer*	LC	Perennial	Dwarf shrub, succulent
ASTERACEAE	*Euryops asparagoides (Licht. ex Less.) DC.*	LC	Perennial	Shrub
ASTERACEAE	*Felicia ovata (Thunb.) Compton*	LC	Perennial	Shrub
APOCYNACEAE	*Fockea comaru (E.Mey.) N.E.Br.*	LC	Perennial	Climber, succulent
AIZOACEAE	*Galenia procumbens L.f.*	LC	Perennial	Dwarf shrub
ASTERACEAE	*Geigeria filifolia Mattf.*	LC	Annual (occ. perennial)	Herb
GISEKIACEAE	*Gisekia pharnacioides L. var. pharnacioides*	LC	Annual	Herb
ASTERACEAE	*Gnaphalium filagopsis Hilliard & B.L.Burtt*	LC	Perennial	Herb
APOCYNACEAE	*Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus*	LC	Annual (occ. perennial)	Herb, shrub
ASTERACEAE	*Helichrysum arenicola M.D.Hend.*	LC	Perennial	Herb
ASTERACEAE	*Helichrysum lucilioides Less.*	LC	Perennial	Dwarf shrub
BRASSICACEAE	*Heliophila minima (Stephens) Marais*	LC	Annual (occ. perennial)	Herb
BORAGINACEAE	*Heliotropium ciliatum Kaplan*	LC	Perennial	Herb
BORAGINACEAE	*Heliotropium curassavicum L.*	NE	Perennial (occ. annual)	Herb, succulent
BORAGINACEAE	*Heliotropium lineare (A.DC.) Gürke*	LC	Perennial	Herb
MALVACEAE	*Hermannia bicolor Engl. & Dinter*	LC	Perennial	Herb
MALVACEAE	*Hermannia comosa Burch. ex DC.*	LC	Perennial	Herb
MALVACEAE	*Hermannia erodioides (Burch. ex DC.) Kuntze*	LC	Annual (occ.	Herb

FAMILY	SPECIES	THREAT STATUS	LIFECYCLE	GROWTH FORMS
			perennial)	
MALVACEAE	*Hermannia lancifolia Szyszyl.*	LC	Perennial	Herb
MALVACEAE	*Hermannia linearifolia Harv.*	LC	Perennial	Dwarf shrub, shrub
MALVACEAE	*Hermannia tomentosa (Turcz.) Schinz ex Engl.*	LC	Perennial	Herb
ASTERACEAE	*Hirpicium echinus Less.*	LC	Perennial	Herb
FABACEAE	*Indigastrum argyraeum (Eckl. & Zeyh.) Schrire*	LC	Perennial	Herb
SCROPHULARIACEAE	*Jamesbrittenia atropurpurea (Benth.) Hilliard subsp. atropurpurea*	LC	Perennial	Dwarf shrub, shrub
JUNCACEAE	*Juncus rigidus Desf.*	LC	Perennial	Helophyte, herb
RUBIACEAE	*Kohautia cynanchica DC.*	LC	Annual (occ. perennial)	Herb
IRIDACEAE	*Lapeirousia plicata (Jacq.) Diels subsp. plicata*	LC	Perennial	Geophyte, herb
HYACINTHACEAE	*Ledebouria undulata (Jacq.) Jessop*	LC	Perennial	Geophyte
MOLLUGINACEAE	*Limeum pterocarpum (J.Gay) Heimerl var. pterocarpum*	LC	Annual	Herb
MOLLUGINACEAE	*Limeum sulcatum (Klotzsch) Hutch. var. sulcatum*	LC	Annual	Herb
FABACEAE	*Lotononis crumanina Burch. ex Benth.*	LC	Perennial	Herb
SOLANACEAE	*Lycium cinereum Thunb.*	LC	Perennial	Dwarf shrub, shrub
MARSILEACEAE	*Marsilea burchellii (Kunze) A.Braun*	LC	Perennial	Herb, hydrophyte
POACEAE	*Melinis repens (Willd.) Zizka subsp. repens*	LC	Annual (occ. perennial)	Graminoid
Mesembryanthemum nodiflorum L.		*LC*	*Annual*	Succulent
APOCYNACEAE	*Microloma armatum (Thunb.) Schltr. var. armatum*	LC	Perennial	Dwarf shrub, shrub
IRIDACEAE	*Moraea polystachya (Thunb.) Ker Gawl.*	LC	Perennial	Geophyte, herb
Nananthus vittatus (N.E.Br.) Schwantes		*DDT*	*Perennial*	Succulent
AMARYLLIDACEAE	*Nerine laticoma (Ker Gawl.) T.Durand & Schinz*	LC	Perennial	Geophyte
ASTERACEAE	*Nidorella resedifolia DC. subsp. resedifolia*	LC	Annual	Herb
RESEDACEAE	*Oligomeris dipetala (Aiton) Turcz. var. dipetala*	LC	Perennial	Dwarf shrub

FAMILY	SPECIES	THREAT STATUS	LIFECYCLE	GROWTH FORMS
POACEAE	*Oropetium capense Stapf*	LC	Perennial	Graminoid
ASTERACEAE	*Osteospermum spinescens Thunb.*	LC	Perennial	Shrub
APOCYNACEAE	*Pachypodium succulentum (Jacq.) Sweet*	LC	Perennial	Shrub, succulent
POACEAE	*Panicum impeditum Launert*	LC	Annual	Graminoid
SCROPHULARIACEAE	*Peliostomum leucorrhizum E.Mey. ex Benth.*	LC	Perennial	Dwarf shrub
ASTERACEAE	*Pentzia calcarea Kies*	LC	Perennial	Shrub, suffrutex
ASTERACEAE	*Pentzia globosa Less.*	LC	Perennial	Shrub
ASTERACEAE	*Pentzia incana (Thunb.) Kuntze*	LC	Perennial	Shrub
ASTERACEAE	*Pentzia lanata Hutch.*	LC	Perennial	Shrub
ASTERACEAE	*Pentzia viridis Kies*	LC	Perennial	Shrub, suffrutex
POACEAE	*Phragmites australis (Cav.) Steud.*	LC	Perennial	Graminoid
PLANTAGINACEAE	*Plantago lanceolata L.*	LC	Perennial	Herb
AIZOACEAE	*Plinthus karooicus I.Verd.*	LC	Perennial	Dwarf shrub
POACEAE	*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC	Perennial (occ. annual)	Graminoid
CARYOPHYLLACEAE	*Pollichia campestris Aiton*	LC	Perennial	Herb
POLYGALACEAE	*Polygala ephedroides Burch.*	LC	Perennial	Dwarf shrub, shrub
Potamogeton pectinatus L.		*LC*	*Perennial*	Herb, hydrophyte
CYPERACEAE	*Pseudoschoenus inanis (Thunb.) Oteng-Yeb.*	LC	Perennial	Cyperoid, helophyte, herb
Psilocaulon articulatum (Thunb.) N.E.Br.		*LC*	*Perennial*	Succulent
ASTERACEAE	*Pteronia erythrochaeta DC.*	LC	Perennial	Shrub
ASTERACEAE	*Pteronia sordida N.E.Br.*	LC	Perennial	Dwarf shrub, shrub
RICCIACEAE	*Riccia pottsiana Sim*		Perennial	Bryophyte
ASTERACEAE	*Rosenia humilis (Less.) K.Bremer*	LC	Perennial	Shrub
CHENOPODIACEAE	*Salsola calluna Fenzl ex C.H.Wright*	LC	Perennial	Dwarf shrub

