Dr B.J.HENNING

BIODIVERSITY MANAGEMENT AND ACTION PLAN (BAP)

BIODIVERSITY MANAGEMENT AND ACTION PLAN FOR THE GLENCORE KROONDAL MINE, NORTH WEST PROVINCE

Prepared for: **Exigo Sustainability (Pty) Ltd**

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Declaration

I, Barend Johannes Henning, declare that -

- I act as the independent specialist;
- I will perform the work relating to the project in an objective manner, even if this results in views and findings that are not favourable to the project proponent;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this project, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998; the Act), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will consider, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the project proponent and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the project; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority or project proponent;
- All the particulars furnished by me in this document are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

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SIGNATURE OF SPECIALIST

LIST OF ABBREVIATIONS

Abbreviation	Description
CARA	Conservation of Agricultural Resources Act
CSIR	Council for Scientific and Industrial Research
CR	Critically Endangered
EN	Endangered
DD	Data Deficient
DAFF	Department of Agriculture, Forestry and Fisheries
DREAD	Department of Rural, Environment and Agricultural Development
DME	Department of Minerals and Energy Affairs
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMPR	Environmental Management Programme Report
ENPAT	Environmental Potential Atlas
GIS	Geographic Information Systems
GPS	Geographical Positioning System
LC	Least Concern
LR	Lower Risk
MAE	Mean Annual Evaporation
MAE	Mean Annual Evaporation
MAMSL	Meter Above Mean Sea Level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
N	Nitrogen
NW	Northwest Province
NEMA	National Environmental Management Act
NFA	National Forest Act
NWA	National Water Act
NWCS	National Wetland Classification System
P	Phosphorus
PQ4	Priority Quaternary Catchment
QDS	Quarter Degree Square
RDL	Red Data List
SANBI	South African National Biodiversity Institute
VU	Vulnerable
WHO	World Health Organisation
WWF	World Wide Fund for Nature

Table of contents

List of Figures

List of Tables

List of Photographs

GLENCORE KROONDAL MINE BIODIVERSITY ACTION PLAN

1 ASSIGNMENT

Dr BJ Henning was appointed by Exigo Sustainability on behalf of Glencore Operations South Africa (Pty) Ltd to conduct a Biodiversity Management and Action Plan for the Glencore Kroondal Mine, Rustenburg Local Municipality, Bojanala Platinum District Municipality, North West Province.

Glencore Kroondal Mine is currently owned by Glencore Alloys, a subsidiary of Glencore Operations South Africa (Pty) Ltd. The mine is situated 10 km east of Rustenburg on portions of the farm Kroondal 304JQ. Historically, mining at Kroondal has consisted of both opencast and underground mining. Currently, all opencast mining has ceased and these areas have been rehabilitated. Only underground mining remains. The mine is operating from various Environmental Management Programme (EMP) reports in addition to the original EMPR compiled in 2003 as follows:

- CHEMC Environmental CC, 2009. Xstrata Alloys' Environmental Management Programme Reports Update.
- Environmental and Energy Services. 2011. EMPR for the Kroondal PGM plant.
- Environmental and Energy Services. 2014. Ventilation shaft EMP addendum Kroondal chrome mine.

The current infrastructure for which the mine is as follows:

- Transport, power and water supply networks;
- Telephone lines;
- An explosives magazine;
- Beneficiation plant (crushing, screening circuit, HMS, spiral and stockpile sections);
- Stockpile areas for product;
- Tailings Storage Facility;
- Waste rock dump;
- Water management infrastructure including storm water management infrastructure, canals, a process dam (capacity 222 kilolitres), an Erickson dam (capacity 1089 kilolitres);
- Silt trap (capacity 800 kilolitres) and the main catchment dam (capacity 20000 kilolitres);
- Monitoring boreholes;
- Water meters;
- Buildings including main office buildings, workshops (engineering, store complex and yard), service department (office, change house and lamp room complex), a salvage yard;
- Garages, toilets, security offices, a lapa, weigh bridge offices and a weighing bridge;
- Fences;

- A diesel storage area (adjacent to the workshop);
- A contractor's hostel;
- A sewage plant;
- Workers housing;
- 2 Inclines shafts and a few ventilation shafts.

The purpose of this investigation is to provide a report that will form the basis for the management of the biodiversity as part of the Environmental Management of the Glencore Kroondal Mine.

2 TERMS OF REFERENCE

2.1 INFORMATION SOURCES

The following information sources were obtained for the study:

1. All relevant topographical maps, aerial photographs and information (previous studies and environmental databases) related to the Glencore Kroondal Mine, Northwest Province.
2. The following documents was used for the compilation of this plan:
    a. Layout plans and maps;
    b. EIA reports;
    c. EMPR's;
    d. Specialist reports, e.g. vegetation, surface and groundwater, etc.
    e. Regional planning reports;
    f. Natural resource database including satellite data as well as GIS data (shapefiles) of the layout plans of the mine;
    g. Relevant legislation regulating all environmental and biodiversity sectors
3. Red data species list from the South African National Biodiversity Institute (SANBI) and the SIBIS website.
4. Requirements regarding the Biodiversity Management and Action Plan as stipulated in the guidelines.
5. On-site data collection.

2.2 THE RATIONALE BEHIND THE BIODIVERSITY MANAGEMENT AND ACTION PLAN CONCEPT

The purpose and rationale for developing and implementing Biodiversity Management and Action Plan (BMP) is to:

- Ensure a consultative, coordinated and proactive approach to stewardship of biodiversity in the context of local and national biodiversity conservation objectives;
- Document the applicable ecosystem and associated biodiversity, assess the biodiversity risks and opportunities and develop biodiversity management objectives and actions;
- To cover five specific areas that have both operational and reputational elements, namely
    - Rehabilitation/restoration actions including biodiversity offsets;
    - Conservation actions/initiatives;
    - Research opportunities;

- Partnerships with conservation / academic / government organisations; and
- Promotion of awareness of biodiversity with employees and external parties.

- Provide a framework for action, monitoring and review and have a consolidated biodiversity document for engagement with internal and external stakeholders.

To ensure the attainment of identified biodiversity objectives and outcomes, the following key principles should be adhered to:

- Targets should be 'SMART' i.e., specific, measurable, attainable, relevant and time-bound;
  - The biodiversity mitigation and enhancement measures of a BMP should be based on defined objectives and measurable targets.
- Biodiversity targets should relate to national or local BMPs where they exist;
  - The principal actions required to reach each of the biodiversity targets should be defined.
- The outcome of these actions should be monitored by creating a monitoring programme adapted to the BMP; management actions should be adapted based on the monitoring results;
- The long-term sustainability of the biodiversity management should be ensured through appropriate partnerships, resourcing and engagement of stakeholders;
- The BMP should be aligned with the site's rehabilitation plan, environmental management system (where applicable) and mining plan; and
- The development and implementation of BMPs should consider various social opportunities and promote sustainable socio-economic activities, such as biodiversity-based microenterprise development.

2.3 SCOPE OF DOCUMENT

This Biodiversity Management and Action Plan report is based on work of previous reports, plans and frameworks with ground truthing where necessary. Based on a review of available literature and data, and specialist analysis of this information, the report presents an overview of the current state of the environment and biodiversity of the Glencore Kroondal Mine and its direct surroundings, noting key constraints, impacts and threats to biodiversity and environmental assets. The report also features potential points of conflict between mining development and sensitive biophysical areas. The information in this report will enable the management team of the Glencore Kroondal Mine to make informed strategic recommendations for biodiversity management.

2.3.1 Purpose of this document

1. The primary aim of this project is to investigate options for enhancing and / or maintaining biodiversity to mitigate the impact of the mining activities with the overall objective of

preventing further loss of biodiversity. The end product would be a tool for promoting and lobbying for the recognition of the importance of species habitat and habitat conservation. Options available to maintain the current level of biodiversity include:

a. Protection of native vegetation restored elsewhere in return for unavoidable clearing;
b. Minimisation of habitat fragmentation;
c. Minimisation of any threats to the native fauna and flora and their habitats during the constructional and operational phases of the mining development;
d. Conservation orientated management of peripheral land; and
e. Rehabilitation to establish plant communities that will provide future habitat values.

2. To produce a clear and agreed species and habitat priorities for conservation actions. This includes the following:
    a. Determine the potential ecological impacts the plant and mining activities will have on the biodiversity on a species and habitat level;
    b. Protection and enhancement of vegetation / habitats of high conservation value;
    c. The retention of a substantial amount of native vegetation / habitat of adequate size and configuration to promote the conservation of the existing flora and fauna communities;
    d. The retention and / or creation of vegetation links, wildlife corridors and vegetation buffers wherever possible, subject to the appropriate bush fire risk management; and
    e. The protection of water quality in the locality so as not to threaten native aquatic fauna and flora that rely on the watercourse for survival.
3. Ensure a consultative, coordinated and proactive approach to stewardship of biodiversity in the context of local and national biodiversity conservation objectives.
4. Document the applicable ecosystem and associated biodiversity, assess the biodiversity risks and opportunities and develop biodiversity management objectives and actions that have a clear business case, and provide recommendations on the ecological mitigation measures to be implemented by the plant and the way forward.
5. To produce a mechanism to monitor success or failure.
6. Within the above objectives to cover five specific areas that have both operational and reputational elements, namely:
    a. Rehabilitation/restoration actions including biodiversity offsets;
    b. Conservation actions/initiatives;
    c. Biodiversity Conservation research opportunities;
    d. Partnerships with conservation / academic / government organisations; and

e. Promotion of awareness of biodiversity with employees and external parties.

Provide a framework for action, monitoring and review and have a consolidated biodiversity document for engagement with internal and external stakeholders.

2.3.2 APPROACH & METHODOLOGY

This section reviews the approach adopted and the methodology used in the preparation of Glencore Kroondal Mine Biodiversity Management and Action Plan (BAP). A BAP is a plan to conserve or enhance biodiversity, more specifically a set of future actions that will lead to the conservation or enhancement of biodiversity. The approach to developing a BAP is shown diagrammatically in Figure 1. The approach firstly involved reviewing the biodiversity values known for the project area. The process to develop a BAP starts with a qualitative assessment of the 'perceived biodiversity value' of land under company charge (Figure 2), which is undertaken at a broad level. Based on this background information, biodiversity management units (BMU's) were developed and defined by such parameters including but not limited to mining lease boundaries, known environmentally sensitive areas, land use and cultural values.

BMU's developed for this project encompassed areas of similar management issues and/or activities. BMU's were profiled using online biodiversity conservation databases and available baseline information to describe their key values and management issues. This information was used to qualitatively assess the biodiversity value of the BMU's in line with the Anglo-American BAP Guideline. The management issues associated with each BMU were listed as high-level activities. From this assessment a business case for biodiversity management at Glencore Kroondal Mine was developed.

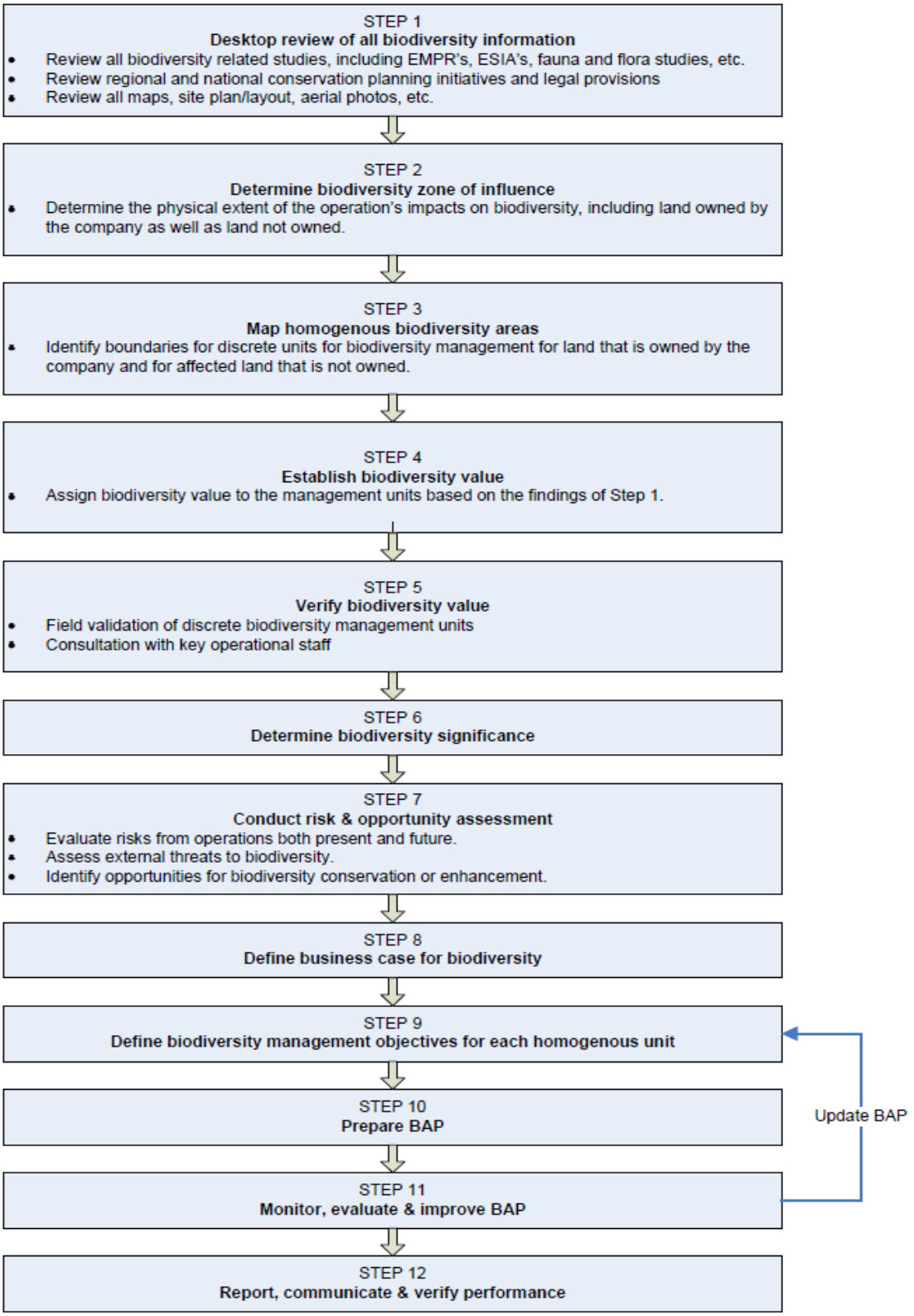


Figure 1: Approach adopted for GLENCORE KROONDAL MINE BIODIVERSITY ACTION PLAN.

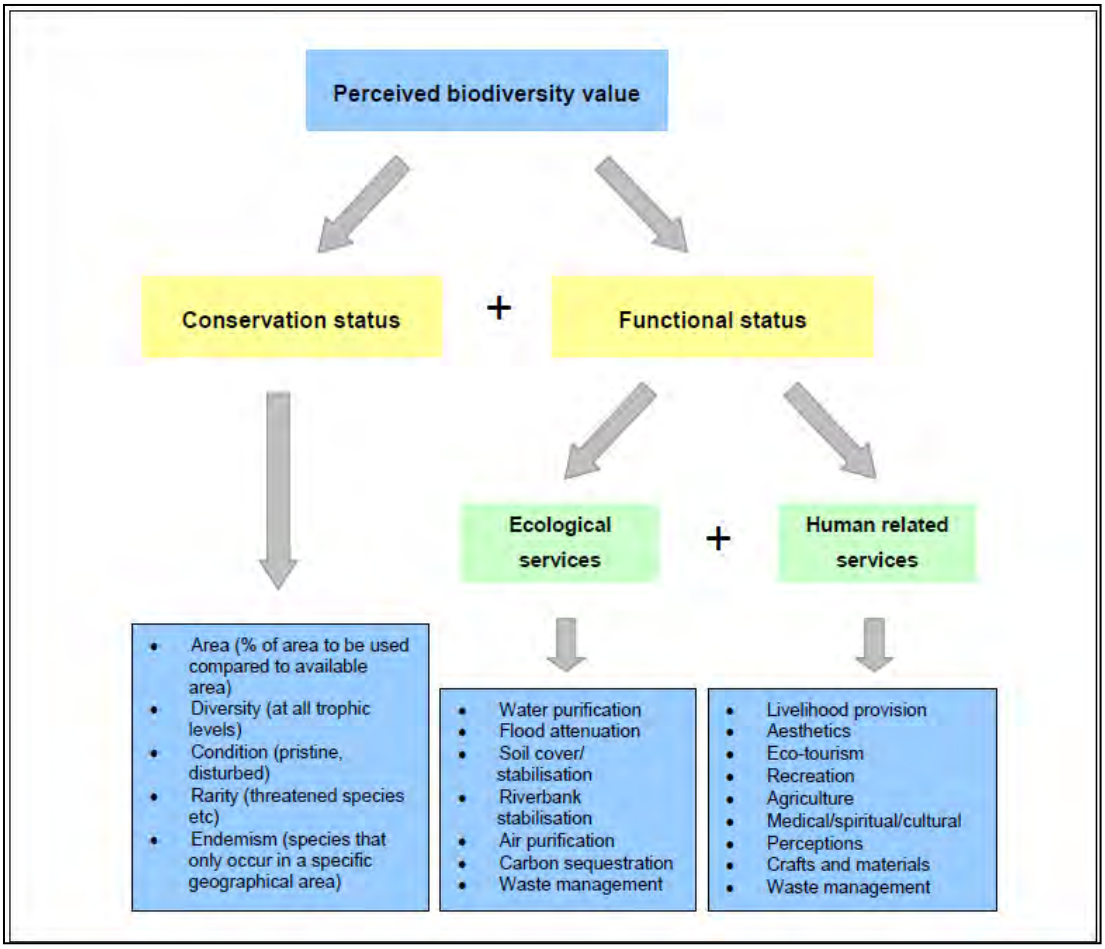


Figure 2: Calculating perceived value of biodiversity as per the Anglo American BAP guideline.

3 FRAMEWORKS FOR BIODIVERSITY

3.1 GLOBAL AND INTERNATIONAL FRAMEWORKS

South Africa has signed and ratified many international conventions, treaties and protocols, thereby committing to sustainable development and international co-operation on global matters relating to the environment, including, for example, wetlands, greenhouse gases, biodiversity, waste disposal and desertification. South Africa is in the process of integrating the commitments it has made with existing legislation, as well as into policies, plans and programmes that are under development. The conventions that are most relevant to biodiversity include:

1. **The Convention on Biological Diversity (CBD), 1993** signed by South Africa in 1995 provides broad principles for the conservation of biodiversity, sustainable use of its components and fair and equitable sharing of benefits arising from genetic resources. The CBD is being implemented through several national policies and laws, including the National Biodiversity Strategy and Action Plan 2005 (NBSAP), the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004; NEMBA) and the Protected Areas Act, 2003 (Act No. 57 of 2003 as amended 2005).

2. **Cartagena Protocol on Biosafety, 2000** ratified by South Africa in 2003, is a supplementary agreement to the CBD. The Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. This protocol will be implemented through the Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997), which is currently under review, to incorporate the protocol's requirements.

3. **Bonn Convention on conservation of migratory species of wild animals, 1979**, acceded to by South Africa in 1991. This convention was developed to provide for the management and conservation of animals that migrate across national borders. This convention pertains strongly to South Africa, as it is a terminus for many Palaearctic and Antarctic migrating species (birds and whales).

4. **Cites Convention on international trade in endangered species of wild fauna and flora, 1973**, ratified by South Africa 1975. Cites was developed to control international trade in wildlife and wildlife products to prevent over exploitation and extinction of species. This convention is implemented through the NEMBA.

5. **The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971**, signed by South Africa in 1975. The Ramsar convention sets out the principles and guidance for wetland conservation and their wise use. The convention recognizes wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities. Each contracting body to the convention must designate at least one wetland for inclusion in the list of Wetlands of International Importance. Ramsar status gives that wetland the prestige of international recognition and obliges the government to take all possible measures to ensure the ecological status of the

site. As of 23 April 2007, 1,669 sites comprising 151,071,270 ha were included as Ramsar sites. South Africa has 17 sites designated to the List of Wetlands of International Importance.