FAMILY	SPECIES	THREAT STATUS	LIFECYCLE	GROWTH FORMS
CHENOPODIACEAE	*Salsola exalata Botsch.*	LC	Perennial	Dwarf shrub
CHENOPODIACEAE	*Salsola geminiflora Fenzl ex C.H.Wright*	LC	Perennial	Dwarf shrub
CHENOPODIACEAE	*Salsola glabrescens Burtt Davy*	LC	Perennial	Dwarf shrub, shrub
CHENOPODIACEAE	*Salsola henriciae I.Verd.*	LC	Perennial	Dwarf shrub
CHENOPODIACEAE	*Salsola humifusa A.Brückn.*	LC	Perennial	Dwarf shrub
CHENOPODIACEAE	*Salsola kali L.*	NE	Annual	Herb
CHENOPODIACEAE	*Salsola rabieana I.Verd.*	LC	Perennial	Dwarf shrub
LAMIACEAE	*Salvia stenophylla Burch. ex Benth.*		Perennial	Herb
POACEAE	*Schismus barbatus (Loefl. ex L.) Thell.*	LC	Annual	Graminoid
POACEAE	*Schmidtia pappophoroides Steud.*	LC	Perennial	Graminoid
CYPERACEAE	*Scirpoides dioeca (Kunth) Browning*	LC	Perennial	Cyperoid, herb
SCROPHULARIACEAE	*Selago geniculata L.f.*	LC	Perennial	Dwarf shrub
SCROPHULARIACEAE	*Selago paniculata Thunb.*	LC	Perennial	Herb
ASTERACEAE	*Senecio reptans Turcz.*	LC	Perennial	Herb
FABACEAE	*Senna italica Mill. subsp. arachoides (Burch.) Lock*	LC	Perennial	Herb
PEDALIACEAE	*Sesamum triphyllum Welw. ex Asch. var. triphyllum*	LC	Annual	Herb
SOLANACEAE	*Solanum elaeagnifolium Cav.*	NE	Perennial	Dwarf shrub
SOLANACEAE	*Solanum lichtensteinii Willd.*	LC	Perennial	Dwarf shrub
APOCYNACEAE	*Stenostelma capense Schltr.*	LC	Perennial	Herb
POACEAE	*Stipagrostis uniplumis (Licht.) De Winter var. uniplumis*	LC	Perennial	Graminoid
CHENOPODIACEAE	*Suaeda fruticosa (L.) Forssk.*	LC	Perennial	Dwarf shrub
APOCYNACEAE	*Tavaresia barklyi (Dyer) N.E.Br.*	LC	Perennial	Succulent
FABACEAE	*Tephrosia burchellii Burtt Davy*	LC	Annual	Herb
AIZOACEAE	*Tetragonia arbuscula Fenzl*	LC	Perennial	Dwarf shrub
POACEAE	*Themeda triandra Forssk.*	LC	Perennial	Graminoid
POACEAE	*Tragus berteronianus Schult.*	LC	Annual	Graminoid

FAMILY	SPECIES	THREAT STATUS	LIFECYCLE	GROWTH FORMS
ZYGOPHYLLACEAE	*Tribulus terrestris L.*	LC	Annual	Herb
FABACEAE	*Trigonella anguina Delile*	LC	Annual	Herb
POACEAE	*Urochloa panicoides P.Beauv.*		Annual	Graminoid
CAMPANULACEAE	*Wahlenbergia nana Brehmer*	LC	Annual	Herb
ZYGOPHYLLACEAE	*Zygophyllum incrustatum E.Mey. ex Sond.*	LC	Perennial	Dwarf shrub, shrub, succulent

12.3. TWINSPAN Preliminary Results

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Relevés 24                          222 1 1    11211  11211
Species 95                          432437232168719689010545

Lyc spp                  0  ...r.....  ...+..rr..rr.
Era x p                  0  ...1r..+33..+..r++r....
Era chl                  0  ...rr......  .....++....
Sal ste                  0  ..........r++++r++r.rr.
Pen lan                  0  ...r.r1aa.  .....r+r....
Nid res                  0  .....rr.rrr..rrr.....
Era bic                  0  .....++..1.11.rr.....
Ser plu                  0  ..........  .....rr.....
Cus cam                  0  ..........  .....rr.....
Era sup                  0  ...+.....r.rr.rr.....
Hyp hir                  0  ..........  .....rr.....
Ber cf                   0  ..........  .....rr.....
Era spp                  0  ..........  .....rr.....
Con boe                  0 r..........  .....+r.....
Zyg inc                  0  ..........r...rr.....
Lyc cin                  0  ...1r..1111.1.11.11.....
Asp spp                  0  ...rr..rrrr..............
Fin afr                  0  ...+r.1r++rr+.++.....
Fel ova                  0  ....rrrr..  ..........
Pan col                  0  .....rr.r....r..r.....
The cf                   0  .....rr.  ..........
Sal ste                  0  .....rr.  ..........
Sal cf                   0  .....rr.rr.rr.....
Mes arb                  0  ...r.1++.  ..........
Sal spp                  0  ....1...  ..........
Psi art                  0  ...+r.....  ..........
Nan vit                  0  ...rr.....  ..........
Atr lin                  0  ...rr.....  ..........
Led spp                  0  ...r......  ..........
Sal kal                  0  ...1......  ..........
Phr aus                  0 1.1........  .a........
Tam ram                  0  ..........  .1.......rrr
Ehr rig                  0  ...rrr....  ..........
Hel lin                  0  ..........  ..........
Atr lin                  0  ..........  ..........
Che alb                  0  .........r  ..........
Sch spp                  0  ..........  .......r....
Euc cri                  0  ....r.....  ..........
Aca tor                  0  ....r.....  ..........
Ind cf.                  0  ..........  .r........
Myr fla                  0  ...rr.....  ..........
Oxa obl                  0  ...r......  ..........
Bue spp                  0  ..........  ..........
Ari con                  0  ...rrr...r.  ....r.....
Ari con                  0 .r..........  ..........
Ari dif                  0  ...ra.....  .........r..
Enn sco                  0  ...rr.....  ..........
Era nin                  0  ....r.....  ..........
Eus pas                  0  ....r.....  ..........
Het con                  0  ...rr.....  ..........
Pan sp.                  0  ..........  .r........
Spo cf.                  0  ....r.....  ..........
Sti uni                  0 r..........  ..........
Ten (Me                  0  ...rr.....  ..........
The tri                  0  ...ra...r..  ..........
Por spp                  0  ..........  .........r..
Ziz muc                  0  ...r......  ..........
Jam aur                  0  ..........  .......r....
Asp cor                  0  ....r.....  ..........
Pel cal                  0  ...r.r....  ..........
Nic gla                  0 rr..........  ..........
Cyp spp                  0  ..........  ..........
Tri ter                  0  ....r.....  rrrr......
Alb spp                  0  ...r......  ..........
Alb spp                  0  ...r......  ..........
Sal ste                  0  .........r  ..........
Cot spp                  0  ..........  .........rr.
Cyp  sp                  0  ...r......  ..........
Led spp                  0  ..........  ..........
Eup arc                  0  ...r.r....  ..........
Ind spp                  0  ..........  .........r..
Pel leu                  0  ....r.....  ..........
Tri pom                  0  ....r.....  ..........
Sea cf                   0  ...r......  .......r....
Sea spp                  0  ....r.....  ..........
Sel gen                  0  ...r.r....  .r.rr.....
Sen spp                  0  ..........  .......r....
Fel spp                  0  .........r  +.++.....r..
Vis spp                  0  ...r......  ..........
Wah nod                  0  ....1.....  ..........
Eri dec                  0  .........r  1r11....r...
Dio lyc                  0  ..........  ..........
Dat str                  0  ..........  ..r.......
Jun rig                  0  ..........  ..........
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12.4. 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. Owls & nightjars	Owls & nightjars.
7. Sandgrouse, doves, etc	Sandgrouse, doves, pigeons, parrots, lovebirds, trogon, turacos & go-away birds (louries), cuckoos & coucals.
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.