6. **Basel Convention, 1992**, ratified by South Africa in 1994. The Basel Convention is a comprehensive global environmental agreement on hazardous and other wastes. Its aim is to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other waste.

7. **United Nations Convention to Combat Desertification (UNCCD), 1994**, ratified by South Africa in 1997. Signatories to the UNCCD commit to prepare and implement action programmes to prevent land degradation. The objective is to combat desertification and mitigate the effects of drought, particularly in countries experiencing severe droughts and desertification through effective action at all levels, supported by international cooperation and partnerships. South Africa is addressing the commitments of the UNCCD through a national action programme.

8. **World Heritage Convention concerning the protection of the world cultural and natural heritage, 1972**, ratified by South Africa in 1997, was developed to establish an effective system of collective protection of natural and cultural heritage sites that are deemed to have universal importance. South Africa has seven such sites. Six of these are natural heritage sites with high biodiversity value. This convention is implemented through the World Heritage Convention Act, 1999 (Act No. 49 of 1999).

9. **Agenda 21, Chapter 15. Conservation of Biological Diversity, 1992:** The objectives and actions presented in this chapter of Agenda 21 are intended to improve the conservation of biological diversity and the sustainable use of biological resources, as well as to support the Convention on Biological Diversity.

3.2 NATIONAL FRAMEWORK

Environmental issues covered in the international conventions, treaties, protocols and other agreements signed by South Africa are largely regulated by statute and are, therefore, binding to all individuals and activities, including mining. Administration and enforcement of environmental laws in South Africa is fragmented with responsibility for the environment being divided between many different government departments (DEA, DWS, DLA, DMR) and the various levels of government (National, Provincial and Local level). This has resulted in problems of interpretation and enforcement. The National Environmental Management Act, 1998 (Act No. 107 of 1998), the cornerstone of environmental law, was established to address these problems by coordinating environmental functions exercised by various organs of state and integrating environmental management in South Africa. A schematic of the hierarchy of the main biodiversity legislation and supporting policies and programs is included as Figure 3.

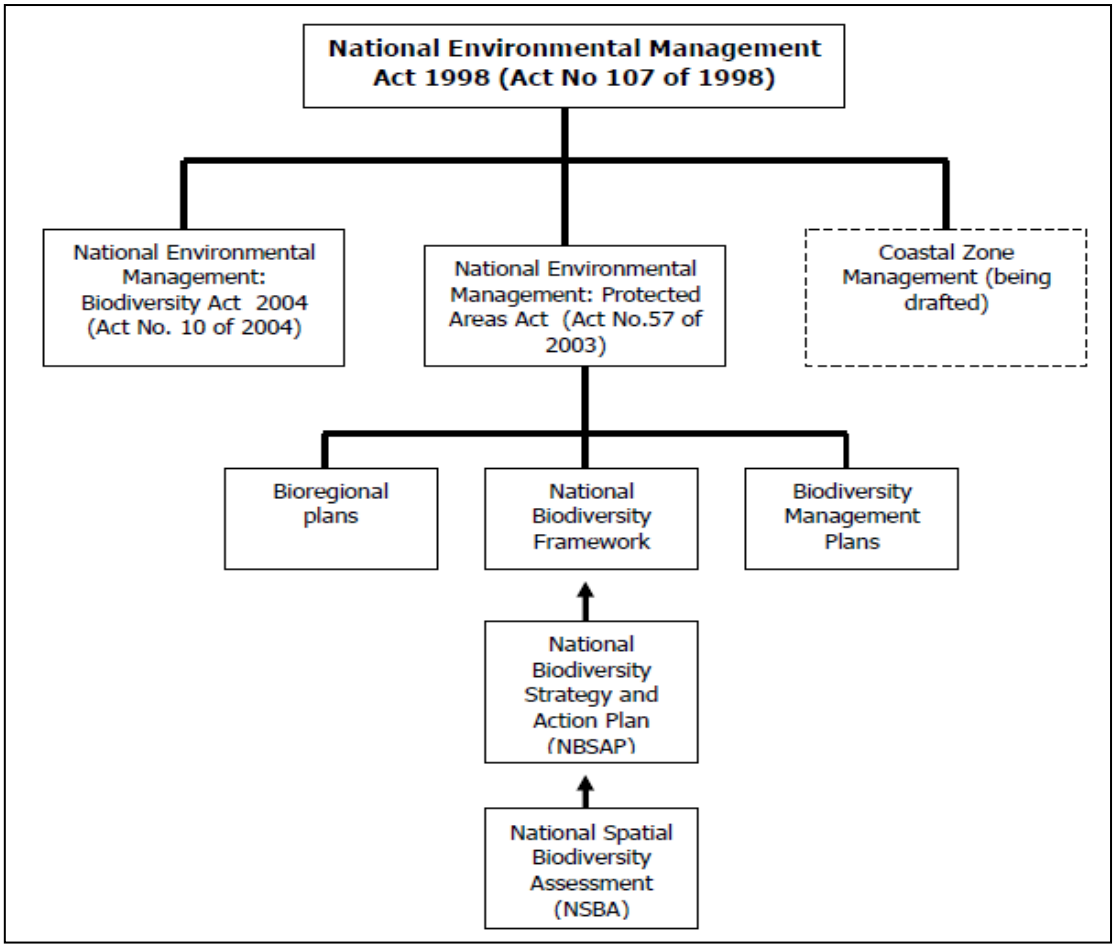


Figure 3: Hierarchy of biodiversity legislation, policies and programmes.

1. National Environmental Management Biodiversity Act (Act No.10 of 2004).

This act addresses the following:

- Biodiversity Planning and monitoring;
- The management of large animals, including predators;
- Protection of threatened or protected ecosystems;
- Protection of threatened or protected species;
- Trade in listed threatened or protected species;
- The control of alien species, invasive species and genetically modified organisms; and
- Bioprospecting.

Although the development of a Biodiversity Action Plan (BAP) is not a legal requirement (refer to Section 43 of the National Environmental Management Biodiversity Act, Act No.10 of 2004), such a plan will be developed to ensure the integrity of the rich biodiversity of the project area and its surroundings. Section 54 of the National Environmental Management Biodiversity Act, Act No.10 of 2004, specifies the general content of a BAP. Based on this document, the following points of the BAP's contents are highlighted:

a. Setting of biodiversity objectives

The baseline assessment will enable the setting of biodiversity objectives and targets. These objectives and targets will be determined for each individual site, and where appropriate, include milestones to achieve the biodiversity targets for each site. Objectives and targets will be aligned with business objectives, priorities and resources.

b. Biodiversity impact assessment

A biodiversity impact assessment will be undertaken. This impact assessment will identify impacts and threats to the existing biodiversity of the site, along with threats to the proposed management of biodiversity. This impact assessment will feed directly into the biodiversity evaluation.

c. Biodiversity evaluation

An evaluation of the information obtained during the steps will be undertaken to develop a biodiversity significance plan / biodiversity balance sheet. This evaluation will consider the perceived biodiversity of the site, along with the actual (measured) biodiversity of each site. Biodiversity value is based on two components:

- Conservation status; and
- Functional status - ecological services and human related services.

The biodiversity evaluation and biodiversity significance plan / biodiversity balance sheet will highlight areas of biodiversity wealth and biodiversity weakness, from which the BAP may be developed. Threats to the biodiversity will be identified and assessed.

2. **Constitution of South Africa:** The Constitution of South Africa (Act No. 108 of 1996) creates a duty on the State and citizens to protect the environment. Section 24 of the constitution provides that everyone has the right to have the environment protected through the prevention of pollution and ecological degradation, to promote conservation, and to secure ecologically sustainable development and the use of natural resources.

3. **Mineral and Petroleum Resources Development Act (Act 28 of 2002).** The Mineral and Petroleum Resources Development Act (MPRDA) regulates the prospecting for and optimal exploitation, processing and utilization of minerals, provides for safety and health in the mining industry and controls the rehabilitation of land disturbed by exploration and mining. The principles set out in section 2 of the National Environmental Management Act (Act 107 of 1998) (NEMA) apply to all prospecting and mining operations and serve as guidelines for the interpretation, administration and implementation of the environmental requirements of the MPRDA. Any prospecting of mining operation must be conducted in accordance with generally accepted principles of sustainable development by integrating social, economic and environmental factors into the planning and implementation of prospecting and mining projects in order to ensure that exploitation of mineral resources serves present and future generations,

Integrated Environmental Management and Responsibility to Remedy. The holder of any reconnaissance, prospecting or mining permit or right:

a. Must always give effect to the general objectives of the integrated environmental management laid down in Chapter 5 of NEMA;

b. Must consider, investigate, assess and communicate the impact of the mining / prospecting on the environment as contemplated in section 24 (7) of NEMA;

c. Must manage all environmental impacts in accordance with their Environmental Management Plan (EMP); and

d. Is responsible for any environmental damage, pollution or ecological degradation as a result of prospecting / mining operations.

4. **Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management (IFC, 2012):** Performance Standard 6 of the International Finance Corporation (2012) recognizes that protecting and conserving biodiversity—the variety of life in all its forms, including genetic, species and ecosystem diversity—and its ability to change and evolve is fundamental to sustainable development. The components of biodiversity, as defined in the Convention on Biological Diversity, include ecosystems and habitats, species and communities, and genes and genomes, all of which have social, economic, cultural and scientific importance. This Performance Standard reflects the objectives of the Convention on Biological Diversity to conserve biological diversity and promote use of renewable natural resources in a sustainable manner. This Performance Standard addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as sustainably manage renewable natural resources.

a. Objectives:

- To protect and conserve biodiversity; and
- To promote the sustainable management and use of natural resources through the adoption of practices that integrates conservation needs and development priorities.

b. Requirements

Protection and Conservation of Biodiversity

To avoid or minimize adverse impacts to biodiversity in the project's area of influence, the client will assess the significance of project impacts on all levels of biodiversity as an integral part of the Social and Environmental Assessment process. The Assessment will consider the differing values attached to biodiversity by specific stakeholders, as well as identify impacts on ecosystem services. The Assessment will focus on the major threats to biodiversity, which include habitat destruction and invasive alien species.

Habitat

Habitat destruction is recognized as the major threat to the maintenance of biodiversity. Habitats can be divided into natural habitats (which are land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions) and modified habitats (where there has been apparent alteration of the natural habitat, often with the introduction of alien species of plants and animals, such as agricultural areas). Both types of habitat can support important biodiversity at all levels, including endemic or threatened species.

Modified Habitat

In areas of modified habitat, the client will exercise care to minimize any conversion or degradation of such habitat, and will, depending on the nature and scale of the project, identify opportunities to enhance habitat and protect and conserve biodiversity as part of their operations.

Natural Habitat

In areas of natural habitat, the client will not significantly convert or degrade such habitat, unless the following conditions are met:

- There are no technically and financially feasible alternatives;
- The overall benefits of the project outweigh the costs, including those to the environment and biodiversity;
- Any conversion or degradation is appropriately mitigated; and
- Mitigation measures will be designed to achieve no net loss of biodiversity where feasible, and may include a combination of actions, such as:
    - Post-operation restoration of habitats;
    - Offset of losses through the creation of ecologically comparable area(s) that is managed for biodiversity; and
    - Compensation to direct users of biodiversity.

Critical Habitat

Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local

communities.

5. **Conservation of Agricultural Resources Act (Act No. 43 of 1983).** Control of the utilization and protection of wetlands, soil conservation and all matters relating thereto; control and prevention of veld fires, control of weeds and invader plants, the prevention of water pollution resulting from farming practices and losses in biodiversity. The act also deals with methods of control in section 15E that stipulates the following:

   (1): Where category 1a, 1b, 2 or 3 plants occur contrary to the provisions of these regulations, a land user shall control such plants by means of one or more of the following methods of control as is appropriate for the species concerned and the ecosystem in which it occurs:

   (a) Uprooting, felling, cutting or burning;

   (b) Treatment with a weed killer (herbicide or pesticide) that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;

   (c) Biological control carried out in accordance with the stipulations of the Agricultural Pests Act, 1983 (Act No. 36 of 1983), the Environment Conservation Act, 1989 (Act No. 73 of 1989) and any other applicable legislation;

   (d) Any other method of treatment recognised by the executive officer that has as its object the control of the plants concerned, subject to the provisions of sub-regulation (4);

   (e) A combination of one or more of the methods prescribed in paragraphs (a), (b), (c), and (d), save that biological control reserves and areas where biological control agents are effective shall not be disturbed by other control methods to the extent that the agents are destroyed or become ineffective.

6. **The National Environmental Management Act (NEMA) (Act No. 107 of 1998).** This Act embraces all three fields of environmental concern namely: resource conservation and exploitation; pollution control and waste management; and land-use planning and development. The environmental management principles include the duty of care for wetlands and special attention is given to management and planning procedures.
7. **National Environmental Management Biodiversity Act (NEMBA: Act 10 0f 2004):** The following aspects of the NEMBA (2004) are important to consider in the compilation of an ecological and BAP report. It:

   - Lists ecosystems that are threatened or in need of national protection;
   - Links to Integrated Environmental Management process;
   - Must be considered in EMP and IDPs; and

- The Minister may make regulations to reduce the threats to listed ecosystems

8. **The National Water Act (Act No. 36 of 1998).** This act is unique and ground breaking as it refers to 'Ecological Reserves'. It includes the protection of aquatic and associated ecosystems and biodiversity and the regulation of water use and activities in wetlands, rivers and lakes.

9. **The National Environmental Management: Protected Areas Act 57 of 2003:** This act provides for the protection and conservation of ecologically viable areas that are representative of South Africa's biological diversity, its natural landscapes and seascapes, and the management of these. The Act envisages a national register of protected areas, with a simplified classification system of special nature reserves, national parks, nature reserves and protected environments. It also introduces the concept of biological-diversity protection and ecosystem management. Biodiversity, conservation and eco system management are noted as important aims in policy and legislation that govern marine and coastal resources, fresh water and natural forests. The Act also proposes a new system of protected areas, linking various kinds of protected environments to replace the existing fragmented system. In addition, the Act enables the Minister of Environmental Affairs to acquire private land by purchasing land rights for the creation of protected areas. Based on experience with biosphere reserves and informed by the new bio regional approach to conservation (linking the protected-area network along mountains, rivers, wetlands, the coastline and other areas of natural vegetation), the Act will result in an interlocking system of protected areas that explicitly encourages the inclusion of private land. It recognizes that people are the custodians of the land, that they need to be involved in the management of the protected land and that they should benefit from it. The Act caters for concurrent competence in the management of protected land. For example, an area with national-park status can now be managed by another agency, such as a provincial parks authority. Steps have been taken to ensure that standards are upheld.

10. **National Forests Act (Act 84 of 1998).**

    The National Forests Act controls forestry in South Africa. The regulations of the Act include the protection of listed indigenous trees, as well as areas listed as natural forest types.

11. **Northwest Nature Conservation Ordinance (No. 12 of 1983)**

This Act deals with the following:

- To provide for the sustainable utilisation and protection of biodiversity within Northwest Province;
- To provide for professional hunting;
- To provide for the preservation of caves and cave formations;
- To provide for the establishment of zoos and similar institutions;
- To provide for the appointment of nature conservators;
- To provide for the issuing of permits and other authorisations;

- To provide for offences and penalties for contravention of the ordinance;
- To implement the provisions of the Bill; and to provide for matters connected therewith.

12. IUCN Integrated Biodiversity Management System (IBMS)

a. Background

Biodiversity is a vital part of every aspect of human well-being; most of the goods and services that we depend on, from oxygen, food and fresh water to medicine and shelter, derive from nature. Yet, human activities are causing an unprecedented rate of biodiversity loss that, if it continues, will pose a serious threat to future societies. As a key part of society, business has an important role to play which provides both the opportunity and the responsibility to help halt biodiversity loss.

Due to the nature of their business, mining companies can have major impacts on landscapes and biodiversity. This is also applicable to mines such as the Glencore Kroondal Mine. These impacts can contribute to habitat degradation, fragmentation and loss and pose a significant risk to business operations. However, when managed adequately, biodiversity can also present an important opportunity, allowing companies to demonstrate to stakeholders that they are responsible stewards of biodiversity thereby improving the ability to secure permits and maintaining a social license to operate among communities surrounding their operations. By adopting an Integrated Biodiversity Management System (IBMS), mining companies such as the Glencore Kroondal Mine can minimise their biodiversity risks and maximise their opportunities to contribute from good biodiversity and ecosystem management practices. An IBMS involves the development of a company-level biodiversity policy with targets, early identification of biodiversity risks and opportunities and a description of differentiated biodiversity management responses that can be implemented at the site level. To increase its chances of success, an IBMS should be integrated within a company's existing processes, from corporate decision making to all stages of field operations.

At the core of an IBMS is the development and adoption of an overarching policy framework for biodiversity management. This framework should be ambitious, but also realistic, and signal the company's intention to safeguard biodiversity within its sphere of influence. The policy framework can begin by recognising the global importance of biodiversity and the company's overall dependence and impact upon natural resources and include specific commitments to responsibly manage biodiversity on and around a company's operations as well as long-term aspirational biodiversity goals.

A risk-based approach should be used to integrate biodiversity into all stages of operations, from planning for extraction through to site closure, with differentiated biodiversity management options based on the value of and expected impacts to biodiversity at each stage. This approach will ensure that the level of management is commensurate with the

level of risk. In the planning stage, companies should prioritise avoidance and minimisation of impacts, to ensure that risks to high-value biodiversity are addressed as early as possible in the lifetime of a project. This early planning allows companies to identify red flag issues related to biodiversity and opt out of an investment if the biodiversity risks appear to outweigh the opportunities. At the operational stage, companies should continue to minimise impacts and capture opportunities for biodiversity enhancement through targeted biodiversity actions.

In preparation for site closure, a company should rehabilitate a site for its final use, in line with biodiversity and other considerations. By investing in the gathering of up-to-date, robust and accurate biodiversity data and putting in place comprehensive biodiversity monitoring systems; a company can ensure that appropriate biodiversity management measures are taken. The collection of site-level biodiversity information ensures that sites are classified correctly with regards to their biodiversity importance category and that the potential impacts of the operations on biodiversity are accurately assessed. Good data will also further support biodiversity management activities and lead to informed decision making. Data collected as part of monitoring activities will then provide assurance that the chosen activities are having the desired effect on biodiversity and can also feed back into management processes for optimal outcomes.

b. Guideline

The effective implementation of an Integrated Biodiversity Management System (IBMS) requires appropriate institutional arrangements, with the development of any new structures and processes building on the company's existing systems. Investment in internal capacity and external partnerships will also be cornerstones of success for an IBMS.

IUCN, International Union for Conservation of Nature, created the guide for an IBMS to help companies to reduce risks and enhance opportunities for biodiversity and ecosystems in their operations. The IBMS guide was developed over the last seven years through a partnership with Holcim, a leading supplier of cement and aggregates. IUCN's work with Holcim has enabled a better understanding of how a company in the sector operates and the challenges it encounters, as well as the opportunities that can arise from good biodiversity management. Through site visits, discussions with operational staff and other stakeholders, a global system for biodiversity management that is applicable to the entire sector was developed and piloted.

The IBMS is part of a series addressing the risks and opportunities for biodiversity and ecosystems that result from mining of fluorspar. While this guide is aimed at businesses and focuses on biodiversity management, the Biodiversity Indicator and Reporting System looks at monitoring and reporting, and a guide on regulatory tools is addressed to policy makers, to support them in creating an enabling policy environment for improved biodiversity management in the cement and aggregates sector. The series emphasises the distinct but

complementary roles that governments and businesses must play in the conservation and sustainable use of nature and natural resources.

4 STUDY AREA LOCATION AND MINING PROCESS

4.1 LOCATION

Kroondal Chrome Mine is currently owned by Glencore Alloys, a subsidiary of Glencore South Africa Operations (Pty) Ltd. The mine is situated 10 km east of Rustenburg on portions of the farm Kroondal 304JQ (Figure 5). Historically, mining at Kroondal has consisted of both opencast and underground mining. Currently, all opencast mining has ceased, and these areas have been rehabilitated. Only underground mining remains. The mine is operating from an approved 2003 Environmental Management Programme (EMP) report. The mining rights were originally issued to Xstrata SA (Pty) Ltd, but Xstrata merged with Glencore and the company's name therefore changed to Glencore (Pty) Ltd.