12.5. List of mammal species for the Study Area

ORDER & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
MACROSCELIDEA	**Elephant-shrews**									
Elephantulus myurus	Rock Elephant-shrew	LC (S)	LC	-	4	1a	x			
TUBULIDENTATA	**Aardvark**									
Orycteropus afer	Aardvark	LC (U)	LC	-	1c	1c		x		
HYRACOIDEA	**Hyraxes**									
Procavia capensis	Rock Hyrax	LC (U)	LC	-	4	1a	x			
LAGOMORPHA	**Hares & rabbits**									
Lepus capensis	Cape Hare	LC (D)	LC	-	2	1a		x		
Pronolagus rupestris	Smith's Red Rock Rabbit	LC (U)	LC	-	4	2				
RODENTIA	**Rodents**									
Cryptomys hottentotus	Common Mole-rat	LC (S)	LC	-	1c	1c		x		
Hystrix africaeaustralis	Porcupine	LC (S)	LC	-	1a	1c	x	x		
Pedetes capensis	Springhare	LC (U)	LC	-	1c	1c		x		
Xerus inauris	Cape Ground Squirrel	LC (S)	LC	-	1c	1c		x		
Graphiurus murinus	Woodland Dormouse	LC (S)	LC	-	4	3				
Mystromys albicaudatus	White-tailed Rat	EN (D)	EN	-	4	3				
Rhabdomys pumilio	Striped Mouse	LC (S)	LC	-	1b	2				
Mus minutoides	Pygmy Mouse	LC (S)	LC	-	1a	2		x	x	
Mastomys coucha	Multimammate Mouse	LC (S)	LC	-	1a	2			x	
Aethomys chrysophilus	Red Veld Rat	LC (U)	LC	-	1a	1a		x	x	
Aethomys namaquensis	Namaqua Rock Mouse	LC (S)	LC	-	4	1a	x			
Otomys unisulcatus	Karoo Bush Rat	LC (S)	LC	-	3	3				

ORDER & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
Desmodillus auricularis	Short-tailed Gerbil	LC (S)	LC	-	2	2				
Gerbillurus paeba	Hairy-footed Gerbil	LC (S)	LC	-	1b	3		x	x	
Tatera leucogaster	Bushveld Gerbil	LC (S)	DD	-	3	2				
Tatera brantsii	Highveld Gerbil	LC (U)	LC	-	3	2				
Saccostomus campestris	Pouched Mouse	LC (S)	LC	-	2	2				
PRIMATES	**Primates**									
Papio ursinus	Chacma Baboon	LC (S)	LC	-	4	3				
/NSECTIVORA	**Insectivores**									
Suncus varilla	Lesser Dwarf Shrew	LC (U)	DD	-	1a	2		x		
Crocidura fuscomurina	Tiny Musk Shrew	LC (U)	DD	-	3	2				
Crocidura cyanea	Reddish-grey Musk Shrew	LC (S)	DD	-	3	2				
Atelerix frontalis	Southern African Hedgehog	LC (S)	NT	PS	2	2				
CHIROPTERA	**Bats**									
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	LC (U)	LC	-	3	3				
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LC (U)	LC	-	2	1c		x		x
Miniopterus natalensis	Natal Long-fingered Bat	LC (U)	NT	-	3	3				
Pipistrellus rusticus	Rusty Pipistrelle	LC (U)	LC	-	2	1a			x	
Neoromicia capensis	Cape Serotine	LC (S)	LC	-	2	1c			x	x
Nycteris thebaica	Egyptian Slit-faced Bat	LC (U)	LC	-	3	3				
CARNIVORA	**Carnivores**									

ORDER & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
Proteles cristatus	Aardwolf	LC (S)	LC	-	1a	1c		x		
Hyaena brunnea	Brown Hyaena	NT (D)	NT	PS	3	3				
Caracal caracal	Caracal	LC (U)	LC	-	3	2				
Felis silvestris	African Wild Cat	LC (D)	LC	-	3	1b	x			
Felis nigripes	Black-footed Cat	VU (D)	LC	PS	2	2				
Genetta genetta	Small-spotted Genet	LC (S)	LC	-	2	1a	x	x		
Suricata suricatta	Suricate	LC (U)	LC	-	2	1c		x		
Cynictis penicillata	Yellow Mongoose	LC (S)	LC	-	1c	1c	x	x	x	x
Galerella sanguinea	Slender Mongoose	LC (S)	LC	-	2	2				
Galerella pulverulenta	Small Grey Mongoose	LC (S)	LC	-	2	2				
Atilax paludinosus	Water Mongoose	LC (D)	LC	-	3	1b			x	
Otocyon megalotis	Bat-eared Fox	LC (U)	LC	-	1a	2		x		
Vulpes chama	Cape Fox	LC (S)	LC	PS	2	2				
Canis mesomelas	Black-backed Jackal	LC (S)	LC	-	2	1b	x	x		
Aonyx capensis	Cape Clawless Otter	LC (S)	LC	-	4	2				
Lutra maculicollis	Spotted-necked Otter	LC (D)	NT	PS	4	4				
Poecilogale albinucha	African Weasel	LC (U)	DD	-	2	2				
Ictonyx striatus	Striped Polecat	LC (S)	LC	-	2	1a		x		
ARTIODACTYLA	**Even-toed ungulates**									
Tragelaphus oryx	Eland	LC (S)	LC	-	1c	1c		x		
Connochaetes taurinus	Blue Wildebeest	LC (S)	LC	-	1c	1c		x		
Alcelaphus buselaphus	Red Hartebeest	LC (D)	LC	-	1c	1c		x	x	
Sylvicapra grimmia	Common Duiker	LC (S)	LC	-	3	1b		x		

ORDER & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
Antidorcas marsupialis	Springbok	LC (I)	LC	-	1c	1c		x	x	
Raphicerus campestris	Steenbok	LC (S)	LC	-	1c	1c		x		
Aepyceros melampus	Impala	LC (S)	LC	-	5	1c		x	x	

Status: CR = Critically Endangered; D = Declining; DD = Data Deficient; EN = Endangered; I = Increasing; LC = Least Concern; NT = Near Threatened; PS = Protected Species; S = Stable; SCH = Schedule Species; U = Unknown population trend; VU = Vulnerable; * Status assigned to species

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; a = NSS survey 1; b = NSS survey 2; c = Both NSS surveys

Sources: [1]Stuart & Stuart (2000); [2]Friedmann & Daly (2004); [3]ToPS List (2007); [4]Monadjem et al. (2010); [5]IUCN (2013.1); [6]MammalMap (2013)