The Water Use Licence (WUL) for the mine was awarded to Glencore (Pty) Ltd on 11 January 2015. The WUL, No 03/A22H/ACFGIJ/2743 (File No: 27/2/2/A822/9/8).

The ownership of the properties taken up in the IWUL is depicted in Table 1. Glencore holds the property rights and all the mineral rights over these properties.

Table 1: Water uses overview for the properties taken up in the IWUL for the Glencore Kroondal Mine.

Water use	Farm and Portion	Surface Owner
Section 21 (a)	Portion 175 of the farm Kroondal 304 JQ	Glencore Operations South Africa (Pty} Ltd
Section 21 (c) and (i)	Portion 175 of the farm Kroondal 304 JQ	Glencore Operations South Africa (Pty) Ltd
Section 21 (f)	Portion 162 of the farm Kroondal 304 JQ	Glencore Operations South Africa (Pty) Ltd
Section 21 (g)	Portion 162 of the farm Kroondal 304 JQ	Glencore Operations South Africa (Pty) Ltd
Section 21 (j)	Portion 175 of the farm Kroondal 304 JQ	Glencore Operations South Africa (Pty} Ltd

4.2 CONTEXTUALIZATION OF THE MINE

4.3 Description of the Activity

The mine is extracting the chromite seams present in the lower part of the Rustenburg Layered Suite (No. 6 seam).

Current infrastructure at the mine includes the following (Figure 6):

- Beneficiation plant (crushing, screening circuit, HMS, spiral and stockpile sections)
- Two Inclines shafts and a few ventilation shafts
- Tailings Disposal Facility (TDF),
- Waste Rock Dump (WRD),

- Product stockpile areas,
- Water Management Infrastructure (Pollution Control Dam, also termed the Catchment Dam, Silt Trap, berms and canals, Erickson Dams, Process Dam etc.),
- Explosives magazine,
- Offices,
- Other supporting infrastructures such as diesel storage area, haul roads, powerlines, water supply pipelines, workshops, salvage yard, weigh bridge, sewage plant, lamp room and change houses etc.)

4.4 Kroondal Mine Residue Expansion Project

The residu expansion project for the Glencore Kroondal is resented in Figure 7 and includes the infrastructures associated with the proposed Co-Disposal Facility (Tailings and Waste Rock) (CDF), Pollution Control Dam (PCD), topsoil stockpiles, silt trap, conyeor and access road, and the process water tank and desilting facility. Waste.

4.5 Key activity related processes and products

4.5.1 Mining Method

The mining method employed at Kroondal mine is underground mining (bord-and-pillar). The chromite seams present in the lower part of the Rustenburg Layered Suite are grouped into the upper, middle and lower groups of which the lower group (No. 6 seam) is being mined.

4.6 Activity life description

The Glencore Kroondal mining operations remaining life of mine (LOM) is documented as approximately 30 years.

4.7 Activity Infrastructure Description

4.7.1 Water use

The bulk water supply to the mine for domestic use is supplied by Rand Water Board while underground mining operations and beneficiation processes make use of underground fissure water (dewatering of underground areas) and recycled process water. Potable water from the Rand Water Board is also used in the plant if no other water is available. All the water used in the plant is recycled and is therefore utilised in a closed water system (MSA, 2010).

4.7.2 Sanitation

The Kroondal Mine operates an on-site Prentec Sewage Plant.

4.7.3 Roads, Railways and Power Supply

The property is bounded on the north side by a tar road from Kroondal to the Waterval road. The

access road is a dirt road which ends at Lanxess Chrome mine to the east of the property. Eskom is the Electrical Supply Authority for all mining activities.

4.8 Waste Management Facilities

Waste is collected around the site and then transported to the Kroondal Salvage yard where it is further sorted into bins, before being disposed of. The waste management operating procedure provides for the salvage yard to be operated according to the Waste Management Licence.

The salvage yard stores general and hazardous waste before it is collected by external contractors for recycling or disposal purposes. The salvage yard is managed by the waste contractors. Waste is transported to these salvage yard where the waste is sorted into various colour coded and marked bins (e.g., plastic, paper, general, hazardous).

The waste at the salvage yard site is separated into 8 categories according to the Glencore Waste procedure document and is separate in the following manner:

1. Plastic;
2. Scrap Metal;
3. Domestic waste (including food wastes);
4. Hazardous waste;
5. Recyclable paper;
6. Old PPE;
7. Cans and tins;
8. Medical waste.

4.8.1 General Waste Storage

Waste is collected and transported to the mine salvage yard where it is sorted into bins. General waste is disposed of at a municipal waste disposal site by a licensed waste contractor.

4.8.2 Hazardous Waste Storage

Waste is sorted on site at the Kroondal Salvage Yard (Photograph 1). Hazardous waste is removed from site by a licensed contractor and disposed of at a licensed facility.

Photograph 1: Separation bins in Kroondal Salvage yard

4.8.3 Oil Storage

Oil filters are drained in the oil filter drainer and disposed of in hazardous waste drums.

Contaminated soil is disposed of as hazardous waste and placed in hazardous waste drums until collected by an external contractor.

Hydrocarbon contaminated cloths is disposed of in hazardous waste drums until collection by an external contractor.

The hazardous waste drums are emptied in the hazardous waste skip when full and collected and disposed of by an external contractor.

All used oil drained form the oil sumps are sold to an external contractor for recycling purposes.

4.8.4 Sewerage Treatment Plants

Kroondal has a Prentec plant which treats raw sewage from the offices and plant and caters for additional sewage from the contractor hostels next to Kroondal to ensure no underground water contamination due to uncontrolled sewage management. The sludge is placed on drying beds and then removed to the municipal facility. The treated water is returned to the process water culvert to be re-used.

4.8.5 Incineration of waste on site

No incineration takes place on the sites.

4.8.6 Explosive boxes

Explosives boxes and used accessories are sent back to the supplier to dispose of.

4.9 Organisational structure of activity or company

- The Environmental superintendent under the mine managers, as well as the waste contractors, should ensure compliance with and implementation of the water and waste management procedures
- The management responsibilities are set out as follows:
  - The Environmental Superintendent is responsible for communicating the Environmental Management System to all employees and contractors,
  - The Environmental Superintendent is responsible to drive the Environmental Management System, to ensure that legal compliances are met in their respective areas of responsibility.

4.10 Business and corporate policies related to the environment

According to Glencore' website (http://www.glencore.com/sustainability/our-sustainability-strategy/) in 2015, Glencore revised their Group sustainability strategy, considering there aims against four core pillars (Figure 4):

- Health
- Safety
- Environment
- Community & human rights

The revised strategy has clearly defined imperatives, objectives, priority areas and targets. It will enable Glencore to meet legislative requirements, manage the catastrophic hazards associated with business, and maintain societal licence to operate.

Figure 4: Glencore Group sustainability strategy

4.10.1 Safety, Health, Environment, Risk and Quality Policy

A safety, health, environment, risk and quality policy exist for the operation through the broader policies of Glencore. These policies are elaborated on in the induction document of Glencore and are relevant for all their South African mining operations. In this policy it is highlighted that the mines adhere and should adhere to the applicable legislation and if possible, should try to improve their management to operate at better standards than set out in these legislations.

4.10.2 Environmental Management System and Operational Procedures

At this point in time, there is a Health, Safety and Environmental policy (HSEC) in place as well as an induction document. These documents describe the environmental policy that explains how the organisation is going to prevent pollution and its commitment to do so, as well as a statement regarding the compliance with legal requirements and its commitment to continual improvement towards these requirements and pollution prevention.

There are waste management plans in place which focus on the operation and maintenance of the infrastructure on site, as well as the identification of waste disposal sites (e.g. which containers are identified for general, hazardous and other types of waste). These can mainly be described as operational management plans, instead of a policy or strategic document. The policies and strategies with regards to water and waste management and environmental management at the mine in general are set out in the induction document of the mine.

4.10.3 Environmental Management Resources and Competence

Both the HSEC manager, as well as the environmental superintendent at the Kroondal operation are qualified and experienced to conduct the water and waste management at the mine. Their work experience, as well as educational background contributes towards fulfilling their management tasks.

4.10.4 Awareness and Training

Environmental awareness and related training are taking place at the mine, this also forms part of the induction document. Employees are undertaking this training at least once a year.

Glencore believes in seven key principles to achieve effective environmental training and awareness:

- Communication
- Urge
- Leadership
- Teamwork
- Understanding
- Recognition
- Empowerment (culture)

According to the 2015 Water Conservation and Demand Management Plan (WC/WDMP) compiled by Ilifa Africa Engineers (Pty) Ltd the following with regards to water conservation need to be done during awareness training:

- Involvement of the municipality in all water related awareness programmes
- Water conservation banners to be made available on-site entrances for employees and passers-by to see, learn and understand.
- Water conservation pamphlets to be distributed on site and during community meeting as an

awareness strategy.

- Changing the opinions and behaviour of employees is a fundamental component of WC/WDM. With sufficient information and campaign, knowledge is deepened, gradually creating a change in attitudes and education. This will be done using monthly Environmental topics that are made available to all employees and managers throughout the organisational structure.
- Awareness on the reporting of water related incidents to combat leaking pipes and dripping taps.

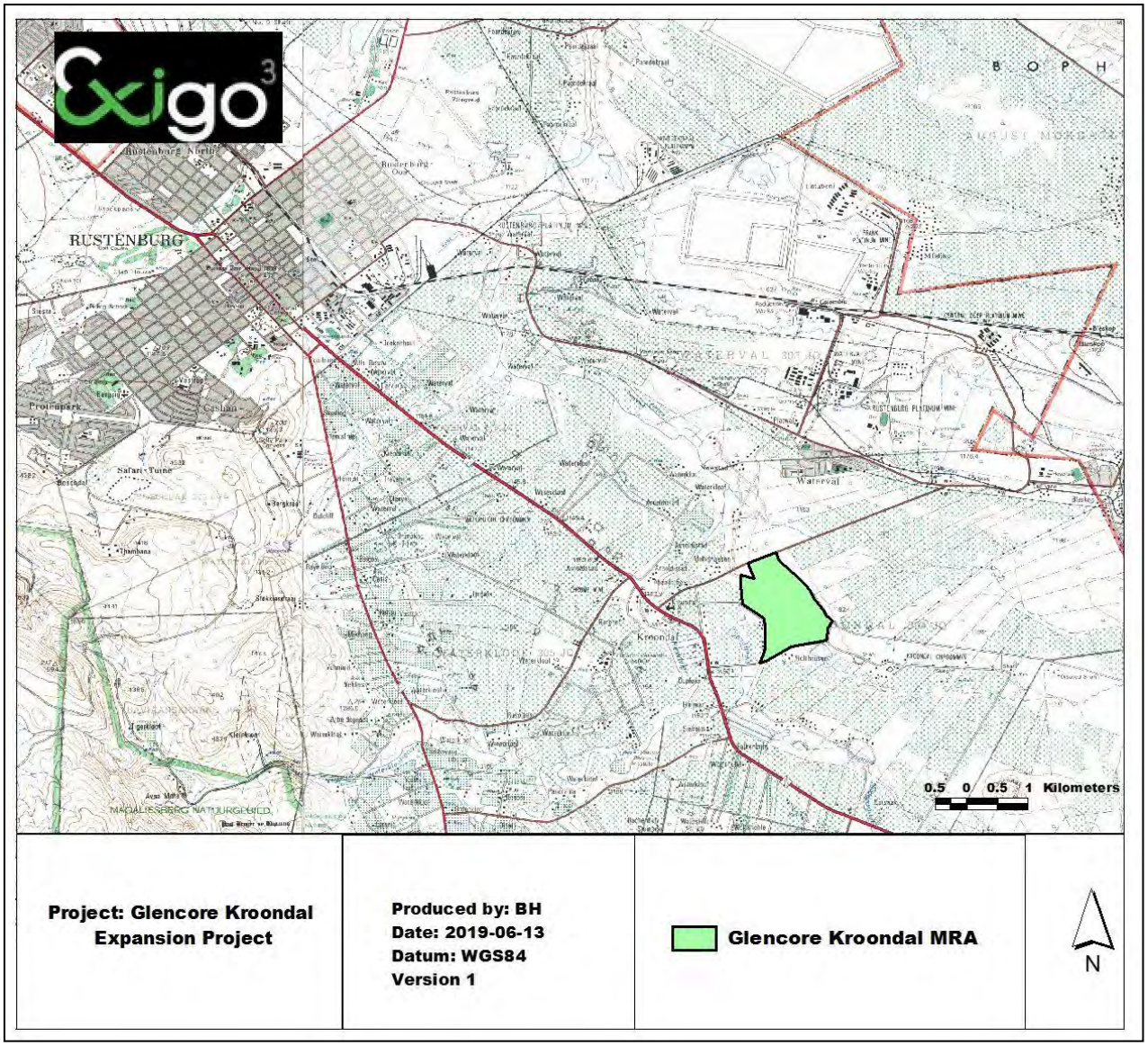


Figure 5: Regional Location Map.

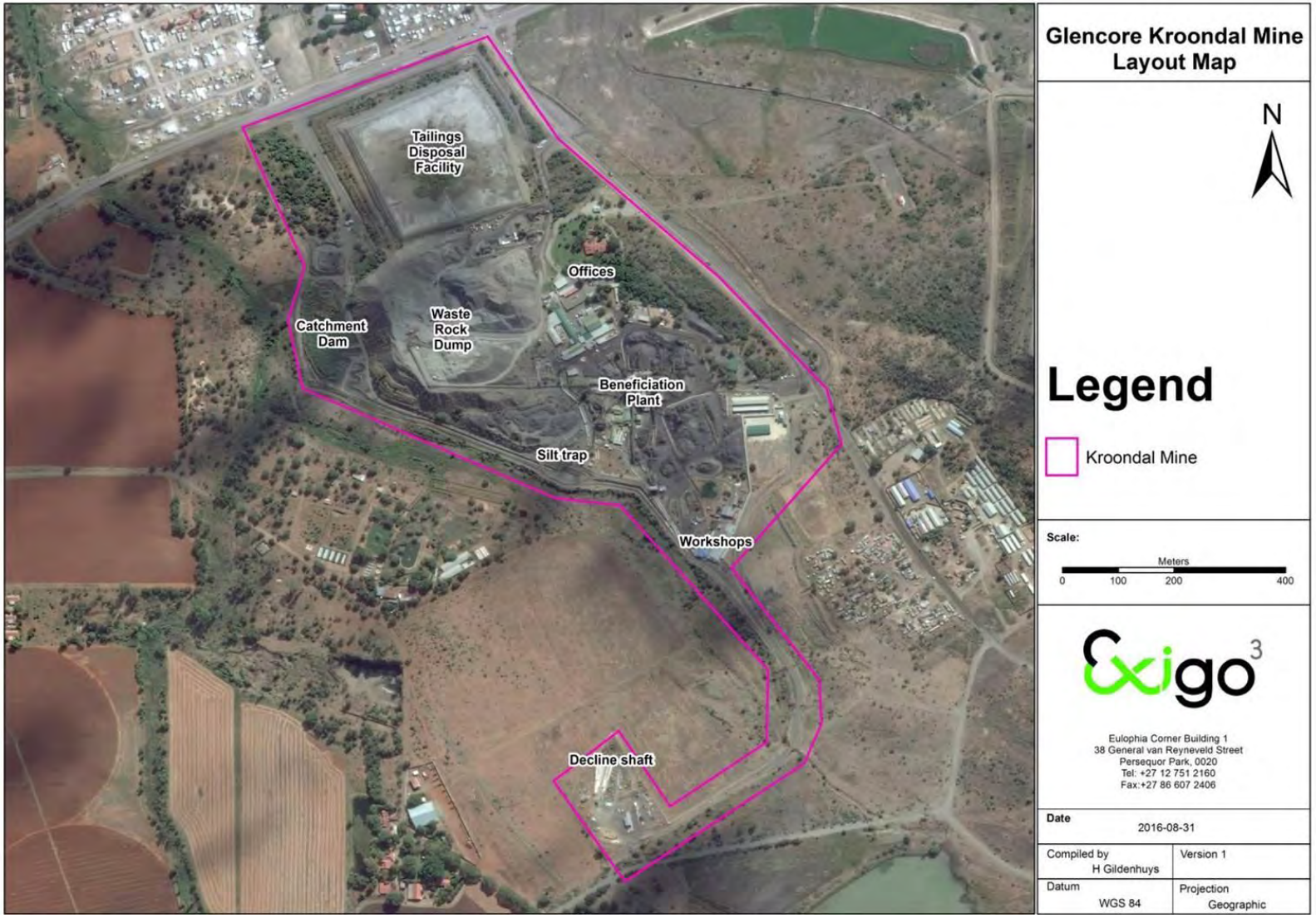


Figure 6: Aerial Map of the Glencore Kroondal impacted mining area (current).

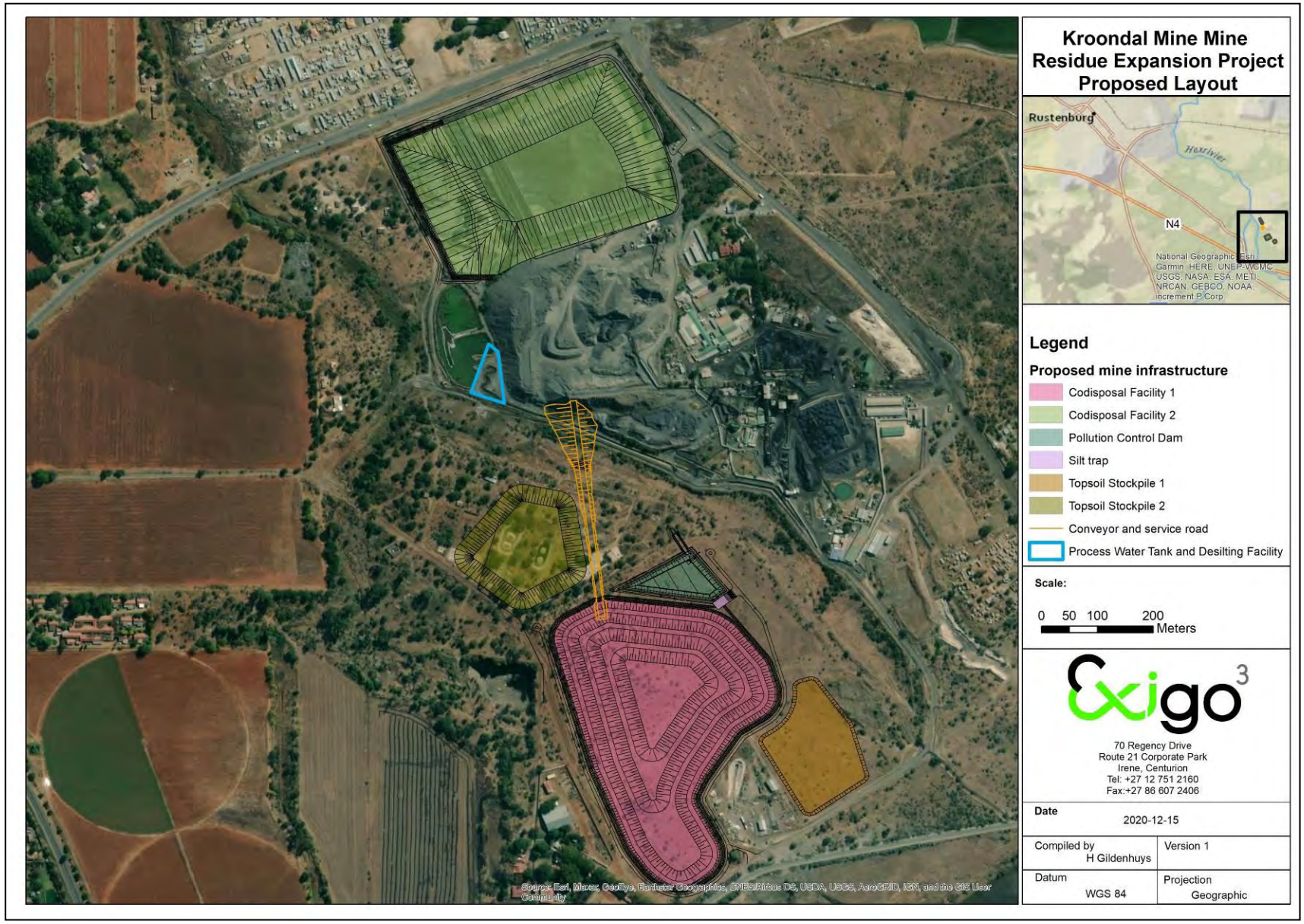


Figure 7: Aerial Map of proposed new infrastructure for the Glencore Kroondal Mine.

5 DESCRIPTION OF BIODIVERSITY AND RELATED INFORMATION AT GLENCORE KROONDAL MINE

5.1 CLIMATE

Climate in the broad sense is a major determinant of the geographical distribution of species and vegetation types. However, on a smaller scale, the microclimate, which is greatly influenced by local topography, is also important. Within areas, the local conditions of temperature, light, humidity and moisture vary greatly, and it is these factors which play an important role in the production and survival of plants (Tainton, 1981).

In terrestrial environments, limitations related to water availability are always important to plants and plant communities. The spatial and temporal distribution of rainfall is very complex and has great effects on the productivity, distribution and life forms of the major terrestrial biomes (Barbour et al. 1987). The climate in the area can be characterised as a warm-temperate summer-rainfall region. Meteorological data were obtained from the closest South African Weather Service Station (SAWSS) in Rustenburg, as well as on site from the Central Management Office (CMO).

5.1.1 Temperature

The site falls within the Highveld Climatic Zone and 85% of the mean annual precipitation falls during summer thunderstorms. The summer thunderstorms are generally of short duration and high intensity. Temperatures in this climatic zone are generally mild with low minimal temperatures experienced in winter. Frost characteristically occurs in the winter months.

The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Rustenburg range from 19.3°C in June to 29.4°C in January. The region is the coldest during July when the mercury drops to 1.7°C on average during the night.

5.1.2 Rainfall and Evaporation

Historic rainfall data from the South Africa weather service were used. Rainfall data (71 years history) from Buffelspoort rainfall station was used because of its proximity to Kroondal mine (Table 2).

Table 1: Historic rainfall data for Buffelspoort (1938 - 2009) used for Glencore, Kroondal (Water Hunters, 2017).

Rainfall data for Buffelspoort (1938 - 2009)

Month	Days/ mth	Average rain days	Avg mm Rain/mth	Std. Dev. Rain/mth	S-Pan mm
Jan	31	12.4	125.0	72.2	195.0
Feb	28	9.7	96.4	58.0	165.0
Mar	31	8.9	84.5	62.0	158.0
Apr	30	5.9	45.5	37.5	125.0
May	31	2.5	14.6	23.9	107.0
Jun	30	0.7	8.5	18.0	87.0
Jul	31	0.7	4.3	10.6	97.0
Aug	31	0.7	6.2	9.3	128.0
Sep	30	2.8	17.9	20.5	168.0
Oct	31	7.3	61.9	36.0	193.0
Nov	30	10.2	88.1	60.5	189.0
Dec	31	11.6	114.8	54.9	199.0
			667.91		**1811.00**

5.1.3 Wind

The wind data for Rustenburg (Table 3) shows that the prevailing wind directions are north-east (2.5 $m.s^{-1}$) for the months January to April, south-west (2.5 $m.s^{-1}$) for May to September and north-west (2.3 $m.s^{-1}$) for October to December.

Table 3: Average wind data for Rustenburg.

	N	NE	E	SE	S	SW	W	NW
%	0.0	23.0	16.0	4.0	9.0	6.0	10.0	32.0
SPEED	0.0	2.5	2.2	2.2	2.4	2.5	2.5	2.3

5.2 GEOLOGY

The Glencore Kroondal Mine and surroundings are underlain by the Rustenburg Layered Suite of the Bushveld Igneous Complex.

Chromite ore is mined and occurs as layers in the host rock pyroxenite in the lower critical zone of the Bushveld Igneous Complex. The Bushveld Complex occurs as younger intruded series into the older Transvaal Sequence sediments as an elliptical basin-shaped layered mass, outcropping 61 000 km^2. The Bushveld Complex is a layered mafic to ultra-mafic sequence with granitic units. The mafic to ultra-mafic layered sequence, the Rustenburg Layered Suite, is a younger intruded series and is part of the Bushveld Complex. The Suite is subdivided into 5 zones:

- Upper zone
- Main zone
- Critical zone

- Lower zone
- Marginal zone

Chrome is present in chromite seams in the lower part of the Rustenburg Layered suite in the northern and south eastern belts as well as in the western lobe. The chromite layers are confined to the critical zone and were grouped from the bottom upwards into lower, middle and upper groups. The lower group contains seven, the middle group four and the upper group two chromite layers.

The lower group consists of 7 chromite seams of which the sixth seam, numbered from bottom to top, namely the LG6 and LG6A, is being mined. This seam is approximately 0.98 and 0.28 m thick and dips north east between 8 and 10 degrees.

5.3 LANDTYPES, SOILS AND LAND CAPABILITY

Geology is directly related to soil types and plant communities that may occur in a specific area (Van Rooyen & Theron, 1996). A Land type unit is a unique combination of soil pattern, terrain and macroclimate, the classification of which is used to determine the potential agricultural value of soils in an area. The land type units represented within the study area include the Ea3 land type (Land Type Survey Staff, 1987) (ENPAT, 2000). The land type, geology and associated soil type is presented in Table 4 below as classified by the Environmental Potential Atlas, South Africa (ENPAT, 2000).

Table 4: Land types, geology and dominant soil types of the Glencore Kroondal Mining Operations site.

Landtype	Soils	Geology
Ea3	One or more of: vertic, melanic, red structured diagnostic horizons, undifferentiated	Norite, gabbro, pyroxenite and anorthosite of the Bushveld Complex. Occasional dykes of syenite and diabase.

The soils are generally vertic, black clay soils or red clayey soils derived from Norite. The soils are derived from norite and have a moderate (15-35%) to high (>35%) clay content, depending on their position in the landscape.

The Institute for Soil, Climate and Water of the Agricultural Research Council (ARC-ISCW) conducted a soil study in 2007. The study found that the site is generally of mixed agricultural potential due to the significant variation in soil depth. The area is predominantly comprised of black topsoils with strong structure and heavy texture (>35% clay). The soils in this unit belong to the Arcadia (Ar) soil form (ARC-ISCW, 2007).

The soil colour throughout the study area consists of dark chromas of black-brown to totally black. The effective soil depth for the largest part of the study area varies between 600mm and 1500mm and the rockiness of the soil surface is between 0% and 5%. On isolated areas, where the rockiness of the soil surface is between 20% and 40%, the soil depth varies between 100mm and 300mm. The latter comprises approximately 10% of the study area (ESS, 2011).

Historically the area has been used for grazing and the production of chillies, tobacco and manna (ESS, 2011). The 2011 EMPR report by ESS included the Table 5 showing the different soils and possible land capability and pre-mining land use.

Table 5: Derived soil properties, Land capability and pre-mining land use (ESS, 2011).

Soil form	Natural fertility	Erodibility	Crop production (dry land)	Crop production (irrigation)	Land capability	Pre mining land use
Willowbrook	High	Low	low	low	Grazing	Natural grassland
Sterkspruit		High	Low-	Low	Grazing	Natural grassland
Katspruit		High	low	Low	Grazing	Natural grassland
Pinedene		Moderate	moderate	Low	Arable	Natural grassland
Hutton		Low	low	Low	Grazing	Natural grassland
Oakleaf	High	low	moderate	low	Arable	Unknown

The current land use in this area, outside of dedicated mining infrastructure areas, consists mainly of game farming or grazing. Riparian zones are the only wetland areas and there are no areas considered suitable to agricultural land use (cultivation).

The soils in this area tend to be sensitive to grazing and anthropogenic pressures in that small effects have large consequences in terms of the loss of soil. This is a problem especially in those areas where the soils are very shallow. Due to the relatively high Mg levels in some of the soils they tend to be highly erodible and soil loss occurs rapidly when plant cover is removed.

Scotney et al. (1991) within the concept of land capability defines land capability as —the extent to which land can meet the needs of one or more uses under defined conditions of management, without permanent damage. Land capability is an expression of the effect of physical factors (e.g., terrain form and soil type), including climate, on the total suitability and potential for use for crops that require regular tillage, for grazing, for forestry and for wildlife without damage. Land capability involves the consideration of (i) the risks of damage from erosion and other causes, (ii) the difficulties in land use caused by physical factors, including climate and (iii) the production

potential‖ (Scotney et al., 1991).

The current land capability data set that is used as the national norm indicates that there is little or no soils in South Africa that are not subject to limitations. Most of the country ‘s soils have moderate to severe limitations largely due to limited soil depth or moderate erodibility, caused by sandy texture or slopes. It was determined that nowhere in South Africa do best soil and good climate classes coincide (Schoeman et al, 2002). The land capability classes used for the South African Agricultural Sector are indicated in Table 6, while Table 7 indicate limitations and land use potential for the Land Capability classes.

Table 6: Land capability classes (Schoeman *et al.* 2002).

Land Capability Class	Increased intensity of use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	Arable land
II	W	F	LG	MG	IG	LC	MC	IC	-	
III	W	F	LG	MG	IG	LC	MC	-	-	
IV	W	F	LG	MG	IG	LC	-	-	-	
V	W	-	LG	MG	-	-	-	-	-	Grazing land
VI	W	F	LG	MG	-	-	-	-	-	
VII	W	F	LG	-	-	-	-	-	-	
VIII	W	-	-	-	-	-	-	-	-	Wildlife

W - Wildlife
F - Forestry
LG - Light grazing
MG - Moderate grazing
IG - Intensive grazing
LC - Light cultivation
MC - Moderate cultivation
IC - Intensive cultivation
VIC - Very intensive cultivation

Table 7: Land capability Classes: Limitations & land use.

Land Capability Class	Definition	Conservation Need	Use suitability
I	No or few limitations. Very high arable potential. Very low erosion hazard.	Good agronomic practice.	Annual cropping.
II	Slight limitations. High arable potential. Low erosion hazard.	Adequate run-off control.	Annual cropping with special tillage or ley (25%)
III	Moderate limitations. Some erosion hazards.	Special conservation practice and tillage methods.	Rotation of crops and ley (50 %).
IV	Severe limitations. Low arable potential. High erosion hazard.	Intensive conservation practice.	Long term leys (75 %)
V	Watercourse and land with wetness limitations.	Protection and control of water table.	Improved pastures or Wildlife
VI	Limitations preclude cultivation. Suitable for perennial vegetation.	Protection measures for establishment e.g., Sod-seeding	Veld and/or afforestation

Land Capability Class	Definition	Conservation Need	Use suitability
VII	Very severe limitations. Suitable only for natural vegetation.	Adequate management for natural vegetation.	Natural veld grazing and afforestation
VIII	Extremely severe limitations. Not suitable for grazing or afforestation.	Total protection from agriculture.	Wildlife

From the databases of Department of Agriculture, the site has the following land capability:

- Class III: Moderate Potential Arable Land

The current mining area was formerly utilised for grazing. During the operational phase the dewatering of the area will limit the land capability, although the vegetation will start to re-establish. Post closure, the vegetation will re-establish, although concerns remain that the water table will take generations to re-establish, and the livestock carrying capability of the mined-out areas will be limited by the vulnerability of the areas to drought.

It is therefore proposed that the area be used for wilderness, and not for grazing post mining until such time as the long-term sustainability of the vegetation is established. This will result in a limiting of the land capability for the initial period post mining.

5.4 TOPOGRAPHY & LANDSCAPE

The Study Area is situated on slightly undulating plains and a non-perennial tributary of the Sandspruit. Small sections of original vegetation remain intact along rivers and water courses where pioneer plant species are prevalent. Other disturbances because of rubble dumping, littering and the area being used as a pass through by local people are also prevalent in the area. The major land uses of the study area as classified by the Environmental Potential Atlas of South Africa (2000) are vacant / unspecified land. The average elevation of the area is between 1140 and 1160amsl.

5.5 HYDROLOGY AND DRAINAGE

The drainage areas of South Africa are also referred to as the primary catchments and constitute the catchment areas of all the major rivers in the country. These drainage regions comprise areas of which the topography is such that all water deposited in the catchments will, except for evaporation and retention in the system, eventually end up in the main river flowing from that same catchment. Primary river catchments such as the Orange, Vaal and Limpopo catchments are subdivided into contributing secondary catchments. They are, in turn, subdivided into even smaller tertiary catchments, which are finally subdivided into quaternary catchments, the smallest catchment units used in the management and planning of water resources at a national level.

Kroondal mine is situated within the Hex River catchment which is situated within the Crocodile

(West) and Marico catchment management agency according to the National Water Resource Strategy in terms of Section 5 of the National Water Act (Act No. 36 of 1998).

The study area is in the Quaternary Catchment Area (QCA) A22H (Figure 8). The study area is drained mainly by means of surface run-off (sheetflow) with storm water collecting along roads and footpaths cutting through the area, to drain into the perennial and non-perennial rivers that bisect through the proposed development area.

The affected catchment includes a perennial stream, i.e., the Sandspruit and its tributary, located towards the south-west of the mine. The Sandspruit flows northwards towards the Hex River that drains to the Bospoort dam towards the north, which then contributes to the Crocodile River.

Figure 8: Quaternary drainage area map and surface water features in the area.

5.6 VEGETATION

5.6.1 Biomes

The project area lies within the Savanna Biome. The Savanna Biome is the largest biome in Southern Africa. It is characterized by a grassy ground layer and a distinct upper layer of woody plants (trees and shrubs). The environmental factors delimiting the biome are complex and include altitude, rainfall, geology and soil types, with rainfall being the major delimiting factor. Fire and grazing also keep the grassy layer dominant.

5.6.2 Vegetation types

Mucina & Rutherford (2006) Classification

The most recent classification of the area by Mucina & Rutherford shows that the Kroondal Mine site is classified as Marikana Thornveld. The Marikana Thornveld vegetation type occurs in the North West and Gauteng Provinces. It occurs on plains from the Rustenburg area in the west, through Marikana and Brits to the Pretoria area in the east. The total mine area falls within this vegetation type.

The Marikana Thornveld vegetation type is considered Endangered. While the national conservation target for this vegetation type is 19%, less than 1% is statutorily conserved. This vegetation type has been transformed (48%), mainly by cultivation and urban or built-up areas. Most agricultural development of this area is in the western regions towards Rustenburg, while in the east industrial development is a greater threat. Alien invasive plants are localised in high densities, especially along drainage lines, in this vegetation type.

The Marikana Thornveld vegetation type is characterised by open Acacia karroo woodland, in valleys and slightly undulating plains and some lowland hills. Shrubs are denser along drainage lines, on termitaria and rocky outcrops or in other habitats protected from fire. Key indicator species of this vegetation type include (dominant species are denoted by (d)):

- Tall tree: *Senegalia burkei;*
- Small trees: *Senegalia caffra (d), Vachellia gerrardii, V. karoo (d), Combretum molle (d), Searsia lancea (d), Ziziphus mucronata (d), Ziziphus mucronata (d), Vachellia nilotica, V. tortilis subsp. heteracantha, Celtis africana, Dombeya rotundifolia, Pappea capensis, Peltophorum africanum, Terminalia sericea;*
- Tall shrubs: *Euclea crispa subsp. crispa (d), Olea europaea subsp. africana (d), Rhus pyroides var. pyroides (d), Diospyros lycoides subsp. guerkei, Ehretia rigida subsp. rigida, Euclea undulata, Grewia flava, Pavetta gardeniifolia;*
- Low shrubs: *Asparagus cooperi (d), Rhynchosia nitens (d), Indigofera zeyheri;*
- Woody climbers: *Clematis brachiata (d), Justicia flava, Helinus integrifolius;*
- Herbaceous climber: *Cyphostemma cirrhosum, Pentarrihum insipidum (d);*

- Graminoids: *Elionurus muticus (d), Eragrostis lehmanniana (d), Setaria sphacelata (d), Themeda triandra (d), Aristida scabrivalvis subsp. scabrivalvis, Fingerhuthia africana, Heteropogon contortus, Hyperthelia dissoluta, Melinis nerviglumis, Barleria macrostegia, Dianthus mooiensis subsp. mooiensis, Ipomoea oblongata, Vernonia oligocephala;*
- Herbs: *Hermannia depressa (d), Ipomoea obscura (d), Barleria macrostegia, Dianthus mooiensis subsp. mooiensis, Ipomoea oblongata, Vernonia oligocephala*; and
- Geophytic herbs: *Ledebouria revoluta, Ornithogalum tenuifolium, Sansevieria aethiopica*

5.7 PLANT COMMUNITIES / VEGETATION UNITS OF THE STUDY AREA

The vegetation communities identified in the area are classified as physiographic physiognomic units, where physiognomic refers to the outer appearance of the vegetation, and physiographic refers to the position of the plant communities in the landscape. The physiographic-physiognomic units will be referred to as vegetation units in the following sections. These vegetation units are divided in terms of the topographical differences, previous land-use and soil differences that had the most definitive influence on the vegetation units. The following species have been recorded in and around the area.

5.7.1 NSS (2007)

The NSS (2007) study identified six habitat types within the vicinity of Kroondal Mine. These were Acacia pockets, Rocky outcrops, a wetland system, rehabilitated areas, agricultural fields and alien bush clumps (Figure 9). A review of the vegetation in the vicinity of the mine in 2011 focussed on the natural vegetation within the mine area, and with only a brief look at a rehabilitated site. Only one broad vegetation unit and the rehabilitated area were identified along with two other non-vegetation land units as listed below:

- Mixed savanna
- Rehabilitated areas
- Mining disturbance
- Urban settlement

During the 2015 study NSS refined the broader units (Table 8). The Kroondal area has been considerably transformed. According to NSS very little viable land remains between infrastructure, the Tailings Storage Facility (TSF), roads and stockpile areas. The small pockets of natural to semi-natural vegetation constitute less than 8% of the site and approximately 34% is under rehabilitation (NSS, 2015).

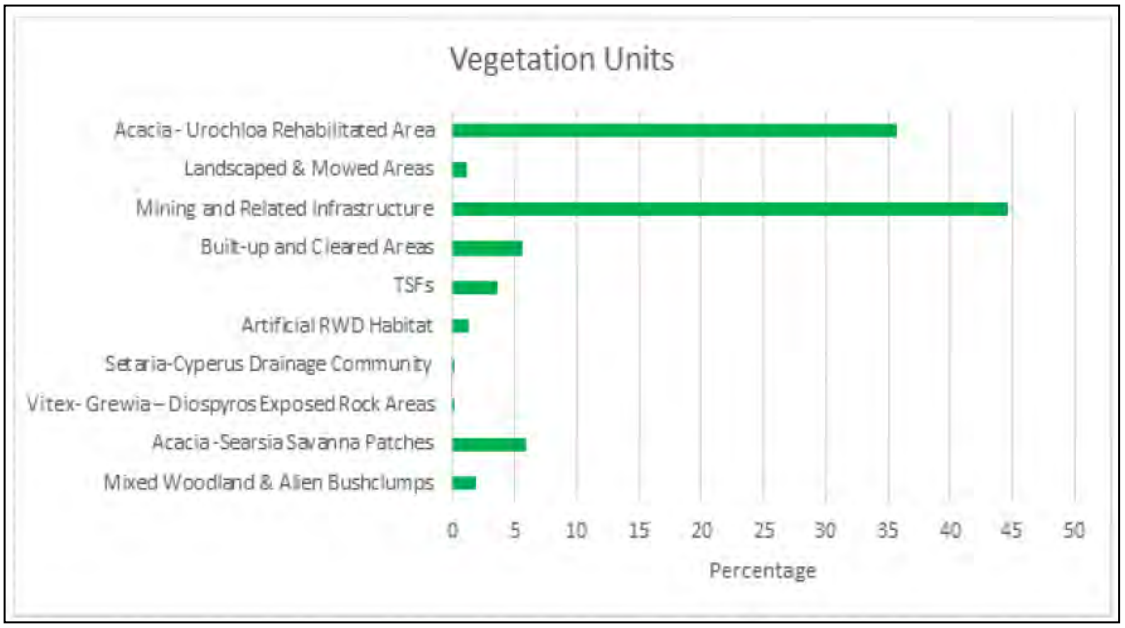


Figure 9: Vegetation units within the Kroondal Area (NSS, 2015).