12.6. List of bird species for the Study Area

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
1. Ocean birds						#					
Sterna caspia	Caspian Tern	LC (I)	NT	-		2	4				
2. Inland water birds						#					
Anhinga rufa	African Darter	LC (D)	LC	-	1	2	4				
Ardea cinerea	Grey Heron	LC (U)	LC	-	1	1a	2			x	
Ardea melanocephala	Black-headed Heron	LC (I)	LC	-	1	1b	2			x	
Bostrychia hagedash	Hadeda Ibis	LC (I)	LC	-	1	1a	1a				x
Bubulcus ibis	Cattle Egret	LC (I)	LC	-	1	1a	2		x	x	
Chlidonias hybrida	Whiskered Tern	LC (S)	LC	-		3	4				
Chlidonias leucopterus	White-winged Tern	LC (S)	LC (NB)	-		3	4				
Ciconia abdimii	Abdim's Stork	LC (D)	LC (NB)	-		3	3				
Ciconia ciconia	White Stork	LC (I)	LC (NB)	-	1	2	2				
Ciconia nigra	Black Stork	LC (U)	NT	VU	1	2	4				
Larus cirrocephalus	Grey-headed Gull	LC (S)	LC	-	1	2	4				
Phalacrocorax africanus	Reed Cormorant	LC (D)	LC	-	1	2	4				
Phalacrocorax carbo	White-breasted Cormorant	LC (I)	LC	-	1	2	4				
Phoenicopterus roseus	Greater Flamingo	LC (I)	NT	-	1	2	4				
Platalea alba	African Spoonbill	LC (S)	LC	-	1	2	4				
Plegadis falcinellus	Glossy Ibis	LC (D)	LC	-	1	2	3				
Scopus umbretta	Hamerkop	LC (S)	LC	-	1	2	2				
Threskiornis aethiopicus	African Sacred Ibis	LC (D)	LC	-		2	2				
3. Ducks & wading birds						#					
Actitis hypoleucos	Common Sandpiper	LC (D)	LC (NB)	-	1	2	2				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Alopochen aegyptiaca	Egyptian Goose	LC (D)	LC	-	1	1c	3			x	
Amaurornis flavirostris	Black Crake	LC (U)	LC	-		2	3				
Anas capensis	Cape Teal	LC (I)	LC	-		3	4				
Anas erythrorhyncha	Red-billed Teal	LC (D)	LC	-		2	4				
Anas hottentota	Hottentot Teal	LC (D)	LC	-		3	4				
Anas smithii	Cape Shoveler	LC (I)	LC	-		2	4				
Anas sparsa	African Black Duck	LC (D)	LC	-		3	4				
Anas undulata	Yellow-billed Duck	LC (S)	LC	-		1c	3			x	
Calidris ferruginea	Curlew Sandpiper	LC (I)	LC (NB)	-	1	2	3				
Calidris minuta	Little Stint	LC (D)	LC (NB)	-		3	4				
Charadrius pecuarius	Kittlitz's Plover	LC (U)	LC	-		2	3				
Charadrius tricollaris	Three-banded Plover	LC (U)	LC	-	1	2	2				
Dendrocygna viduata	White-faced Duck	LC (I)	LC	-		2	3				
Fulica cristata	Red-knobbed Coot	LC (D)	LC	-		2	4				
Gallinago nigripennis	African Snipe	LC (U)	LC	-		3	4				
Gallinula chloropus	Common Moorhen	LC (U)	LC	-		2	3				
Himantopus himantopus	Black-winged Stilt	LC (I)	LC	-	1	2	3				
Philomachus pugnax	Ruff	LC (D)	LC (NB)	-		2	4				
Plectropterus gambensis	Spur-winged Goose	LC (I)	LC	-	1	1b	3			x	
Recurvirostra avosetta	Pied Avocet	LC (U)	LC	-	1	2	4				
Tachybaptus ruficollis	Little Grebe	LC (D)	LC	-		2	4				
Tadorna cana	South African Shelduck	LC (I)	LC	-	1	2	3				
Tringa glareola	Wood Sandpiper	LC (S)	LC (NB)	-		2	2				
Tringa nebularia	Common Greenshank	LC (S)	LC (NB)	-		2	4				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Tringa stagnatilis	Marsh Sandpiper	LC (D)	LC (NB)	-		3	3				
Vanellus armatus	Blacksmith Lapwing	LC (I)	LC	-	1	2	1c		x		
Vanellus coronatus	Crowned Lapwing	LC (I)	LC	-	1	2	1c		x		
4. Large terrestrial birds						#					
Afrotis afraoides	Northern Black Korhaan	-	LC	-	1	1a	1b		x		
Anthropoides paradiseus	Blue Crane	VU (S)	VU	EN		1d	3				
Ardeotis kori	Kori Bustard	NT (D)	VU	VU		3	3				
Balearica regulorum	Grey Crowned-crane	EN (D)	VU	EN		3	3				
Burhinus capensis	Spotted Thick-knee	LC (S)	LC	-	1	1c	1a		x	x	
Coturnix coturnix	Common Quail	LC (D)	LC	-		3	3				
Eupodotis caerulescens	Blue Korhaan	NT (S)	NT (N-End)	VU	1	1b	1a		x		
Francolinus levaillantoides	Orange River Francolin	LC (S)	LC	-		2	2				
Francolinus swainsonii	Swainson's Spurfowl	LC (S)	LC	-		3	3				
Neotis ludwigii	Ludwig's Bustard	EN (D)	VU	VU		2	3				
Numida meleagris	Helmeted Guineafowl	LC (S)	LC	-	1	1b	1c		x	x	
Rhinoptilus africanus	Double-banded Courser	LC (S)	LC	-	1	1a	1c		x		
Sagittarius serpentarius	Secretarybird	VU (D)	NT	-	1	1c	2		x		
Struthio camelus	Common Ostrich	LC (D)	LC	-	1	1b	1c		x		
5. Raptors						#					
Aquila rapax	Tawny Eagle	LC (S)	VU	VU	1	2	3				
Aquila verreauxii	Verreaux's Eagle	LC (S)	LC	-	1	2	3				
Buteo buteo	Steppe Buzzard	LC (I)	LC (NB)	-	1	1b	2		x		
Buteo rufofuscus	Jackal Buzzard	LC (S)	LC (N-End)	-		1a	1a		x		x

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Circaetus pectoralis	Black-chested Snake-eagle	LC (U)	LC	-		3	4				
Circus maurus	Black Harrier	VU (S)	NT (N-End)	-		3	3				
Elanus caeruleus	Black-shouldered Kite	LC (S)	LC	-	1	2	2				
Falco amurensis	Amur Falcon	LC (S)	LC (NB)	-		1a	1a		x		x
Falco biarmicus	Lanner Falcon	LC (I)	NT	-		3	3				
Falco naumanni	Lesser Kestrel	LC (S)	VU (NB)	VU	1	2	3				
Falco rupicoloides	Greater Kestrel	LC (S)	LC	-	1	1a	1a		x		x
Falco rupicolus	Rock Kestrel	-	LC	-	1	3	4				
Gyps africanus	White-backed Vulture	EN (D)	VU	EN	1	2	3				
Haliaeetus vocifer	African Fish-eagle	LC (S)	LC	-	1	2	4				
Melierax canorus	Southern Pale Chanting Goshawk	LC (S)	LC	-	1	1a	2		x		x
Polemaetus bellicosus	Martial Eagle	VU (D)	VU	VU		3	4				
Pandion haliaetus	Western Osprey	LC (I)	LC (NB)	-		1c			x	x	
6. Owls & nightjars						#					
Bubo africanus	Spotted Eagle-owl	LC (S)	LC	-		1a	2		x		x
Caprimulgus rufigena	Rufous-cheeked Nightjar	LC (S)	LC (B)	-		3	3				
Tyto alba	Barn Owl	LC (S)	LC	-		1b	2		x		x
7. Sandgrouse, doves etc						#					
Centropus burchelli	Burchell's Coucal	LC (S)	LC	-		3	4				
Chrysococcyx caprius	Dideric Cuckoo	LC (S)	LC (B)	-	1	1c	3		x		
Columba guinea	Speckled Pigeon	LC (S)	LC	-	1	1b	1b		x	x	x