Table 8: Broad Habitat/Vegetation communities (NSS, 2015).

UNIT	Habitat - Vegetation Unit	AoC Ranking	% % Cover
	Marikana Thornveld Habitats		
A	*Acacia -Searsia* Savanna Patches	Medium	5.67
	- Mixed Woodland & Alien Bushclumps	Medium -Low	1.8
B	*Vitex- Grewia – Diospyros* Exposed Rock Areas	Medium-High	0.18
	Wetland / Drainage Habitats		
C	*Setaria-Cyperus* Drainage Community	Medium (Fauna)	0.07
	Artificial RWD Habitat	Medium (Fauna)	1.21
	Transformed Habitats		
D	*Acacia - Urochloa* Rehabilitated Area	Medium-Low	34.60
	Landscaped & Mowed Areas	Low	1.088
	Vegetated TSF Walls	Low	3.22
	Mining and Related Infrastructure	Low-None	43.17
	Built-up and Cleared Areas	Low-None	3.54
	TSFs	Low-None	5.45

* AoS: Areas of Significance (Fauna; Flora; Wetland Importance)

5.7.2 Exigo studies (recent)

Recent studies conducted by Exigo Sustainability on the Kroondal Mine area and surroundings revealed the following vegetation units. Each unit is described in terms of its characteristics. A species list is included in Appendix B, while a species list for the quarter degree grid square (QDS) is included in Appendix A according to the POSA database of Sanbi. The species are listed as identified throughout the QDS over a lengthy period and not necessarily representative of the project area.

The proposed development sites occur on slightly undulating plains and flat plains with a non –perennial river and wetland occurring to the south of the Kroondal Mines. The farms surrounding this farm are primarily used for mining, small-scale subsistence crop cultivation and rural developments.

Vegetation units were identified according to plant species composition, previous land-use, soil types and topography. The state of the vegetation of the proposed mining sites varies from being natural to completely degraded. The farms are currently zoned for mining.

The vegetation communities identified in the area are classified as physiographic physiognomic units, where physiognomic refers to the outer appearance of the vegetation, and physiographic refers to the position of the plant communities in the landscape. The physiographic-physiognomic units will be referred to as vegetation units in the following sections. These vegetation units are divided in terms of the topographical differences, previous land-use and soil differences that had the most definitive influence on the vegetation units. Each unit is described in terms of its characteristics. A species list is included in the Photographic Guide at the end of the document.

The broad classification is done for each of the proposed infrastructure areas as follows:

1. Secondary old fields
    - Degraded *Vachellia tortilis – Dichrostachys cinerea – Ziziphus mucronata* woodland;
    - Degraded *Ischaemum fasciculatum - Vachellia nilotica* secondary old fields;
2. Alien invasive bushclumps
3. Hydrological features:
    - River and riparian woodland;
    - Valleybottom wetland with channel;
    - Man-made dam (Depression)
    - Stormwater canal

    The vegetation units as identified during site visits, databases and aerial imagery are indicated in Figure 10.

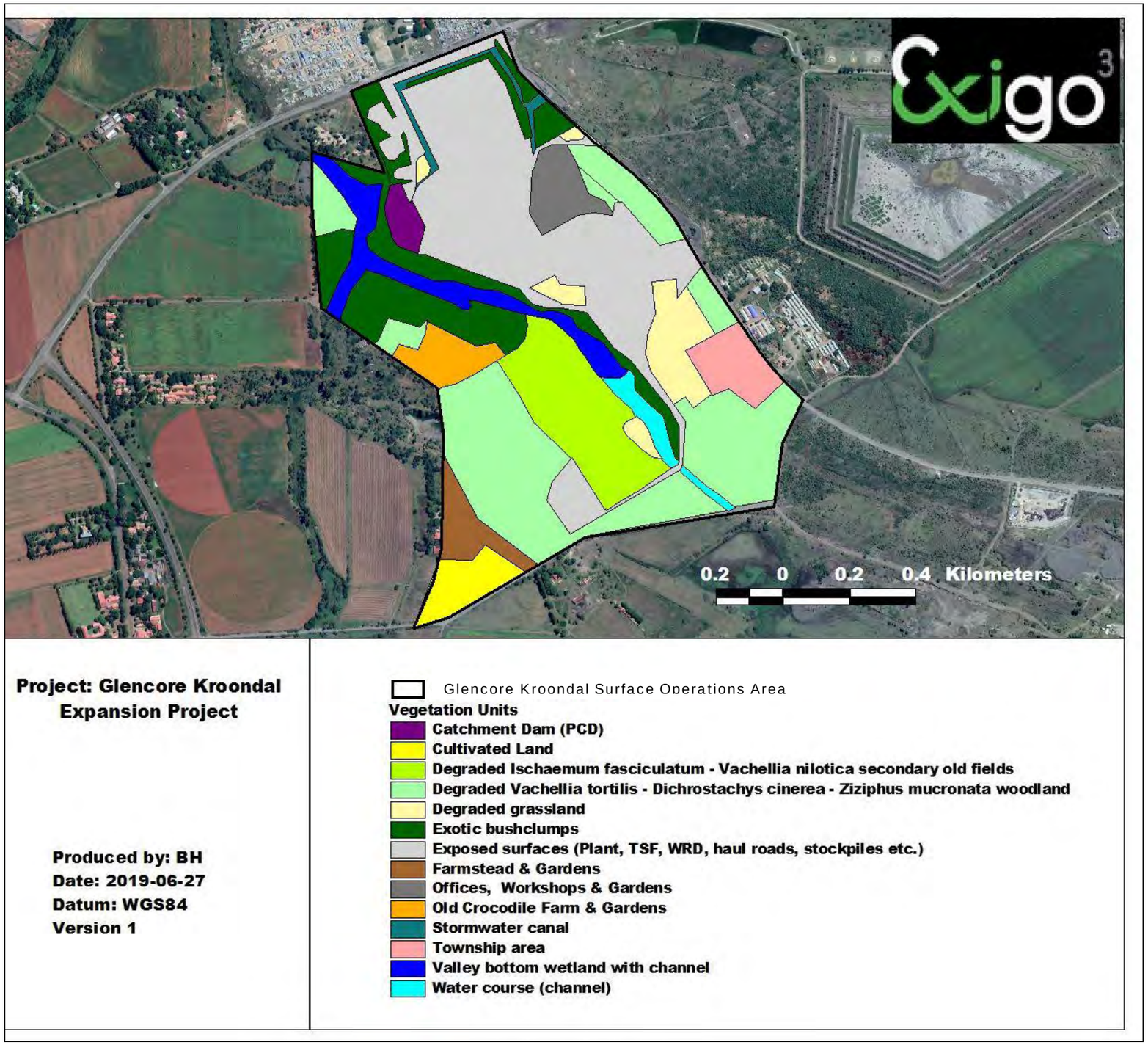


Figure 10: Vegetation unit locations within the project area.

5.7.2.1 Secondary Old fields

The secondary old fields occur to the east of the old crocodile farm and represent the proposed footprint area for the new CDF, PCD, silt trap and some of the associated infrastructure to the north of the Sandspruit and east of the Kroondal Mine. When cultivated fields are left fallow, it results in a landscape mosaic of patches of secondary vegetation varying in age and dominated by various grass species (Moll, 1965). Different stages of succession occur in the old fields, and Wildi (2002) described how dynamic these systems are over time and space. The outer successional stage of old fields (as observed on site) only starts after several years of abandonment when woody species start to invade. These secondary old fields are usually dominated by species such as *Dichrostachys cinerea, Vachellia tortilis* and *Ziziphus mucronata*. In the project area, two variation of the secondary old fields occur according to the soil type.

The Degraded *Vachellia tortilis – Dichrostachys cinerea – Ziziphus mucronata* woodland occur on red clayey soils and forms open woodland, while the Degraded *Ischaemum fasciculatum - Vachellia nilotica* secondary old fields can be classified as open grassland with scattered woody species on black, vertic clay soils.

The state of the vegetation is indicated in photograph 2 and 3, while the characteristics of the variations of this vegetation unit are summarized in Table 9.

Table 9: Botanical analysis and characteristics of the vegetation associated with the *Vachellia karroo* woodland in the study area.

	***Vachellia tortilis – Dichrostachys cinerea – Ziziphus mucronata* woodland**	***Ischaemum fasciculatum - Vachellia nilotica* grassland**
State of the vegetation:	Open microphyllous woodland in a state of succession	Grassland with scattered microphyllous trees
Conservation priority	Medium-low	Medium
Characteristics	Open savanna woodland on red apedal soils	Grassland with scattered trees on vertic, black clay soils
Dominant plant species	*Vachellia tortilis, Dichrostachys cinerea, Ziziphus mucronata*	*Ischaemum fasciculatum, Vachellia nilotica, Brachiaria nigropedata*
Density of woody layer	Trees: 2-5% (avg. height: 3-6m) Shrubs:5-10% (avg. height: 1-2m)	Trees: <1% (avg. height: 3-6m) Shrubs:1-2% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 50-60% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)	Grasses: 70-80% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)
Sensitivity	Medium-low	Medium
Red data species	None observed	None observed

Protected tree species (DAFF)	None observed	None observed

The following specific recommendations for the vegetation unit regarding the proposed development should be adhered to:

- The vegetation unit is classified as having a Medium and Medium-low Sensitivity due to being in a state of succession. The old fields on the black, clayey soils are more sensitive due to the soil type having a high risk of erosion;

Photograph 2. *Ischaemum fasciculatum* - *Vachellia nilotica* secondary old fields in the project area.

Photograph 3. Degraded *Vachellia tortilis – Dichrostachys cinerea – Ziziphus mucronata* woodland in the project area.

5.7.2.2 Alien invasive bushclumps

The areas surrounding the silt dumping areas from the pollution control dam (PCD) on which the new WRD is proposed, is largely dominated by alien invasive stands dominated by species such as *Tecoma stans, Leucacaena leucocephala, Lantana* and *Solanum mauritianum,* with only isolated indogenous trees such as *Vachellia karroo* and *Ziziphus mucronata* scattered in between the dense alien stands. The state of the vegetation is indicated in photograph 4 and location in between the silt dumps in photograph 5, while the characteristics of the vegetation unit are summarized in Table 10.

Table 10: Botanical analysis and characteristics of degraded bushveld.

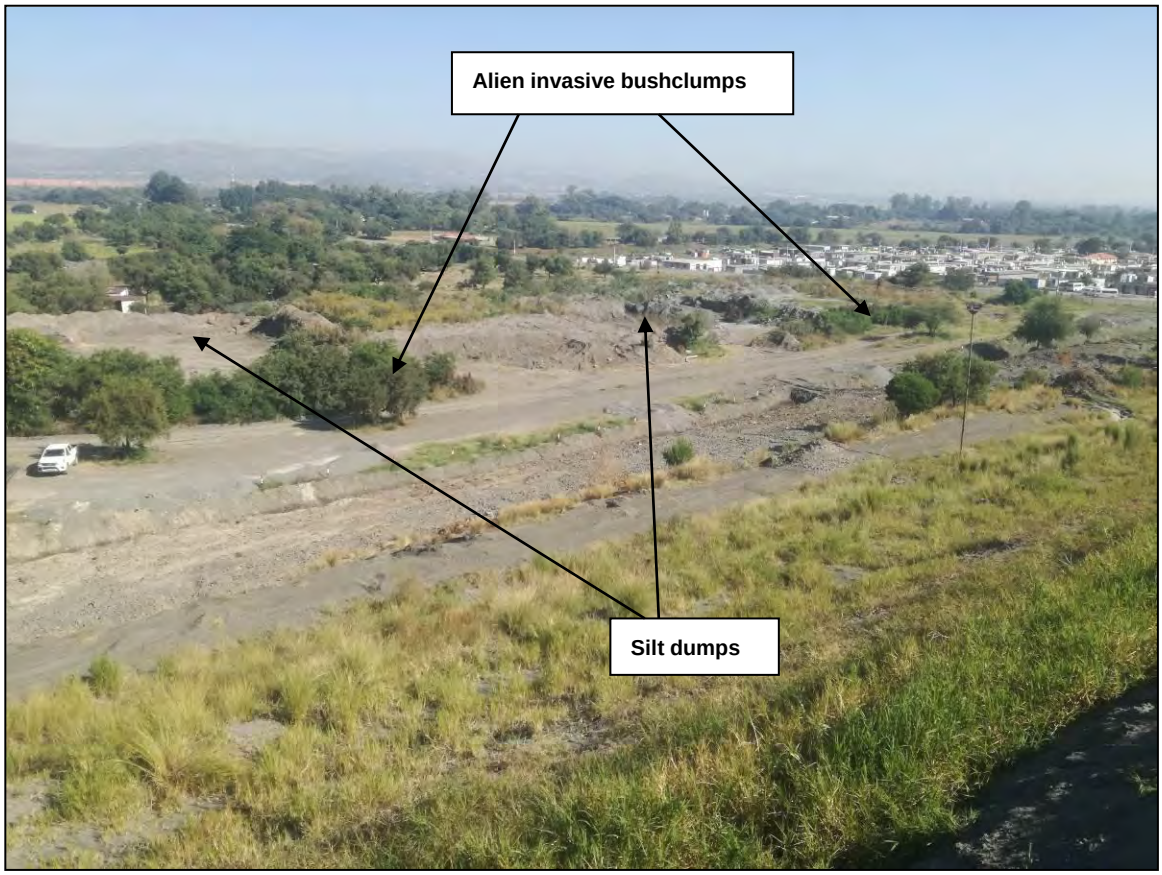
State of the vegetation:	Degraded
Need for rehabilitation	High
Conservation priority	Low
Soils & Geology	Mostly silt dumps, with a small section on red apedal soils of the Hutton soil form derived from shale / mudstone
Density of woody layer	Trees: 2-5% (avg. height: 3-6m)

	Shrubs: 30-40% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 10-20% (avg. height: 0.5m) Forbs: 5-10% (avg. height: 0.3m)
Sensitivity	Low
Dominant plant species	*Tecoma stans, Leucacaena leucocephala, Lantana* and *Solanum mauritianum*
Red data species	None observed
Protected tree species (DAFF)	None observed

The following specific recommendations and conclusions were made for this vegetation unit:

- The degraded variation of this vegetation unit is classified as having a Low Sensitivity due to the high density of alien invasive shrubs in the area.

Photograph 4. State of the degraded alien invasive bushclumps



Photograph 5. Location of the alien invasive bushclumps surrounding the silt (sludge) dumps

5.7.2.3 Degraded grassland

The degraded grassland represents a small area adjacent to the offices and haul road at the new WRD site. The area is characterised by the grass species *Cynodon dactylon, Aristida congesta, Melinis repens* and *Sporobolus africanus*, while the area also became invaded by various alien invasive species such as *Ricinus communis, Bidens pilosa* and *Tagetes minuta*. The state of the vegetation and location is indicated in photograph 6, while the characteristics of the variations of this vegetation unit are summarized in Table 11.

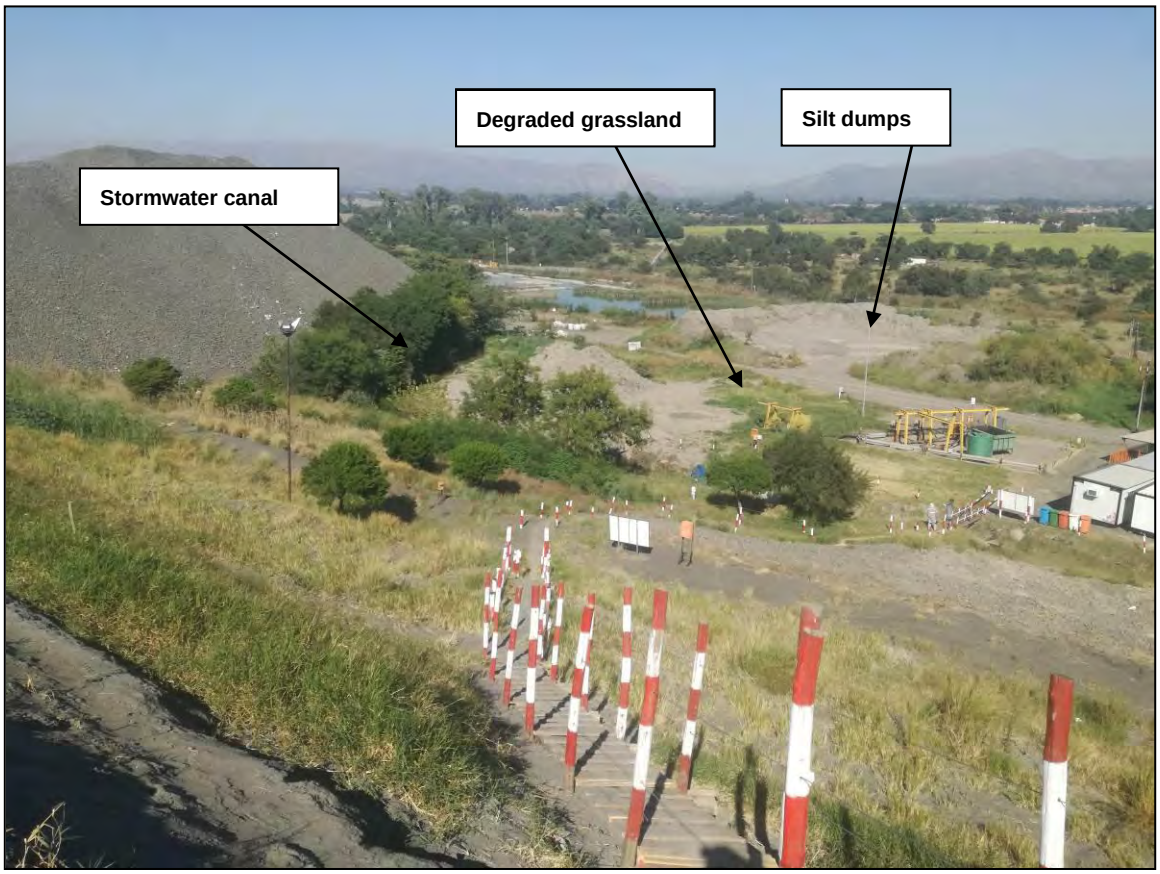
Table 11: Botanical analysis and characteristics of degraded grassland.

State of the vegetation:	Degraded
Need for rehabilitation	High
Conservation priority	Low
Soils & Geology	Red apedal soils of the Hutton soil form derived from mudstone / shale
Density of woody layer	Trees: <1% (avg. height: 3-6m) Shrubs: <1% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 40-50% (avg. height: 0.5m) Forbs: 2-5% (avg. height: 0.3m)

Sensitivity	Low
Dominant plant species	*Cynodon dactylon, Aristida congesta, Melinis repens* and *Sporobolus africanus*, *Ricinus communis, Bidens pilosa* and *Tagetes minuta*
Red data species	None observed
Protected tree species (DAFF)	None observed

The following specific recommendations and conclusions were made for this vegetation unit:

- The degraded variation of this vegetation unit is classified as having a Low Sensitivity due to the high density of pioneer grasses and alien invasive weeds in the area. The development in this area is highly suitable.



Photograph 6. Degraded grassland and other aspects in the proposed western section of the new WRD site

5.7.2.4 Drainage features

The drainage features near the proposed mining infrastructure on site are valleybottom wetland with channel, river with riparian woodland (largely modified), offstream man-made dam (PCD) as well as stormwater canals.

5.7.2.4.1 Valleybottom wetland with channel

The Sandspruit and its tributary from the south are classified as a Valley bottom wetland with a channel. Valley bottom wetlands are classified as low-lying, gently-sloped areas that receive water from an upstream channel and/or form adjacent hillslopes, not subject to periodic over-bank flooding by a river channel. Surface water in the valley bottom wetlands of the study area flows only seasonally, although the channels are in most cases perennial.

One type of valley bottom wetlands is associated with the study area as classified by Sanbi (2009) namely channelled valley bottom wetlands (Photograph 7). A channelled valley-bottom wetland is classified as a mostly flat valley-bottom wetland dissected by and typically elevated above a channel. Dominant water inputs to these areas are typically from the channel, either as surface flow resulting from overtopping of the channel bank/s or as interflow, or from adjacent valley-side slopes (as overland flow or interflow). Water generally moves through the wetland as diffuse surface flow, although occasional, short-lived concentrated flows are possible during flooding events. Small depressional areas within a channelled valley-bottom wetland can result in the temporary containment and storage of water within the wetland. Water generally exits in the form of diffuse surface flow and interflow, with the infiltration and evaporation of water from these wetlands also being potentially significant (particularly from depressional areas). The hydrodynamic nature of channelled valley-bottom wetlands is characterised by bidirectional horizontal flow, with limited vertical fluctuations in depressional areas (SANBI, 2009).

The vegetation structure of the valley bottom wetlands varies from the actual channels being closed grassland in certain areas, to a sandy riverbed with alluvial sand and conglomerates along the riverbanks. The drainage channels that from part of the channelled valley bottom wetlands is mostly non-perennial.

The most abundant and most conspicuous plant species is hygrophilous grasses such as *Sporobolus africanus, Paspalum dilatatum, Andropogon eucomis, Hyparrhenia tamba, Eragrostis gummiflua* and *Setaria sphacelata*. Other plants associated with valley bottom channels are *Cyperus sexangularis, Schoenoplectus corymbosus* and *Typha capensis*.

Unfortunately, the valley bottom wetlands provide a distribution route for weeds and invading trees (Photograph 8). Many of the usual weeds were recorded together with *Tecoma stands, Solanum mauritianum, Leucaceana leucocephala, Xanthium strumarium*, *Datura stramonium* and *Flaveria bidentis*. Weeds and invaders should be removed, as well as destruction of such plants in a safe place and manner.

Photograph 7. Sandspruit to the north of the proposed CDF and PCD

Photograph 8. Alien invasive species along the banks of the Sandspruit

5.7.2.4.2 Channels (water courses) and riparian woodland (including stormwater canal)

The modified canals represent river channels and are classified as channels or water courses. A Channel (river, including the banks) can be described as follows: an open conduit with clearly

defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. At Level 4A of the classification system, the entire active channel (including wetlands occurring on the banks, i.e., in the riparian zone) is treated as a unit.

No vegetation grows in the channel itself other than the edges of the channel where sedges (Cyperaceae spp) and hygrophilous grasses (*Sporobolus africanus, Setaria sphacelata*) grow.

The substrate in the channel is composed of sediment with smaller pebbles and some areas where large rocks occur along the banks. The modified section of the valley bottom wetland to the west of the culverts represents a water course rather than a wetland area due to the area previously being part of the opencast mining area (Photograph 9).

In the case of the major channel, the riparian woodland of the area is mostly sparse with species such as *Searsia lancea* and *Vachellia karroo* documented. Most of the riparian woodland has been removed by local communities and the herbaceous component is poorly developed along the riverbanks due to overgrazing by the livestock of the local communities and dominated by species such as *Sporobolus africanus* and *Cynodon dactylon*.

Photograph 9. Modified section of a valley bottom representing a river

5.7.2.4.3 Man-made dam (depression)

The Pollution Control Dam (PCD) represents a man-made dam also classified as a depression (Photograph 10). A depression is classified as a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow. For 'depressions with channelled inflow', concentrated overland flow is typically a major source of water for the wetland, whereas this is not the case for 'depressions without channelled inflow'. Dominant hydrodynamics are (primarily seasonal) vertical fluctuations. Depressions may be flat-bottomed (in which case they are often referred to as 'pans') or round bottomed (in which case they are often referred to as 'basins') and may have any combination of inlets and outlets or lack them completely.

The vegetation associated with depressions is mostly reeds, sedges and bulrushes depending on the depth of the water and the substrate. Species such as *Typha capensis, Phragmites australis, Schoenoplectus corymbosus, Ludwigia stolonifer* and *Leersia hexandra* mostly grow along the shallow edges of the return water dam in the project area on a muddy substrate.

Photograph 10. Return water dam representing a man-made depression in the project area

The following specific recommendations for the wetland areas should be adhered to for the hydrological features on site;

- The vegetation associated with the water courses that forms part of the floodline area in the project area has a high sensitivity with a high conservation priority. The man-made features have a Medium (PCD dam) and Low Sensitivity (stormwater canals);
- A detailed rehabilitation and riverine management plan should be developed by a wetland specialist in collaboration with a civil engineer;
- Any development activities that would include crossing of drainage channels by roads would need a water license application to DWA. The location where the road cross the drainage channels or bisect riparian woodland (within 32 m of a water course) should be on the least sensitive areas. The site should preferably be indicated by an ecologist after consultation by the engineers;
- Riparian areas: DWS has stipulated specific guidelines for the identification of such areas in a guide. These are sensitive areas and prime examples of such areas are the riparian woodland areas associated with the major drainage channels in the area. A survey and delineation of the drainage systems and wetlands in the area was conducted as part of a detailed ecological survey. The predicted impact of the development activities will be significant and strict mitigation measures should be addressed as part of the construction phase to ensure limited impacts on the drainage channels and riparian woodland;

- The following aspects should be considered as part of the layout of the future development activities on the drainage channels:
    - Identify areas of historic or potential vulnerability, such as geologically unstable materials or areas subject to flooding.
    - Avoid problematic areas and avoid construction locations on the layout in areas of high natural hazard risk, such as landslides, rock-fall areas, steep slopes (over 60-70%), wet areas, saturated soils, etc.
    - Avoid or minimize construction in narrow canyon bottoms or on flood plains of rivers that will inevitably be inundated during major storm events.
    - Minimize changes to natural drainage patterns and crossings to drainages. Drainage crossings are potentially problematic, so they must be well designed. Changes to natural drainage patterns or channels often result in either environmental damage or failures.
    - Perform scheduled maintenance to be prepared for storms. Ensure that culverts have their maximum capacity, ditches are cleaned, and that channels are free of debris and brush than can plug structures.
    - Typically keep cut and fill slopes as flat as possible and well covered (stabilized) with vegetation to minimize slumping as well as minimize surface erosion. Well-cemented but highly erosive soils may best resist surface erosion with near-vertical slopes that minimize the surface area exposed to erosion.
    - Use deep-rooted vegetation for biotechnical stabilization on slopes. Use a mixture of good ground cover plus deep-rooted vegetative species, preferably native species, to minimize deep-seated mass instability as well as offer surface erosion control protection.
    - Locate roads crossings on narrow sections of rivers and in areas of bedrock where possible. Avoid fine, deep alluvial deposits (of fine sand and silt) that are scour susceptible and problematic, or which otherwise require costly foundations.
    - Place retaining structures, foundations, and slope stabilization measures into bedrock or firm, in-place material with good bearing capacity to minimize undermining, rather than placing these structures on shallow colluvial soil or on loose fill material.

5.7.2.5 Degraded terrain

The mining areas (including shafts, infrastructure, TSF, WRD, Plant and all cleared land) and haul roads represent zero sensitivity degraded areas characterised only by landscaping areas, a few pioneer grasses, alien invasive shrubs and exotic weeds. No further description of these degraded areas was considered necessary. The location of the areas is indicated in the vegetation map.

5.8 RECOMMENDATIONS & MANAGEMENT STRATEGIES FOR FLORA

South Africa has been recognized as having remarkable plant diversity with high levels of endemism. The major threats to plants in the study area are urban expansion, non-sustainable harvesting, collecting, overgrazing/browsing, mining and agriculture. The objective of this section was to compile a list of plant species for which there is conservation concern. This included threatened, rare, declining, protected and endemic species.

5.8.1 Species of conservation concern

Species of conservation concern are species that have a high conservation importance in terms of preserving South Africa's high floristic diversity and include not only threatened species, but also those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient – Insufficient Information (DDD). It should also be noted that not all species listed as protected are threatened or vice versa. A list of SCC plant species previously recorded in the study area in which the proposed development is planned was obtained from the Plants of Southern Africa (POSA) database of SANBI. Figure 11 indicates the classification system used by SANBI for SCC:

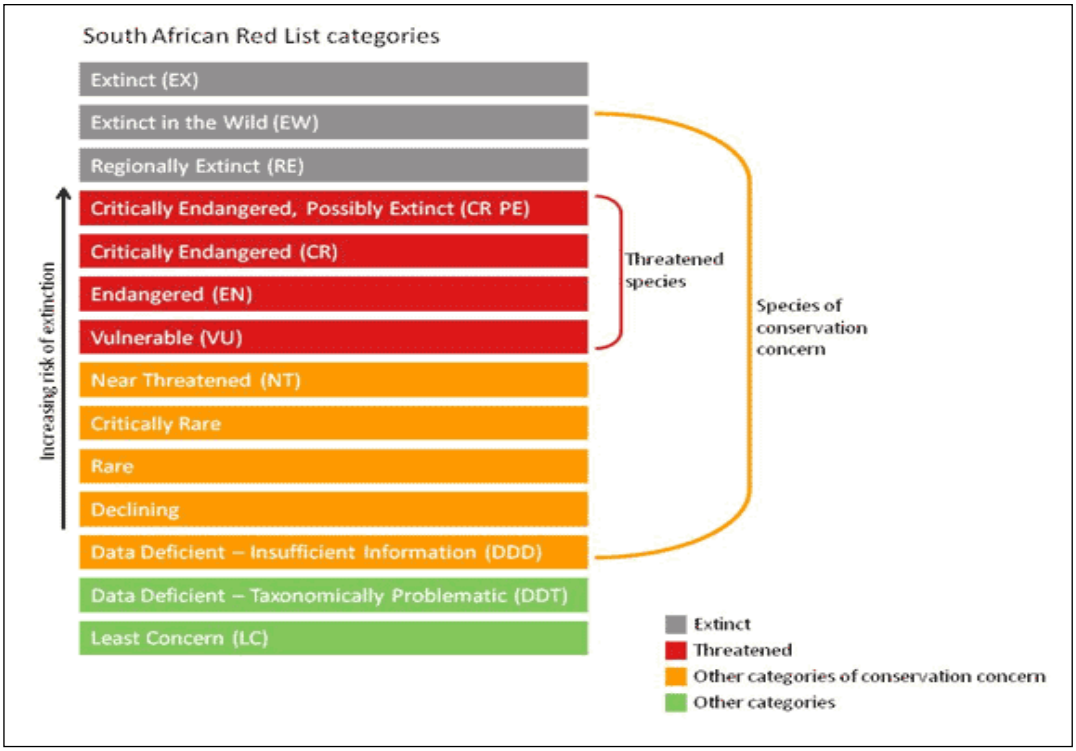


Figure 11: South African red list categories indicating the categories to be used for Species of Conservation Concern.

A list of red data plant species previously recorded in the study area in which the proposed development is planned was obtained from the Plants of Southern Africa (POSA) database of SANBI. The following red data species are listed for the specific Quarter Degree Grid Square (QDS) (Table 12).

Table 12: Red data species potentially occurring in the project area according to the POSA database.

Family	Species	Common Name	Threat status
Myrothamnaceae	*Myrothamnus flabellifolius*	Resurrection Plant	Data Deficient

None of this species was documented during the surveys considering that the habitat is completely different (normal habitat rocky ridges and boulders in pristine mountainous terrain).

5.8.2 Protected Plants (LEMA)

Plant species are also protected according to the North West Nature Conservation Ordinance. According to this Act, no person may pick, import, export, transport, possess, cultivate or trade in a specimen of a specially protected or protected plant species. The Appendices to the Act provide an extensive list of species that are protected. After a detailed survey of the vegetation surrounding the site, it was concluded that none of the listed species potentially occurred on the proposed development sites.

5.8.3 Protected tree species (NFA)

The National Forest Act (no.84 of 1998: National Forest Act, 1998) provides a list of tree species that are considered important in a South African perspective because of scarcity, high utilization, common value, etc. In terms of the National Forest Act of 1998, these tree species may not be cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold – except under license granted by DWAF (or a delegated authority). Obtaining relevant permits are therefore required prior to any impact on these individuals. Taking cognizance of the data obtained from the field surveys of the direct surrounding, it was concluded that no protected trees occurred on the proposed development sites.

5.8.4 Invasive alien species

Invasive alien plants pose a direct threat not only to South Africa's biological diversity, but also to water security, the ecological functioning of natural systems and the productive use of land. They intensify the impact of fires and floods and increase soil erosion. Of the estimated 9000 plants introduced to this country, 198 are currently classified as being invasive. It is estimated that these plants cover about 10% of the country and the problem is growing at an exponential rate.

The Alien and Invasive Species Regulations (GNR 599 of 2014) are stipulated as part of the National Environmental Management: Biodiversity Act (10/2004). The regulation listed a total of 559 alien species as invasive and further 560 species are listed as prohibited and may not be introduced into South Africa. Below is a brief explanation of the four categories of Invasive Alien Plants as per the regulation.

- Category 1a: Invasive species requiring compulsory control. Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.
- Category 2: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.
- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed,

move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Cat 3 plants to exist in riparian zones.

The following alien invasives and exotic plant species were recorded on the site and surroundings during the surveys as stipulated in the Alien and Invasive Species Regulations (GNR 599 of 2014) (Table 13):

Table 13: List of exotic plant species of the study area.

Species	Category
Argemone ochroleuca	1b
Cereus jamacaru	1b
Conyza albida / Conyza bonariensis	1b
Datura stramonium	1b
Eucalyptus camaldulensis	1b
Ipomoea purpurea	1b
Jacaranda mimosifolia	2
Laggera decurrens	1b
Lantana camara	1b
Leucacena leucacephala	2
Melia azedarach	1b
Morus alba	2
Nicotiana glauca	1b
Opuntia ficus-indica	1b
Ricinus communis	2
Sesbania bispinosa	1b
Solanum mauritianum	1b
Tamarisk chinensis	1b
Tecoma stans	1b
Tipuana tipu	1b
Tithonia rotundifolia	1b
Verbena brasiliensis	1b
Xanthium struamrium	1b

According to the amended regulations (No. R280) of March 2001 of the Conservation of

Agricultural Resources Act 1983 (Act no. 43 of 1983), it is the legal duty of the land user/landowner to control invasive alien plants occurring on the land under their control. The State has the right to clear invasive plants at the landowner's expense if the landowner refuses to remove invasive plants.

5.9 WETLAND / RIPARIAN SPECIALIST STUDIES

DWAF (2003) states that to classify an area as a wetland it must have one or more of the following attributes:

- Hydromorphic soils that exhibit features characteristic of prolonged saturation.
- The presence of hydrophytes (even if only infrequently); and
- A shallow water table that results in saturation at or near the surface, leading to the development of anaerobic conditions in the top 50cm of the soil.

Dr. Henning from Exigo conducted a site visit in 2016, with a follow up survey during 2019. The following is a summary of the findings. The following wetland types have been identified on site and are described below:

- Valley bottom wetland with channel;
- Water course;
- Man-made dam (depression).

The state of the wetlands on site was found to be unchanged between 2016 and 2019.

5.9.1 Valley bottom with channel

The Sandspruit and its tributary from the south are classified as a Valley bottom wetland with a channel. Valley bottom wetlands are classified as low-lying, gently sloped areas that receive water from an upstream channel and/or form adjacent hillslopes, not subject to periodic over-bank flooding by a river channel. Surface water in the valley bottom wetlands of the study area flows only seasonally, although the channels are in most cases perennial.

One type of valley bottom wetlands is associated with the study area as classified by SANBI (2009) namely channelled valley bottom wetlands. A channelled valley-bottom wetland is classified as a mostly flat valley-bottom wetland dissected by and typically elevated above a channel. Dominant water inputs to these areas are typically from the channel, either as surface flow resulting from overtopping of the channel bank/s or as interflow, or from adjacent valley-side slopes (as overland flow or interflow). Water generally moves through the wetland as diffuse surface flow, although occasional, short-lived concentrated flows are possible during flooding events. Small depressional areas within a channelled valley-bottom wetland can result in the temporary containment and storage of water within the wetland. Water generally exits in the form of diffuse surface flow and interflow, with the infiltration and evaporation of water from these wetlands also being

potentially significant (particularly from depressional areas). The hydrodynamic nature of channelled valley-bottom wetlands is characterised by bidirectional horizontal flow, with limited vertical fluctuations in depressional areas (SANBI, 2009).

The vegetation structure of the valley bottom wetlands varies from the actual channels being closed grassland in certain areas (Photograph 11), to a sandy riverbed with alluvial sand and conglomerates along the riverbanks. The drainage channels that from part of the channelled valley bottom wetlands is mostly non-perennial.

The most abundant and most conspicuous plant species is hygrophilous grasses such as *Sporobolus africanus, Paspalum dilatatum, Andropogon eucomis, Hyparrhenia tamba, Eragrostis gummiflua* and *Setaria sphacelata*. Other plants associated with valley bottom channels are *Cyperus sexangularis, Schoenoplectus corymbosus* and *Typha capensis*.

Unfortunately, the valley bottom wetlands provide a distribution route for weeds and invading trees (Photograph 12). Many of the usual weeds were recorded together with *Tecoma stands, Solanum mauritianum, Leucaceana leucocephala, Xanthium strumarium*, *Datura stramonium* and *Flaveria bidentis*. Weeds and invaders should be removed, as well as destruction of such plants in a safe place and manner.

Photograph 11. Sandspruit at the point where it leaves the Glencore Kroondal property to the south-west of the mining operations

Photograph 12. Alien invasive species along the banks of the Sandspruit

5.9.2 Channels (water courses) and riparian woodland

The modified canals (Photograph 13) and a small channel in a rocky section of the project area represent river channels and are classified as channels or water courses. A Channel (river, including the banks) can be described as follows: an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. At Level 4A of the classification system, the entire active channel (including wetlands occurring on the banks, i.e., in the riparian zone) is treated as a unit.

No vegetation grows in the channel itself other than the edges of the channel where sedges (*Cyperaceae* spp) and hygrophilous grasses (*Sporobolus africanus, Setaria sphacelata*) grow.

The substrate in the channel is composed of solid bedrock in gorges, while in the lower-lying open valleys the channel is characterized by riversand with smaller pebbles and some areas where large rocks occur along the banks. The modified section of the valley bottom wetland to the west of the

culverts represents a water course rather than a wetland area due to the area previously being part of the opencast mining area (Photograph 14).

In the case of the major channel, the riparian woodland of the area is mostly sparse with species such as *Searsia lancea* and *Acacia karroo* documented. Most of the riparian woodland has been removed by local communities and the herbaceous component is poorly developed along the riverbanks due to overgrazing by the livestock of the local communities and dominated by species such as *Sporobolus africanus* and *Cynodon dactylon*.

Photograph 13. Canal to the east of the culverts

Photograph 14. Modified section of a valley bottom representing a water course

5.9.3 Man-made dam (depression)

The Catchment Dam (stormwater dam) represents a man-made dam also classified as a depression (Photograph 15). A depression is classified as a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates. Dominant water sources are precipitation, dewatering water, interflow and (diffuse or concentrated) overland flow. For 'depressions with channelled inflow', concentrated overland flow is typically a major source of water for the wetland, whereas this is not the case for 'depressions without channelled inflow'. Dominant hydrodynamics are (primarily seasonal) vertical fluctuations. Depressions may be flat-bottomed (in which case they are often referred to as 'pans') or round bottomed (in which case they are often referred to as 'basins') and may have any combination of inlets and outlets or lack them completely.

The vegetation associated with depressions is mostly reeds, sedges and bulrushes depending on the depth of the water and the substrate. Species such as *Typha capensis, Phragmites australis, Schoenoplectus corymbosus, Ludwigia stolonifer* and *Leersia hexandra* mostly grow along the shallow edges of the return water dam in the project area on a muddy substrate.

Photograph 15.Catchment dam representing a man-made depression in the project area

5.10 WETLAND INTEGRITY ASSESSMENTS

In determining the integrity of the water courses, the condition of the site and the indirect and direct disturbances is considered. The embankments, roads, alien invasive vegetation species, littering etc. was considered in determining the PES and EIS of these wetland units at the crossing. Appendix F and G indicate the scores for the PES and EIS respectively.

Evidence was observed on site of transformation of the floristic characteristics of the site.