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Columba livia	Rock Dove	LC (D)	AL	-		2	2				
Oena capensis	Namaqua Dove	LC (I)	LC	-	1	2	2				
Pterocles namaqua	Namaqua Sandgrouse	LC (S)	LC	-	1	2	1a		x	x	
Streptopelia capicola	Cape Turtle Dove	LC (I)	LC	-	1	1b	1b		x		x
Streptopelia semitorquata	Red-eyed Dove	LC (I)	LC	-		2	2				
Streptopelia senegalensis	Laughing Dove	LC (S)	LC	-	1	1b	1b		x		x
8. Aerial feeders, etc						#					
Alcedo cristata	Malachite Kingfisher	LC (S)	LC	-		3	4				
Apus affinis	Little Swift	LC (I)	LC	-	1	1b	2		x		x
Apus apus	Common Swift	LC (D)	LC (NB)	-		3	3				
Apus barbatus	African Black Swift	LC (S)	LC	-		1c	3		x		
Apus bradfieldi	Bradfield's Swift	LC (S)	LC	-	1	1a	1a		x		x
Apus caffer	White-rumped Swift	LC (I)	LC (B)	-		1b	1b		x	x	x
Ceryle rudis	Pied Kingfisher	LC (U)	LC	-		3	4				
Colius colius	White-backed Mousebird	LC (I)	LC	-	1	1a	2			x	x
Coracias garrulus	European Roller	NT (D)	LC (NB)	-		3	3				
Cypsiurus parvus	Palm Swift	LC (I)	LC	-		3	3				
Dendropicos fuscescens	Cardinal Woodpecker	LC (S)	LC	-		3	4				
Hirundo albigularis	White-throated Swallow	LC (I)	LC	-	1	2	2				
Hirundo cucullata	Greater Striped-swallow	LC (I)	LC	-	1	1b	1a		x		x
Hirundo dimidiata	Pearl-breasted Swallow	LC (S)	LC	-		2	2				
Hirundo fuligula	Rock Martin	LC (S)	LC	-	1	1b	2		x		x
Hirundo rustica	Barn Swallow	LC (D)	LC (NB)	-	1	1a	1a		x		x
Hirundo semirufa	Red-breasted Swallow	LC (I)	LC	-	1	2	2				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Hirundo spilodera	South African Cliff-swallow	LC (I)	LC (B, N-End)	-	1	1b	1a		x		
Indicator indicator	Greater Honeyguide	LC (I)	LC	-		3	4				
Indicator minor	Lesser Honeyguide	LC (S)	LC	-		3	4				
Megaceryle maxima	Giant Kingfisher	LC (D)	LC	-		3	4				
Merops apiaster	European Bee-eater	LC (D)	LC (B/NB)	-	1	2	1c		x		
Merops bullockoides	White-fronted Bee-eater	LC (I)	LC	-		1a	2		x		x
Merops hirundineus	Swallow-tailed Bee-eater	LC (S)	LC	-	1	3	3				
Rhinopomastus cyanomelas	Common Scimitarbill	LC (D)	LC	-		2	3				
Riparia paludicola	Brown-throated Martin	LC (D)	LC	-	1	1b	2		x	x	
Tachymarptis melba	Alpine Swift	LC (S)	LC (B)	-		1c	3	x	x		
Trachyphonus vaillantii	Crested Barbet	LC (D)	LC	-		2	2				
Tricholaema leucomelas	Acacia Pied Barbet	LC (I)	LC	-	1	2	3				
	Black-collared Barbet					1c				x	
Upupa africana	African Hoopoe	-	LC	-	1	1a	3				x
Urocolius indicus	Red-faced Mousebird	LC (U)	LC	-	1	2	3				
9. Cryptic & elusive insect-eaters						#					
Acrocephalus baeticatus	African Reed-warbler	-	LC (B)	-		2	1c			x	x
Acrocephalus gracilirostris	Lesser Swamp-warbler	LC (S)	LC	-		3	3				
Anthus cinnamomeus	African Pipit	LC (S)	LC	-	1	1b	1b		x		
Anthus leucophrys	Plain-backed Pipit	LC (S)	LC	-		2	2				
Anthus pseudosimilis	Kimberley Pipit	-	LC (B, End?)	-		3	3				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Anthus similis	Long-billed Pipit	LC (S)	LC	-		2	2				
Anthus vaalensis	Buffy Pipit	LC (I)	LC	-		3	3				
Calandrella cinerea	Red-capped Lark	LC (I)	LC	-	1	2	2				
Chersomanes albofasciata	Spike-heeled Lark	LC (D)	LC	-	1	1a	1c		x		
Cisticola aridulus	Desert Cisticola	LC (I)	LC	-	1	1a	1a		x		
Cisticola fulvicapilla	Neddicky	LC (S)	LC	-		1c	1c		x		
Cisticola juncidis	Zitting Cisticola	LC (I)	LC	-		2	2				
Cisticola subruficapilla	Grey-backed Cisticola	LC (D)	LC	-		2	2				
Cisticola textrix	Cloud Cisticola	LC (D)	LC (N-End)	-		2	2				
Cisticola tinniens	Le Vaillant's Cisticola	LC (S)	LC	-		2	1c			x	x
Eremomela icteropygialis	Yellow-bellied Eremomela	LC (S)	LC	-	1	2	2				
Eremopterix verticalis	Grey-backed Sparrowlark	LC (S)	LC	-	1	2	2				
Galerida magnirostris	Large-billed Lark	LC (I)	LC (N-End)	-		2	2				
Macronyx capensis	Cape Longclaw	LC (S)	LC	-	1	1a	1a		x		
Malcorus pectoralis	Rufous-eared Warbler	LC (S)	LC	-	1	1b	1a		x		
Mirafa africanoides	Fawn-coloured Lark	LC (S)	LC	-		2	2				
Mirafra africana	Rufous-naped Lark	LC (D)	LC	-		3	3				
Mirafra fasciolata	Eastern Clapper Lark	-	LC	-	1	1c	1c		x		
Mirafra sabota	Sabota Lark	LC (I)	LC	-	1	2	2				
Motacilla aguimp	African Pied Wagtail	LC (S)	LC	-		3	4				
Motacilla capensis	Cape Wagtail	LC (S)	LC	-	1	1b	2			x	x
Phragmacia substriata	Namaqua Warbler	LC (I)	LC (N-End)	-		3	3				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Phylloscopus trochilus	Willow Warbler	LC (D)	LC (NB)	-		3	4				
Prinia flavicans	Black-chested Prinia	LC (S)	LC	-	1	1a	2		x		
Prinia maculosa	Karoo Prinia	LC (D)	LC (N-End)	-		1b	1b	x		x	
Pycnonotus nigricans	African Red-eyed Bulbul	LC (I)	LC	-	1	1b	1b		x		x
Sylvietta rufescens	Long-billed Crombec	LC (S)	LC	-		2	3				
10. Regular insect-eaters						#					
Acridotheres tristis	Common Myna	LC (I)	AL	-		1c	2				x
Anthoscopus minutus	Cape Penduline-tit	LC (S)	LC	-		1c	4		x		
Batis pririt	Pririt Batis	LC (S)	LC	-		2	3				
Bradornis infuscatus	Chat Flycatcher	LC (S)	LC	-	1	2	2				
Cercomela familiaris	Familiar Chat	LC (S)	LC	-	1	1b	1a		x		
Cercomela schlegelii	Karoo Chat	LC (S)	LC	-		3	3				
Cercomela sinuata	Sickle-winged Chat	LC (S)	LC (N-End)	-	1	2	2				
Corvus albus	Pied Crow	LC (S)	LC	-	1	1b	2b		x		
Cossypha caffra	Cape Robin-chat	LC (S)	LC	-	1	1a	3				x
Creatophora cinerea	Wattled Starling	LC (S)	LC	-	1	1c	2		x	x	x
Dicrurus adsimilis	Fork-tailed Drongo	LC (S)	LC	-		3	4				
Nilaus afer	Brubru	LC (S)	LC	-		2	4				
Erythropygia coryphaeus	Karoo Scrub-robin	LC (S)	LC	-	1	2	2				
Erythropygia paena	Kalahari Scrub-robin	LC (S)	LC	-		2	3				
Lamprotornis nitens	Cape Glossy Starling	LC (S)	LC	-	1	1c	2		x		
Laniarius atrococcineus	Crimson-breasted Shrike	LC (I)	LC	-		3	4				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Lanius collaris	Common Fiscal	LC (I)	LC	-	1	1b	1b		x		x
Lanius collurio	Red-backed Shrike	LC (D)	LC (NB)	-		2	2				
Lanius minor	Lesser Grey Shrike	LC (D)	LC (NB)	-		2	2				
Monticola brevipes	Short-toed Rock-thrush	LC (S)	LC	-		3	4				
Muscicapa striata	Spotted Flycatcher	LC (D)	LC (NB)	-		2	3				
Myrmecocichla formicivora	Anteating Chat	LC (S)	LC	-	1	1b	1b		x		
Oenanthe monticola	Mountain Wheatear	LC (S)	LC	-	1	1b	1b	x	x		x
Oenanthe pileata	Capped Wheatear	LC (S)	LC (B)	-	1	1a	1a		x		
Onychognathus nabouroup	Pale-winged Starling	LC (S)	LC	-	1	1c	1c		x		
Parisoma layardi	Layard's Tit-babbler	-	LC (N-End)	-		2	3				
Parisoma subcaeruleum	Chestnut-vented Tit-babbler	-	LC	-		1a	3	x			
Parus cinerascens	Ashy Tit	LC (S)	LC	-		3	4				
Saxicola torquatus	African Stonechat	LC (S)	LC	-		2	2				
Sigelus silens	Fiscal Flycatcher	LC (S)	LC (N-End)	-	1	1a	2				x
Spreo bicolor	Pied Starling	LC (S)	LC (N-End)	-	1	1c	1c		x		
Stenostira scita	Fairy Flycatcher	LC (S)	LC (N-End)	-	1	2	2				
Tchagra australis	Brown-crowned Tchagra	LC (S)	LC	-		3	4				
Telophorus zeylonus	Bokmakierie	LC (S)	LC	-	1	1b	1c		x		
Turdus olivaceus	Olive Thrush	LC (U)	LC	-	1	4	4				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Turdus smithi	Karoo Thrush	-	LC (N-End)	-	1	1a	3				x
11. Oxpeckers & nectar feeders						#					
Nectarinia talatala	White-bellied Sunbird	LC (S)	LC	-		2	2				
Zosterops capensis	Cape White-eye	-	LC (N-End)	-	1	3	3				
Zosterops pallidus	Orange River White-eye	LC (U)	LC	-	1	1a	2			x	x
12. Seed-eaters						#					
Amadina erythrocephala	Red-headed Finch	LC (S)	LC	-		2	2				
Crithagra albogularis	White-throated Canary	LC (S)	LC	-	1	2	2				
Crithagra atrogularis	Black-throated Canary	LC (S)	LC	-	1	2	2				
Crithagra flaviventris	Yellow Canary	LC (S)	LC	-	1	1b	2		x	x	
Emberiza capensis	Cape Bunting	LC (S)	LC	-	1	2	2				
Emberiza impetuani	Lark-like Bunting	LC (S)	LC	-	1	1b	2		x	x	
Emberiza tahapisi	Cinnamon-breasted Bunting	LC (S)	LC	-		1b	3			x	
Estrilda astrild	Common Waxbill	LC (S)	LC	-		2	2				
Estrilda erythronotos	Black-faced Waxbill	LC (S)	LC	-		3	4				
Euplectes afer	Yellow-crowned Bishop	LC (S)	LC	-	1	2	2				
Euplectes orix	Southern Red Bishop	LC (S)	LC	-	1	1b	1b		x	x	
Euplectes progne	Long-tailed Widowbird	LC (S)	LC	-		3	3				
Granatina granatina	Violet-eared Waxbill	LC (S)	LC	-		3	4				
Lagonosticta senegala	Red-billed Firefinch	LC (S)	LC	-		3	3				

CATEGORY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SABAP1&2	STUDY AREA	SITE	ROCKY	OPEN	WETLAND	MAN-MADE
Ortygospiza atricollis	African Quailfinch	LC (S)	LC	-		2	1c		x		
Passer diffusus	Southern Greyheaded Sparrow	LC (S)	LC	-		2	2				
Passer domesticus	House Sparrow	LC (D)	AL	-	1	1a	2				x
Passer melanurus	Cape Sparrow	LC (S)	LC	-	1	1b	1b		x		x
Plocepasser mahali	White-browed Sparrow-weaver	LC (S)	LC	-	1	1b	2		x		x
Ploceus velatus	Southern Masked-weaver	LC (S)	LC	-	1	1b	1b		x	x	
Pytilia melba	Green-winged Pytilia	LC (S)	LC	-		3	4				
Quelea quelea	Red-billed Quelea	LC (S)	LC	-	1	2	2				
Sporopipes squamifrons	Scaly-feathered Finch	LC (S)	LC	-	1	1a	2		x		
Vidua macroura	Pin-tailed Whydah	LC (S)	LC	-		1a	1a		x	x	x

Status: AL = Alien; B = Breeding; CR = Critically Endangered; D = Declining; DD = Data Deficient; EN = Endangered; End = Endemic; EX = Extinct; I = Increasing; LC = Least Concern; NB = Non-breeding; N-End = Near-Endemic; NT = Near Threatened; PS = Protected Species; S = Stable; SCH = Schedule Species; U = Unknown population trend; Vag = Vagrant; VU = Vulnerable

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; a = NSS survey 1; b = NSS survey 2; c = Both NSS surveys

Sources: [1]Newman (2002); [2]ToPS List (2007); [3]IUCN (2013.1); [4]SABAP 1 (2013); [5]SABAP2 (2013)