Impacting activities which may have altered the expected floristic composition include alien infestation, impoundment and road development crossings.

Table 14 indicate the PES and EIS as determined for this crossing. The secondary roads, impoundments and alien invasion had a definite impact on downstream areas.

Table 14: Present Ecological State and Ecological Importance & Sensitivity of the wetland and riparian systems on the project area.

Wetland	PES	EIS
Sandspruit & tributary	Class D Largely modified	Low

The Sandspruit and its tributary are classified as having a 'Largely Modified' PES, due to the protected environment created by the dense riparian woodland along its banks, although the ecosystem is still impacted by erosion, sedimentation, alien species invasion and water pollution from upstream activities. This wetland system has a 'Low' EIS and is ecologically important and sensitive on a local scale. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.

5.11 FAUNA

5.11.1 Overview

A healthy environment is inhabited by animals that vary from micro-organisms to the birds and mammals. The species composition and diversity are often parameters taken into consideration when determining the state of the environment. A comprehensive survey of all animals is a time-consuming task that will take a long time and several specialists to conduct. The alternative approach to such a study is to do a desktop study from existing databases and conduct a site visit to verify the habitat requirements and condition of the habitat. If any rare or endangered species are discovered in the desktop study that will be negatively influenced by the proposed development, specialist surveys will be conducted.

Previous surveys were conducted in the project area to identify specific fauna habitats, and to compare these habitats with habitat preferences of the different fauna groups (birds, mammals, reptiles, amphibians) occurring in the QDS. During the site visits mammals, birds, reptiles, and amphibians were identified by visual sightings through random transect walks. In addition, mammals were also recognized as present by means of spoor, droppings, burrows or roosting sites. The 500 meters of adjoining properties were scanned for important fauna habitats.

During the site observations by NSS the following have been observed on site:

- Five mammal species

- Sixty-Five bird species
- One frog and
- Ten dragonfly species

MammalMap (2015) lists 27 species for the Quarter Degree Square (QDS) 2527CB covering the study area. Species observed on site include Single-striped Mouse, Scrub Hare, Common Mole-rat, Multimammate Mouse and Water Mongoose (NSS, 2015).

Mine shafts in the vicinity may provide suitable habitat for a few bat species (NSS, 2015).

Of the 400 regionally occurring bird species 331 have been recorded during SABAP 1 & 2 (2015) surveys in the QDS (2627DB) and pentad (2540_2715) covering Kroondal. Most of these species are likely to have been recorded at more significant habitat features in the area and only some 225 species are likely to occur on site. During all visits to Kroondal NSS has recorded 65 species.

Kroondal is likely to receive a mixed compliment of bird species from bank nesting species to waterbirds, bushveld and garden birds. The steep-sided tailings and stockpile slopes in the south-east provide suitable nesting habitat for certain kingfishers, bee-eaters, martins and swifts. The various small artificial dams with their dense marginal vegetation provide suitable habitat for several waterbird species such as crakes, rails, coots, ducks, herons and warblers.

Of the 70 regionally occurring reptile species 31 have been recorded during atlassing projects in the QDS (ReptileMap, 2015) and 37 are considered likely to occur on site based on distribution and the availability of suitable habitat. During the 2015 site visits by NSS three species were detected namely variable skink and rock monitor (NSS, 2015). Nile crocodile is not a species that, under normal circumstances would be expected to occur. However, at the time of writing the report, a large crocodile breeding facility bordered Kroondal Mine to the south-east and it is entirely possible that escapees may utilise the various waterbodies on site and indeed there have been reports of and individual wandering onto site in the past (NSS, 2015).

Of the 24 regionally occurring frog species 12 species have been recorded during atlassing surveys in the QDS (FrogMap, 2015) but 14 are considered likely to occur on site based on distribution and the availability of suitable habitat. One frog species was recorded during the NSS site visit, namely the Eastern Olive Toad. (NSS, 2015).

5.12 Fauna Habitats

The number of mammal species supported by a plant community depends on several factors like the primary production, seasonal availability of resources, floral heterogeneity, diversity of plant structure, nature of the substratum and previous history (Delany, 1982). Each mammal species has a particular niche, which can be regarded as the sum of all ecological requirements of a species namely food, space, shelter and physical conditions. Mills & Hes (1997) stated that the

distribution and abundance of animal species does not rigorously follow that of plant communities or biomes. Instead, mammal species seem to have certain preferences for a specific habitat type (Skinner & Smithers, 1990).

A survey was conducted during May 2019 to identify specific fauna habitats, and to compare these habitats with habitat preferences of the different fauna groups (birds, mammals, reptiles, amphibians) occurring in the quarter degree grid. The area represents degraded grassland, alien bushclumps, microphyllous woodland and riverine habitats (including riparian woodland and open water) with a diverse vegetation structure and height class. A detailed species list for the fauna of the area is included in Appendix C, D and E.

During the site visits mammals, birds, reptiles, and amphibians were identified by visual sightings through random transect walks. In addition, mammals were also recognized as present by means of spoor, droppings, burrows or roosting sites.

The regional fauna has been studied extensively and is known to exhibit many unique features. The area has been settled for many centuries, and the fauna is usually considered impoverished due to the degradation caused by mining activities, built-up land and other man-induced impacts. There are four main faunal habitat types present on the site that might be impacted on by the proposed project.

Four major fauna habitats were observed in the area namely:

- Exotic bushclumps.
- Microphyllous woodland.
- Degraded grassland.
- Riverine habitat

5.13 Mammals

Large mammals that occurred historically at the site are mainly restricted to game reserves and national parks in the area. This loss of large species on the private land that forms part of the project area means that the mammal diversity on these sites is far from its original natural state not only in terms of species richness but also with regards to functional roles in the ecosystem.

Mammals are sensitive to disturbances and habitat destruction and degradation and as such the anticipated species diversity of the study area would be low. Settlement areas have negated the possibility of encountering any medium to large mammals. The presence of feral dogs and cats as well as poaching activities, poses a threat to the presence of mammals on sites. The mammals are mostly represented by generalised species such as rodents, scrub hares and smaller antelope (steenbok, common duiker) that will move through the area while foraging. The proximity of the

informal settlements does however place constant pressure on these mammal populations and many of these populations will eventually disappear from the area completely. The natural habitats associated with the area will still support populations of herbivores such as duiker and steenbok

Most of the habitat types are degraded and fragmented, although the habitat will still be utilized by small mammals such as rodents still intact. Therefore, the expected mammalian richness on these areas is considered low, especially for the more degraded areas. Antelope species such as duiker still roam this small area (dung, spoor identified) and are not restricted by game fences. Smaller mammal species such as honey badgers and serval can become habituated to anthropogenic influences, while other species will rather move away from the construction activities and will seldom use the area. Many of the bat species of conservation concern in the project area are cave-dependant for roosting or alternatively could inhabit the mine shafts on site. Any individuals that utilize the proposed new infrastructure area would therefore either be foraging or migrating and would not be affected by the localized loss of habitat due to the development. The dominant species composition therefore comprises of widespread taxa with unspecialised life history traits.

Most mammal species are highly mobile and will move away during construction. The impact will also be low if one compares the footprint of the development and the overall range of individual species. It is therefore considered highly unlikely that any mammal species that still occur in the area will be affected negatively by the development of the mining infrastructure, although mitigation measures should be enforced. The connectivity1 of the project site to the remainder of the larger area is poor due to other developments, roads, agriculture and mining activities. The most important corridors that need to be preserved for free-roaming mammal species in the larger area include Sandspruit and its tributary. The only area where these areas will be impacted is at the crossing of the pipeline or indirect impacts associated with construction and operational activities. The use of trapping techniques was not deemed necessary due to the degraded state of the natural environment.

5.14 Birds (avifauna)

Three major bird habitat systems were identified within the borders of the study site, including the woodland, degraded grassland and riverine habitats.

Most bird species identified within the study area are common species known to nest within or utilise the degraded grassland, riparian woodland and microphyllous woodland habitat in the region and may be either permanently or occasionally present within the study area. According to

1 C**onnectivity (habitat connectivity)** - Allowing for the conservation or maintenance of continuous or connected habitats, to preserve movements and exchanges associated with the habitat.

Birdlife South Africa, the study area falls inside the Magaliesberg Important Bird Area (IBA), although in terms of habitat the site is not typical of the Magaliesberg habitat type for avifauna.

Microphyllous woodland usually supports much higher bird numbers compared to the broadleaved woodlands. The ground cover between the trees consists of mainly short grasses interspersed with shrubs (Barnes, 1998). The plains area where the proposed CDF and PCD is planned, represents microphyllous woodland and supports many smaller bird species such as Ashy Tit, Pied Babbler, Kalahari Robin, Burntnecked Eremomela, Desert Barred Warbler, Marico Flycatcher, Pririt Batis, Crimsonbreasted Shrike, Longtailed Shrike, Threestreaked Tchagra, Great Sparrow, Whitebrowed Sparrowweaver, Scalyfeathered Finch, Violeteared Waxbill and Blackcheeked Waxbill.

In general terms the open grassland patches in between the microphyllous woodland could attract the Secretarybird, White-bellied Korhaans, and White Stork and Abdim's Stork. However, the proximity to various residential areas and informal settlements means that disturbance levels in these areas are likely to be high due to humans, and hunting by dogs, and therefore the potential to find these species in the area are considered very low. The low reporting for these species is evidence of the impact that the surrounding communities are having on the birds that would, under optimum conditions, inhabit these open areas. The grassland patches are also a favourite foraging area for non Red Data game birds such as Swainson's Spurfowl and Helmeted Guineafowl. This in turn could attract large because of both the presence and accessibility of prey. Many habitat generalist species utilize this habitat type predominantly for foraging and hunting purposes. The disturbances of the topsoil layers also very often allow for greater foraging for insectivorous species. The farmland habitat type, however, is not a habitat type that is relied upon by any avifaunal species for survival.

The conservation status of many of the bird species that are dependent on riverine areas reflects the critical status of wetlands or rivers nationally, with many having already been destroyed. The Sandspruit is in a degraded state therefore the probability of finding any red data species in this area was considered low.

5.15 Herpetofauna (Reptiles and Amphibians)

There is a potential presence of some toads and sand frogs in the non-perennial river on site, as they only need temporary pools for reproduction and the riverine area may provide suitable habitat. Amphibian species potentially occurring in the area include Common River Frog, Natal Sand Frog, Gutteral Toad, Raucous Toad and Bubbling Kassina. These species are non-threatened and widespread species, and as such the development will not have any impact on amphibian conservation within the region.

Reptile species such as the southern rock python, the black mamba, puff adder, snouted cobra

boomslang, vine snake, spotted bush snake and several members of the green snakes (Philothamnus spp.) is expected to occur in the larger area, although the potential to find these species in the project area is low due to the anthropogenic influences. The general habitat type for reptiles consists of open to very dense bushveld, with limited available habitat for diurnally active and sit-and-wait predators, such as terrestrial skinks and other reptiles. Arboreal species are the more prominent components of the local herpetofauna in the woodland areas outside the fenced mining area.

A few baby crocodiles were observed in the Catchment Dam and the Silt Trap of the Kroondal Mine. The crocodiles hatched from eggs that were left behind when the Crocodile Farm was abandoned recently. The small crocodiles need to be removed from the area by a crocodile specialist.

5.16 Red data species

According to the existing databases and field survey the following number of fauna species included in the IUCN red data lists can potentially be found in the study area (Table 12):

Table 15: Red data list of potential fauna for the study area.

English Name	Conservation Status	Probability of occurrence
MAMMALS		
Brown Hyena	Near Threatened	Low
Serval	Near Threatened	Low
Tsessebe	Vulnerable	Zero – restricted to game reserves
Sable antelope	Vulnerable	Zero – restricted to game reserves
Leopard	Vulnerable	Low
BIRDS		
Korhaan, Southern Black	Vulnerable	Low
Kingfisher, Half-collared	Near Threatened	Low
Eagle, Tawny	Endangered	Medium
Eagle, Verreauxs'	Vulnerable	Low
Stork, Abdim’s	Near Threatened	Low
Stork, Black	Vulnerable	Low
Roller, European	Near Threatened	Medium
Korhaan, White-bellied	Vulnerable	Low
Falcon, Lanner	Vulnerable	Low
Vulture, White-backed	Endangered	Low
Vulture, Cape	Endangered	Low
Duck, Maccoa	Near Threatened	Low

English Name	Conservation Status	Probability of occurrence
Eagle, Martial	Endangered	Low
Secretarybird	Vulnerable	Low
Owl, African Grass	Vulnerable	Low
HERPETOFAUNA		
Crocodile	Vulnerable	Confirmed

6 BIODIVERSITY IMPACT ASSESSMENT & VALUE

An environmental impact is defined as a change in the environment, be it the physical/chemical, biological, cultural and or socio-economic environment. Any impact can be related to certain aspects of human activities in this environment and this impact can be either positive or negative. It could also affect the environment directly or indirectly and the effect of it can be cumulative.

There are three major categories of impacts on biodiversity namely:

- Impacts on habitat resulting in loss, degradation and / or fragmentation;
- Direct impacts on fauna and flora and species, for example plants and animals that are endemic / threatened / special to a particular habitat will not be able to survive if that habitat is destroyed or altered by the development; and
- Impact on natural environmental processes and ecosystem functioning. This can lead to an accumulated effect on both habitat and species.

There are three levels at which biodiversity can be approached - namely the genetic, the species and the ecosystem levels. Genetic diversity refers to the variation of genes within species. Species diversity refers to the variety and abundance of species within a geographic area. Ecosystem diversity can refer to the variety of ecosystems within a certain political or geographical boundary (National Environmental Management Biodiversity Act, 2004). This biodiversity assessment focused on the description of ecosystem- and species-related biodiversity. It can be expected that if ecosystem diversity is managed effectively, species and genetic diversity should also be protected. Emphasis was therefore placed on the ecosystem diversity (landscape/habitat types) within the proposed mining operational area, with reference to biota observed and expected to utilise these landscapes or habitat types. The impact of the mining on the biodiversity of the study area is presented in the form of a Risk Analysis for each of the biodiversity components related to the plant. The analysis will relate to each biodiversity component (topography, soil, vegetation, fauna), as well as the biodiversity management units for the mining sites and the surrounding areas that might be impacted on as well.

6.1 PER ENVIRONMENTAL / BIODIVERSITY COMPONENT

- Vegetation (vegetation classification and units, threatened plants, declared weeds and alien plants); and
- Fauna (frogs, reptiles, birds, mammals, fish, aquatic macro-invertebrates, threatened fauna).

6.2 PER BIODIVERSITY MANAGEMENT UNITS (VEGETATION UNIT) ASSOCIATED WITH THE PROJECT SITE:

The Glencore Kroondal Mine was divided into 2 biodiversity management units (BMU's). The aim of defining biodiversity management units was to identify homogenous discernible areas, each with distinctive biodiversity composition and related aspects. The broad-scale vegetation units provided a basis for the determination of different areas with homogenous vegetative characteristics, which in general also reflects discernible different faunal biotopes and are also visually identifiable within the study area. For these reasons, the vegetation units therefore formed the basis for the determination of the Biodiversity Management Units.

The identification and description of the Biodiversity Management Units (BMU's) is discussed in section 7 of the report.

6.3 POTENTIAL IMPACTS OF THE GLENCORE KROONDAL MINE ON BIODIVERSITY

6.3.1 CONSTRUCTION PHASE

The development and start-up of the mining operations covers the period when considerable changes take place as the mine infrastructure are constructed. The most immediate impacts are disruptions and disturbances to flora communities due to site clearance for construction of the CDFs, PCD, topsoil stockpiles and support infrastructure (conveyor, roads etc.). This is usually a significant change to the visual appeal of the area.

Exposure of rocks, ore and soils to rainfall and wind may lead to atmospheric contamination by dusts and increased erosion of the site and sedimentation of local water courses. An increase in the movement of construction vehicles will result in an increase in the dust levels in the area.

The following impacts will occur during the Construction Phase of the proposed Glencore Kroondal Mine expansion project:

- The construction phase of the mining development will result in loss of and damage to natural habitats if the vegetation is cleared for the development of infrastructure (CDFs, PCD, silt trap, and laydown areas for the stockpiles. Rehabilitation of some areas would be possible but there is likely to be long-term damage in large areas. Most habitat destruction will be caused during the construction phase. Vegetation communities are likely to be impacted on a very small spatial scale in comparison to the extent of the vegetation communities' total area in the region;
- The mining development will inevitably result in natural movement patterns being disrupted and, to a varying degree depending on how different species react to these barriers will result in the fragmentation of natural populations. The fencing of the mining area and construction of mining infrastructure will have a large, significant impact in

fragmenting the habitats on and around the site.

- The construction activities associated with the mining developments may result in widespread soil disturbance and is usually associated with accelerated soil erosion. Soil erosion promotes a variety of terrestrial ecological changes associated with disturbed areas, including the establishment of alien invasive plant species, altered plant community species composition and loss of habitat for indigenous flora;
- Construction work of the magnitude contemplated for the proposed development will always carry a substantial risk of soil and water pollution, with large construction vehicles contributing substantially due to oil and fuel spillages. If not promptly dealt with, spillages or accumulation of waste matter can contaminate the soil and surface or ground water, leading to potential medium/long-term impacts on the flora of the site;
- The environmental impacts of wind-borne dust, gases and particulates from the construction activities associated with the proposed development will have an impact on the vegetation of the area when dust settles on plant material reducing the amount of light reaching the chlorophyll in the leaves, thereby reducing photosynthesis, which in turn reduces plant productivity, growth and recruitment;
- Continued movement of personnel and vehicles on and off the site during the construction phase, as well as occasional delivery of materials required for maintenance, will result in a risk of importation of alien species. Vehicles often transport many seeds and some may be of invader species, which may become established along the road, especially where the area is disturbed. The construction almost certainly carries by far the greatest risk of alien invasive species being imported to the site, and the high levels of habitat disturbance also provide the greatest opportunities for such species to establish themselves, since most indigenous species are less tolerant of disturbance. The biggest risk is that seeds of noxious plants may be carried onto the site along with materials that have been stockpiled elsewhere at already invaded sites.
- Disturbance of remnant terrestrial wild mammal, avian, amphibian and insect fauna would probably occur through physical habitat destruction, noise, traffic and movement of people. The impact of the construction would be MODERATE considering that animals would move away from the area, while some ground-burrowing species such as moles and reptiles might be killed in the process. There are however no specific red data species that would be critically impacted on by the constructional phase.
- Potential increase in feral animals and impact on indigenous fauna e.g., cats, rats.
- Illegal hunting or disturbance.

- Operation or disturbance during breeding season can precipitate long-term cumulative effect on populations.

The following impacts on the flora and fauna apply to both the Glencore Kroondal Mine Expansion Project for the various components during the construction phase:

Tailings Storage Facility and Return Water Dam

- **Activity 1:** Vegetation clearing
- **Related impacts**
    - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
    - Fragmentation of fauna habitats;
    - Potential establishment and spread of declared weeds and alien invader plants
- **Activity 2:** Topsoil and subsoil stripping
- **Related impacts**
    - Increased Soil erosion and sedimentation;
    - Habitat degradation due to dust;
- **Activity 3: Vehicle movement**
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna

Waste rock dumps

- **Activity 1:** Vegetation clearing
- **Related impacts**
    - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
    - Fragmentation of fauna habitats;
    - Potential establishment and spread of declared weeds and alien invader plants
- **Activity 2:** Topsoil and subsoil stripping
    - Increased Soil erosion and sedimentation;
    - Habitat degradation due to dust;
- **Activity 3: Vehicle movement**
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;

- Road mortalities of fauna

6.3.2 Support infrastructure

- **Activity 1:** Vegetation clearing
- **Related impacts**
  - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
  - Fragmentation of fauna habitats;
  - Potential establishment and spread of declared weeds and alien invader plants
  - Impacts on drainage regime at wetland / riverine crossings
- **Activity 2:** Topsoil and subsoil stripping
  - Increased Soil erosion and sedimentation;
  - Habitat degradation due to dust;
- **Activity 3: Vehicle movement during construction of surface infrastructure**
  - Spillages of harmful substances to the ecosystem;
  - Habitat degradation due to dust;
  - Road mortalities of fauna

Cumulative Impact

The cumulative impacts associated with the construction phase are the same as discussed above for the different mining components. The rating will be higher compared to the individual component ratings as the landscape scarring of are permanent features affecting the species diversity and composition of the general vegetation patterns of the study area.