12.7. List of reptile species for the Study Area

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	STUDY AREA	ROCKY	OPEN	WETLAND	MAN-MADE
	Freshwater side-necked									
PELOMEDUSIDAE	**terrapins**									
Pelomedusa subrufa	Marsh Terrapin	-	2LC	-	2	1b			x	
TESTUDINIDAE	**Tortoises**									
Homopus femoralis	Greater Dwarf Tortoise	-	1LC (End)	-	4	3				
Psammobates oculifer	Serrated Tent Tortoise	-	1LC	-	3	2				
Stigmochelys pardalis	Leopard Tortoise	-	1LC	-	1b	1b		x		
CROCODYLIDAE	**Crocodile**									
GEKKONIDAE	**Geckos**									
Chondrodactylus bibronii	Bibron's Gecko	-	1LC	-	2	1a	x			
Pachydactylus capensis	Cape Gecko	-	2LC	-	2	2				
Pachydactylus mariquensis	Common Banded Gecko	-	1LC (End)	-	4	2				
Ptenopus garrulus garrulus	Common Barking Gecko	-	1LC	-	4	3				
AMPHISBAENIDAE	**Worm lizards**									
Monopeltis capensis	Cape Spade-snouted Worm Lizard	-	1LC	-	3	2				
Zygaspis quadrifrons	Kalahari Dwarf Worm Lizard	-	2LC	-	4	3				
LACERTIDAE	**Typical lizards**									
Nucras holubi	Holub's Sandveld Lizard	-	2LC	-	1b	1b		x		
Nucras intertexta	Spotted Sandveld Lizard	-	2LC	-	3	2				
Pedioplanis lineoocellata lineoocellata	Spotted Sand Lizard	-	2LC	-	1b	1b		x		
Pedioplanis namaquensis	Namaqua Sand Lizard	-	2LC	-	2	2				

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	STUDY AREA	ROCKY	OPEN	WETLAND	MAN-MADE
CORDYLIDAE	**Girdled lizards & relatives**									
Karusasaurus polyzonus	Karoo Girdled Lizard	-	1LC	-	3	1b	x			
GERRHOSAURIDAE	**Plated lizards**									
SCINCIDAE	**Skinks**									
Acontias gracilicauda	Thin-tailed Legless Skink	LC (U)	1LC (End)	-	3	3				
Trachylepis capensis	Cape Skink	-	2LC	-	2	1a				x
Trachylepis occidentalis	Western Three-striped Skink	-	2LC	-	3	3				
Trachylepis punctatissima	Speckled Rock Skink	LC (S)	2LC	-	4	3				
Trachylepis punctulata	Speckled Sand Skink	-	2LC	-	4	3				
Trachylepis spilogaster	Kalahari Tree Skink	-	2LC	-	4	2				
Trachylepis sulcata sulcata	Western Rock Skink	-	2LC	-	4	1a	x			
Trachylepis variegata	Variegated Skink	-	2LC	-	3	3				
VARANIDAE	**Monitors**									
Varanus albigularis albigularis	Southern Rock Monitor	-	2LC	-	4	3				
Varanus niloticus	Nile Monitor	-	2LC	-	1a	2			x	
CHAMAELEONIDAE	**Chameleons**									
Chamaeleo dilepis dilepis	Common Flap-neck Chameleon	LC (S)*	2LC	-	4	3				
AGAMIDAE	**Agamas**									
Agama aculeata aculeata	Western Ground Agama	-	1LC	-	1b	1a		x		
Agama atra	Southern Rock Agama	-	1LC (N-End)	-	4	1a	x			
TYPHLOPIDAE	**Blind snakes**									
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	-	2LC	-	2	2				

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	STUDY AREA	ROCKY	OPEN	WETLAND	MAN-MADE
LEPTOTYPHLOPIDAE	**Thread snakes**									
Leptotyphlops scutifrons	Peter's Thread Snake	-	2LC	-	2	2				
VIPERIDAE	**Adders**									
Bitis arietans arietans	Puff Adder	-	2LC	-	2	2				
LAMPROPHIDAE	**Advanced snakes**									
Aparallactus capensis	Black-headed Centipede-eater	LC (S)	2LC	-	3	3				
Boaedon capensis	Common House Snake	-	2LC	-	2	2				
Lamprophis aurora	Aurora Snake	LC (D)	1LC (End)	-	3	3				
Lycodonomorphus rufulus	Common Water Snake	-	1LC	-	4	3				
Lycophidion capense capense	Cape Wolf Snake	-	2LC	-	2	2				
Psammophis notostictus	Karoo Sand Snake	-	2LC	-	2	2				
Psammophis trinasalis	Fork-marked Sand Snake	-	2LC	-	2	1a		x		
Psammophylax tritaeniatus	Striped Grass Snake	LC (S)	2LC	-	2	1a	x			
Prosymna sundevallii	Sundevall's Shovel-snout	-	1LC	-	2	2				
Pseudaspis cana	Mole Snake	-	2LC	-	2	2				
ELAPIDAE	**Cobras & relatives**									
Elapsoidea sundevallii media	Sundevall's Garter Snake	-	1LC	-	2	2				
Naja nivea	Cape Cobra	-	2LC	-	2	2				
COLUBRIDAE	**Typical snakes**									
Crotaphopeltis hotamboeia	Red-lipped Snake	-	2LC	-	3	2				
Dasypeltis scabra	Rhombic Egg-eater	LC (U)	2LC	-	2	2				
Dispholidus typus	Boomslang	-	2LC	-	4	3				
Telescopus beetzii	Beetz's Tiger Snake	-	1LC	-	2	2				

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	STUDY AREA	ROCKY	OPEN	WETLAND	MAN-MADE

Status: D = Declining; 1LC = Globally Least Concern; 2LC = Regionally Least Concern; S = Stable; U = Unknown population trend; * Status assigned to species

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; a = NSS survey 1; b = NSS survey 2; c = Both NSS surveys

Sources: Branch (1990); ToPS List (2007); IUCN (2013); Bates et al. (2014); ReptileMAP (2015)

12.8. List of frog species for the Study Area

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	STUDY AREA	ROCKY	OPEN	WETLAND	MAN-MADE
BREVICIPITIDAE	**Rain frogs**									
Breviceps adspersus adspersus	Bushveld Rain Frog	LC (U)*	LC	-	1c	1a		x		
BUFONIDAE	**True toads**									
Amietophrynus gutturalis	Guttural Toad	LC (I)	LC	-	2	2			x	
Amietophrynus poweri	Western Olive Toad	LC (U)	LC	-	3	3				
Amietophrynus rangeri	Raucous Toad	LC (D)	LC	-	2	1a			x	
Poyntonophrynus vertebralis	Southern Pygmy Toad	LC (U)	LC	-	2	1a			x	
Vandijkophrynus gariepensis gariepensis	Karoo Toad	LC (U)*	LC	-	3	3				
HYPEROLIIDAE	**Leaf-folding & reed frogs**									
Kassina senegalensis	Bubbling Kassina	LC (U)	LC	-	2	1a			x	
PIPIDAE	**Platannas (African clawed frogs)**									
Xenopus laevis	Common Platanna	LC (I)	LC	-	2	1a			x	
PYXICEPHALIDAE	**River, stream, moss & sand frogs**									
Amietia angolensis	Common River Frog	LC (S)	LC	-	3	1a			x	
Amietia fuscigula	Cape River Frog	LC (S)	LC	-	3	1b			x	
Cacosternum boettgeri	Boettger's Caco	LC (U)	LC	-	2	1a			x	
Pyxicephalus adspersus	Giant Bullfrog	LC (D)	NT	PS	3	2				
Tomopterna cryptotis	Tremolo Sand Frog	LC (S)	LC	-	2	1b			x	
Tomopterna tandyi	Tandy's Sand Frog	LC (U)	LC	-	2	2				

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	STUDY AREA	ROCKY	OPEN	WETLAND	MAN-MADE

Status: CR = Critically Endangered; D = Declining; DD = Data Deficient; EN = Endangered; I = Increasing; LC = Least Concern; NT = Near Threatened; PS = Protected Species; S = Stable; U = Unknown population trend; VU = Vulnerable; * Status assigned to species

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; a = NSS survey 1; b = NSS survey 2; c = Both NSS surveys

Sources: [1]Minter et al. (2004); [2]ToPS List (2007); [3]Du Preez & Carruthers (2009); [4]Measey (2011); [5]FrogMap (2013); [6]IUCN (2013.1)

12.9. List of butterfly species for the Study Area

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
HESPERIDAE	**Skippers & relatives**									
Spialia diomus ferax	Common Sandman	-	1LC	-	2	2				
Spialia mafa mafa	Mafa Sandman	-	1LC	-	3	3				
Spialia nanus	Dwarf Sandman	-	1LC	-	3	3				
PAPILIONIDAE	**Swallowtails & relatives**									
Papilio demodocus demodocus	Citrus Swallowtail	-	1LC	-	3	1a				x
PIERIDAE	**Whites, Yellows & relatives**									
Belenois aurota	Brown-veined White	-	1LC	-	1b	1b		x		
Catopsilia florella	African Migrant	-	1LC	-	3	3				
Colias electo electo	African Clouded Yellow	-	1LC	-	2	2				
Colotis evenina evenina	Orange Tip	-	1LC	-	3	3				
Eurema brigitta brigitta	Broad-bordered Grass Yellow	-	1LC	-	2	2				
Pinacopteryx eriphia eriphia	Zebra White	-	1LC	-	4	1c		x	x	
Pontia helice helice	Common Meadow White	-	1LC	-	2	2				
Teracolus agoye bowkeri	Speckled Sulphur Tip	-	1LC	-	4	3				
NYMPHALIDAE	**Acraeas, Browns, Charaxes & relatives**									
Acraea neobule neobule	Wondering Donkey Acraea	-	1LC	-	4	3				
Byblia ilithyia	Spotted Joker	-	1LC	-	3	3				
Danaus chrysippus orientis	African Monarch	-	1LC	-	3	3				
Hypolimnas misippus	Common Diadem	-	1LC	-	2	2				

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
Junonia hierta cebrene	Yellow Pansy	-	1LC	-	3	3				
Stygionympha irrorata	Karoo Hillside Brown	-	1LC	-	3	3				
Vanessa cardui	Painted Lady	-	1LC	-	2	2				
Ypthima asterope hereroica	African Ringlet	-	1LC	-	1a	2		x		
LYCAENIDAE	**Blues, Coppers, Opals & relatives**									
Aloeides gowani	Gowan's Copper	-	1LC (End)	-	3	3				
Aloeides molomo molomo	Molomo Copper							x		
Azanus jesous	Topaz Babul Blue	-	1LC	-	2	2				
Azanus ubaldus	Velvet-spotted Babul Blue	-	1LC	-	4	2				
Brephidium metophis	Tinktinkie Blue	-	1LC	-	1a	2		x		
Cacyreus marshalli	Common Geranium Bronze	-	1LC	-	4	2				
Chilades trochylus	Grass Jewel	-	1LC	-	4	3				
Cigaritis phanes	Silvery Bar	-	1LC	-	4	2				
Cupidopsis jobates jobates	Tailed Meadow Blue	-	1LC	-	2	2				
Eicochrysops messapus mahallakoaena	Cupreous Blue	-	1LC	-	2	2				
Harpendyreus notoba	Salvia Mountain Blue	-	1LC	-	3	3				
Lampides boeticus	Pea Blue	-	1LC	-	2	2				
Lepidochrysops letsea	Free State Blue	-	1LC	-	1a	1a		x		
Lepidochrysops patricia	Patricia Blue	-	1LC	-	2	2				
Lepidochrysops pirithous pirithous	Common Zebra Blue	-	1LC	-	2	2				
Lepidochrysops plebeia plebeia	Twin-spot Blue	-	1LC	-	4	1a		x		

FAMILY & SPECIES	COMMON NAME	GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
Oraidium barberae	Dwarf Blue	-	1LC	-	2	2				
Stugeta subinfuscata reynoldsi	Dusky Marbled Sapphire	-	1LC	-	4	3				
Tarucus sybaris linearis	Dotted Blue	-	1LC	-	4	3				
Thestor protumnus aridus	Boland Skolly	-	1LC	-	2	2				
Tylopaedia sardonyx sardonyx	King Copper	-	1LC	-	2	2				
Zintha hintza hintza	Hintza Pierrot	-	1LC	-	4	3				
Zizeeria knysna knysna	Sooty Blue	-	1LC	-	4	2				
Zizina otis antanossa	Clover Blue	-	1LC	-	4	3				

Status: 1LC = Globally Least Concern; 2LC = Regionally Least Concern

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; a = NSS survey 1; b = NSS survey 2; c = Both NSS surveys

Sources: Woodhall (2005); ToPS List (2007); Mecenero et al. (2013); IUCN (2015); LepiMAP (2015)

12.10. List of scorpion species for the Study Area

FAMILY & SCIENTIFIC NAME	COMMON NAME	STATUS	LoO		HABITAT			
		S.A. NEM:BA	SITE	AREA	ROCKY	OPEN	WETLAND	MAN-MADE
BUTHIDAE	**Thick-tailed scorpions & relatives**							
Parabuthus granulatus		-	2	2				
Parabuthus mossambicensis		-	3	3				
Uroplectes carinatus		-	2	2				
Uroplectes triangulifer		-	2	2				
SCORPIONIDAE	**Burrowing scorpions & relatives**							
Opistophthalmus carinatus		PS	1c	2		x		
Opistophthalmus pictus		PS	2	2				

Status: PS = Protected Species

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; a = NSS survey 1; b = NSS survey 2; c = Both NSS surveys

Sources: Leeming (2003); ToPS List (2007)

12.11. List of odonata species for the Study Area

FAMILY & SPECIES	COMMON NAME	STATUS GLOBAL IUCN	S.A. RED DATA	S.A. NEM:BA	BIOTIC INDEX	LoO SITE	LoO AREA	HABITAT ROCKY	HABITAT OPEN	HABITAT WETLAND	HABITAT MADE
LESTIDAE	**Spreadwings**										
Lestes plagiatus	Highland Spreadwing	-	-	-	2	3	3				
PROTONEURIDAE	**Threadtails**										
Elattoneura glauca	Common Threadtail	-	-	-	1	4	3				
COENAGRIONIDAE	**Citrils, Sprites & relatives**										
Pseudagrion massaicum	Masai Sprite	-	-	-	2	4	3				
Ischnura senegalensis	Marsh Bluetail	-	-	-	0	2	1b			x	
Africallagma glaucum	Swamp Bluet	-	-	-	1	4	1c			x	
AESHNIDAE	**Hawkers, Emperors & relatives**										
Anax speratus	Orange Emperor	-	-	-	2	4	3				
Anax imperator	Blue Emperor	-	-	-	1	4	1c			x	
GOMPHIDAE	Tails										
Ceratogomphus pictus	Common Thorntail	-	-	-	2	3	3				
LIBELLULIDAE	**Skimmers, Dropwings & relatives**										
Nesciothemis farinosa	Black-tailed Skimmer	-	-	-	1	2	3				
Palpopleura jucunda	Yellow-veined Widow	-	-	-	2	4	3				
Crocothemis erythraea	Broad Scarlet	-	-	-	0	2	1b			x	
Sympetrum fonscolombii	Nomad	-	-	-	0	2	2				
Trithemis arteriosa	Red-veined Dropwing	-	-	-	0	2	2				

Status: None of the listed species have a known threatened or protected status

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; a = NSS survey 1; b = NSS survey 2; c = Both NSS surveys

Sources: Samways (2006); Samways (2008)