6.3.3 OPERATIONAL PHASE

The routine operational phases account for most of the environmental impacts associated with mining and are considered to have the greatest potential to drive environmental change. The extent to which mining operational activities act as drivers of environmental change depends in part on the type, scale, duration and magnitude of the activities, and the sensitivity of the receiving environment.

The removal and storage (stockpiling) of ore in the operational phase is usually the most intensive activity on any mine operation. The process involves loading and transportation of the ore to the stockpile sites. These activities are characterized by large-scale disturbance due to noise and generation of dust from the movement of vehicles and possible wind-blown dust from stockpiles

at the recovery plant.

Typical activities of the operational phase will include:

- Processing of ore in the processing plant (already constructed);
- Storage of tailings in CDF;
- Disposal of waste rock on CDF;
- Transporting of people and equipment;
- Transportation of product off-site;
- Transportation of supplies to the site;
- Handling and storage of hazardous materials and substances;
- Domestic waste generation, storage and disposal;
- Water storage facilities;
- Hazardous waste storage and disposal;

A short description of the impacts associated with the operational phase is included below:

- The operational phase of the mine will have a very low impact on the vegetation of the proposed mining development site. Considering that most infrastructure (plant etc.) have already been constructed during this mining phase, the only impacts that might create habitat disturbance or loss of plant communities might be loss of plant communities and flora species of significance on the laydown areas of the waste rock and stockpiles that used to represent natural vegetation communities;
- The spread of alien invasive plants on site is more INTENSE during the operational phase of the mine due to the movement of vehicles over an extended area on and from the site, causing a higher risk of potentially spreading the seeds or vegetative material from invasive species. Although construction creates the suitable conditions for establishment of invasive species, the operational phase certainly carries by far the greatest risk of alien invasive species being spread through the area and even through the wetland systems to the greater region. This risk is further influenced by increased run-off because of exposed areas and hardened surfaces created during the construction phase of the mine;
- The increased hardened surfaces around infrastructure and exposed areas created alongside the roads and additional surface areas created on the slopes of the stockpiles and waste rock dumps will have a definite impact on the potential erosion of exposed areas that will eventually cause sedimentation in the wetlands and streams of the area. Soil erosion promotes a variety of terrestrial ecological changes associated with disturbed

areas, including the establishment of alien invasive plant species, altered plant community species composition and loss of habitat for indigenous flora;

- During the operational phase heavy machinery and vehicles as well as sewage and domestic waste would be the main contributors to potential pollution problems;
- The impact of the operational phase of the mine relates more to the habitat loss of fauna because of specific mining activities. Furthermore, developments can threaten migration routes or flight paths because of noise and dust pollution. Cumulative impact of illegal collecting, road kills or power line related deaths reduce population viability in the long-term. Some mining related habitats also favour species leading to un-natural competition with endemic fauna. Much of the impacts of the fauna related to the construction phase of the mining development also apply to the operational phase of the mine.

The following impacts on the flora and fauna apply to the Glencore Kroondal Mine for the various components during the operational phase:

Run of Mine Ore Stockpiles

- **Activity 1: Laydown areas of stockpiles**
- **Related impacts**
    - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
    - Fragmentation of fauna habitats;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Increased soil erosion and sedimentation (increased runoff from laydown areas); and
    - Habitat degradation due to dust.
- **Activity 2: Materials handling, storage and transportation**
    - Habitat degradation due to dust; and
    - Road mortalities of fauna.
- **Activity 3: Crushing and stockpiling**
    - Habitat degradation due to dust; and
    - Increased soil erosion and sedimentation (increased runoff from hardened surfaces and slopes of stockpiles);

6.3.3.2 Co-Disposal Facilities, Pollution Control Dam, stockpiles, silt trap

- **Activity 1: Stockpiling of residue deposits**
- **Related impacts**
    - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
    - Fragmentation of fauna habitats;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Increased Soil erosion and sedimentation (increased runoff from laydown areas);
    - Habitat degradation due to dust.
- **Activity 2: Materials handling and storage**
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna.
- **Activity 3: Disposal of tailings and waste rock dump on CDF:**
    - Spillages of harmful substances to the ecosystem.

6.3.3.3 Support infrastructure

- **Activity 1: Materials handling and storage**
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna
- **Activity 2: Storm water management:**
    - Increased Soil erosion and sedimentation;
- **Activity 3: Vehicle movement during construction of surface infrastructure, access road and bridges**
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna

6.3.3.4 Cumulative Impact

The cumulative impacts associated with the operational phase are the same as discussed above for the different mining components. The rating will be higher compared to the individual

component ratings, especially if one considers that water extraction and dust pollution will be increased through the operation of the mines. This will contribute to a loss of diversity and species composition over the larger area of the Vegetation Type. Cumulative effects only become critical if there are no other suitable habitats in the adjacent areas.

6.3.4 DECOMMISSION PHASE

This phase starts when all the economically exploitable mineral reserves in an area have been extracted. The actions which mark this phase include:

- Cessation of mining; and
- Removal of mine infrastructure.

The only major impacts on the vegetation during this phase would be the potential increased invasion of alien species and weeds on the cleared areas, while the risks of spreading fires will also still exist. Otherwise, there should be no further negative impact on surrounding vegetation during decommissioning.

6.3.4.1 Processing Plant, and Mine shaft

- **Activity 1: Demolition of mining infrastructure**
- **Related impacts**
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust; and
    - Road mortalities of fauna.

6.3.4.2 Co-Disposal Facilities, Pollution Control Dam, silt traps, Waste rock dump (WRD), Return Water Dam (RWD) and Tailings Storage Facility (TSF)

- **Activity 1: Demolition of mining infrastructure**
- **Related impacts**
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna

6.3.4.3 Support infrastructure

- **Activity 1: Demolition of mining infrastructure**

- **Related impacts**
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna.

6.3.4.4 Cumulative Impact

The cumulative impacts associated with the decommissioning phase are the same as discussed above for the different mining components. The rating will be slightly higher compared to the individual component ratings.

6.3.5 CLOSURE PHASE

The closure phases of the mine involve rehabilitation actions to mitigate impacts caused during the construction and operational phase of the mine. Some of the rehabilitation actions include the following:

- Rehabilitation of the areas surrounding the shafts, plant and the decline;
- Ripping and rehabilitation of all haul roads;
- Rehabilitation of the CDFs, WRDs and PCDs; and
- Seeding of ripped and rehabilitated surfaces.

Amongst the more pronounced post-closure impacts on flora are landscape scarring in the form of unrehabilitated mine facilities, discard dumps and open pits, as well as continuing environmental damage from wind-blown dusts and the dispersal of contaminated solid waste. If mitigation measures are correctly implemented there should be not be any further significant impact on the surrounding natural vegetation after closure.

The following impacts are associated with the closure phase of the mine:

- Soil compaction is likely to occur over much of the rehabilitated area because of the storage and placement of soil and the change in structure following replacement. The poor soil cover associated with the cleared areas also renders the site more susceptible to erosion and soil loss. It is probable that these soils will be transferred through the rehabilitated landscape into the draining water courses and receiving water bodies as described earlier. The rehabilitation of the site and decreased surfaces will however still reduce the risk of erosion and sedimentation carried into the wetlands and rivers during

the closure phase, compared to the other phases;

- During the closure phase of the mine the risk of spillages are still pertinent, although the impact will mainly be limited to potential spillages from vehicles. The impact will therefore be greatly reduced because of concurrent rehabilitation;

- Dust generation can temporarily increase during closure phases of the mine. This is due to rehabilitation activities. During this phase, the impacts should last for a short period. The impact of dust on the vegetation will however be at a reduced intensity during the closure phase compared to the construction and operational phases of the mine because of the rehabilitation measures. The revegetation of exposed areas will play a major role in this regard;

- The control of alien invasive species will be more pertinent during the closure phase of the mine and the risk of spreading is therefore reduced. Although the movement of vehicles on site during rehabilitation will still have a potential impact on the spreading of alien invasive species, the intensity of spread of alien invasive plants on site is more intense during the operational phase of the mine due to the movement of vehicles over an extended area on and from the site, causing a higher risk of potentially spreading the seeds or vegetative material from invasive species; and

- The impact on fauna mortality will continue during the closure phase because of rehabilitation activities on site.

6.3.5.1 Processing Plant and mining shafts

- **Activity 1: Rehabilitation**
- **Related impacts**
    - Positive impact through habitat improvement in rehabilitated areas;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust; and
    - Road mortalities of fauna

WRDs, CDFs and PCDs

- **Activity 1: Rehabilitation**
- **Related impacts**
    - Positive impact through habitat improvement in rehabilitated areas;
    - Potential establishment and spread of declared weeds and alien invader plants;

- Spillages of harmful substances to the ecosystem;
- Habitat degradation due to dust;
- Road mortalities of fauna

Support infrastructure

- **Related impacts**
  - Positive impact through habitat improvement in rehabilitated areas;
  - Potential establishment and spread of declared weeds and alien invader plants;
  - Spillages of harmful substances to the ecosystem;
  - Habitat degradation due to dust; and
  - Road mortalities of fauna.

Cumulative Impact

The cumulative impacts associated with the closure phase are the same as discussed above for the different mining components. The rating will be slightly higher compared to the individual component ratings, although much lower compared to the other phases of the development. The impacts associated with the rehabilitation of the mining sites are positive considering that the rehabilitated land will improve habitats in the area, even though it still represents degraded land.

7 ASSESSMENT OF BIODIVERSITY VALUE

The biodiversity of an area is a combination of its variety of species and habitats, its ecological processes and functional value. This can be captured in two broader categories namely conservation status and functional status. The conservation status encompasses ecological services and human use services.

It is suggested due to the number of variables to be considered, that the following scoring system is used to first determine the value of each of the components namely conservation status and functional status, from which overall biodiversity is determined.

7.1 IDENTIFICATION OF BMU'S

Two main biodiversity management units (BMU's) were defined for Glencore Kroondal Mine and its associated infrastructure, distinguished by differences in biodiversity value or activities taking place within the area and outside of the owned area or licence that that may be affected by the activities.

7.2 BIODIVERSITY REVIEW AND ASSESSMENT METHODOLOGY

7.2.1 High level biodiversity review and assessment

A high-level desktop biodiversity review and assessment was conducted for each BMU based on existing documentation available for the Glencore Kroondal Mine and online biodiversity databases available at the following websites:

- Plants of southern Africa: an online checklist;
- SABIS:SABIF Integrating Biodiversity Information;
- Biodiversity GIS; and
- IBAT for Business – Integrated Biodiversity Assessment Tool.

7.2.2 Anglo American BAP Guideline biodiversity assessment

The scoring system below, taken from the Anglo-American Guideline (Anglo American, 2003) was used to qualitatively assess the value of the land under each of these categories (i.e., conservation status and functional status). This method was considered the most suitable considering that it is used for other BAP's for mines in South Africa. These values were then used to determine overall biodiversity value.

7.2.2.1 Conservation status

A. How much of the larger vegetation type or system of which the defined area is a representative example still exists?

   i. Only a small area still exists (<500km^2) 7
   ii. A moderate area still exists (500 to 1000km2) 5
   iii. A large area still exists (>1000km2) 3

B. What is the species and habitat diversity of the defined area?

   i. Noticeably high 7
   ii. Difficult to assess 5
   iii. Obviously low 3

C. What is the condition of the defined area?

   i. Pristine and largely undisturbed 7
   ii. Moderately disturbed 5
   iii. Highly disturbed 3

The possible results for the conservation status of the defined area are based on a combination of the attributes, as follows:

A (Size) + B (diversity) + C (condition) = Conservation Status

Based on the combined score, the conservation status can range from very high to low as follows:

- Very high conservation status, largely undisturbed, needs to be maintained (19-21 score);
- High conservation status, moderately disturbed, needs to be maintained and where necessary improved (15-18);
- Moderate conservation status, heavily disturbed and will require improvement (12-14); and
- Low conservation status, heavily reduced and of limited value (9-11).

The conservation status and values for each of the components for each of the BMU is presented in the tables below:

7.2.2.2 Functional status

A. Are there currently any signs of obvious recreational use of the area, such as walking / hiking, bird watching, mountain biking, fishing, etc?

- Obvious signs of regular use

  7
- S*i*gns of periodic use

  5
- No noticeable signs of use

  3

B. Does the area carry out any ecological service, such as water purification, flood attenuation, riverbank stabilisation, soil stabilisation etc.?

(a) Has an obvious functional role 7

(b) Difficult to determine its functional role 5

(c) Clearly has no to very limited functional role 3

C. Does the area serve an aesthetic role?

i. Forms part of a larger landscape that is widely visible and has a high aesthetic appeal 7

ii. Forms part of a landscape that has high aesthetic appeal, but which is not widely visible 5

iii. Forms part of a landscape that has low aesthetic appeal 3

The possible results for the functional status of the defined area are based on a combination of the attributes, as follows:

Very high service value	19 to 21
High service value	15 to 18
Moderate service value	12 to 14
Low service value	9 to 11

7.2.2.3 Biodiversity Value

The perceived biodiversity value of an area to human development is not always easy to describe, but it includes the natural system and its variety of species, the ecological processes and the service or functional value that it provides. The combination of conservation status and functional status scores provides a ranking of the overall biodiversity value for a defined area, as shown in the matrices below (Table 16):

Table 16: Matrix indicating biodiversity values from which landscapes can be classified.

	Functional status			
Conservation status	**Very high service value**	**High service value**	**Moderate service value**	**Low service value**
Very high	**Very High**	**Very High**	**Very High**	**High**
High	**Very High**	**High**	**High**	**Moderate**
Moderate	**High**	**Moderate**	**Moderate**	**Low**
Low	**Moderate**	**Moderate**	**Low**	**Low**

7.2.3 BMU profile and assessments

The following two broad BMUs were identified for the Glencore Kroondal Mine:

BMU 1: Degraded mining footprint areas; and

BMU2: Remnant natural vegetation outside the mining area but within the Glencore Kroondal Mine project area.

These BMU's are described below in Tables 17 and 18. The biodiversity value for each BMU is assessed as per the methodologies described in Section 7.2.2.

Table 17: Biodiversity profile and assessment of BMU1.

Biodiversity Unit: BMU 1 – Glencore Kroondal Mine Footprint Area	
Description: The area demarcated as the Mine Footprint BMU is comprised of those areas within the mine lease area that have been and are planned to be directly impacted through the construction of mining related infrastructure e.g., roads, shafts, offices, conveyor belt, stockpiles, stormwater dams etc.	
Diversity	The vegetation type that previously dominated the area within this BMU was Marikana Thornveld. Any biodiversity occurring in this unit is expected to be of very low diversity. Fauna is expected to have moved out into the surrounding areas.
Condition	The vegetation of this unit has either been completely removed or where any vegetation remains this has been highly disturbed. Some alien plant species have been recorded on site which indicate the modified and disturbed state of the area (refer to section under alien invasive species) The presence of alien plant species on site is symptomatic of the site's

	disturbed nature. Recommendations were made to optimise the results of rehabilitation efforts and to minimise future risks.
Rarity	Considering the degraded and in most cases completely modified state of the mining footprint areas, no rare or threatened plant species have been previously recorded within the mine footprint area. The potential to find any red data fauna on site is relatively low, except for species such as waterbirds utilizing the water sources and catchment dam for breeding and foraging.
Conservation status of vegetation type	Only small pockets of the Marikana Thornveld still occur in the mining footprint area. The conservation status of the area can therefore be considered as contributing very little to ecosystem functioning or conservation status of the vegetation types.
Ecological services	The ecosystem services likely to have been provided by this area prior to disturbance from mining activities are listed below. Provisioning services – wild foods, timber and other wood fibres, biomass fuel, freshwater, genetic resources. Regulating services – air quality regulation, global climate regulation, water regulation, erosion regulation, water purification and waste treatment, pest regulation, pollination cultural services – recreation and ecotourism, ethical and spiritual values, education and inspirational values. Other – Source of natural recovery. However, with the removal of vegetation and the decline in the condition of any remaining vegetation this area is likely to currently have none or very limited functional value.
Human use services	With the removal of vegetation and the decline in the condition of any remaining vegetation this area is likely to currently have none or very limited human use value.

Assessment			
	Low	Moderate	High
Area of habitat in used or to be used	Small	Significant	Large

in comparison to available habitat			
Diversity	Low	Moderate	High
Condition of biodiversity	Disturbed	Moderately disturbed	Pristine / near pristine
Rarity	Common	Occasional	Rare
Threat	Least concern	Vulnerable / Data deficient / Near threatened	Endangered
Endemism	Low degree of endemism	Moderate degree of endemism	High degree of endemism
Conservation status	Equivalent ecosystem protection exists	Protection of equivalent ecosystem protection planned	No protection of equivalent ecosystem
Knowledge for biodiversity management	Well researched & documented	Relatively poor	Extremely limited
Ecological service provided	Relatively unimportant	Important	Critically important
Human use service provided	Low intensity	Moderate intensity	High intensity

Biodiversity evaluation	
Conservation status criteria	**Score**
A. A large areas still exist (80%)	3

B. Low habitat and species diversity	3
C. Highly disturbed	3
Conservation status score	9 (low)
Functional status score	**Score**
A. No obvious signs of regular use	3
B. Has an obvious functional role	3
C. Forms part of a larger landscape that is widely visible and has a high aesthetic appeal	3
Functional status score	9 (low)
Biodiversity value	Low

Table 18: Biodiversity profile and assessment of BMU2.

Biodiversity Unit: BMU 2 – Remnant natural vegetation on the mining premises and mining right area.	
Description: The area demarcated as the Remnant Natural Vegetation BMU is comprised of those areas within the mine lease area that is currently naturally vegetated (although this vegetation may be in a poor condition) and is expected to remain so post closure.	
Area	All remnant natural vegetation other than the mining activity footprint (area unknown since it is constantly changing).
Diversity	The vegetation type that previously dominated the area within this BMU is Marikana Thornveld. Any biodiversity occurring in this unit is expected to be of very low diversity. Although fauna is expected to have moved out into the surrounding areas, some general game species such as duiker, steenbok and warthog still utilize the area

	successfully, while other smaller mammal and reptile species such as monkeys, slender mongoose and snakes are problem animals that need active management.
Condition	The vegetation of this unit is in a degraded state with old fields and small pockets of microphyllous woodland occur in the area. Impacts from wood harvesting, overgrazing, mining and crop cultivation. With the commencement of mining activities on site disturbance of the biodiversity of this unit has increased. The patches of remnant vegetation have been negatively impacted directly and indirectly from mining related activities in adjacent areas (dust etc.). These impacts have been exacerbated by the fragmentation of this vegetation into smaller patches. The presence of alien plant species on site is symptomatic of the site's disturbed nature.
Ecological services	The ecosystem services that are likely to be provided to a small degree by this unit are listed below. Provisioning services – wild foods, timber and other wood fibres, biomass fuel, freshwater, genetic resources. Regulating services – air quality regulation, global climate regulation, water regulation, erosion regulation, water purification and waste treatment, pest regulation, pollination. Cultural services – recreation and ecotourism, ethical and spiritual values, education and inspirational values. Other – Source of natural recovery with the decline in the condition of the vegetation of this unit and the removal of vegetation in surrounding areas the functional value of this unit is likely to be very limited. The most valuable ecosystem service still provided by the biodiversity of this unit is as a source of natural recovery. The value of this service will increase as the mine approaches closure.
Human use services	As the condition of the vegetation of this unit has declined so too has its human use value.

Assessment			
	Low	Moderate	High
Area of habitat in used or to be used in comparison to available habitat	Small	Significant	Large
Diversity	Low	Moderate	High
Condition of biodiversity	Disturbed	Moderately disturbed	Pristine / near pristine
Rarity	Common	Occasional	Rare
Threat	Least concern	Vulnerable / Data deficient / Near threatened	Endangered
Endemism	Low degree of endemism	Moderate degree of endemism	High degree of endemism
Conservation status	Equivalent ecosystem protection exists	Protection of equivalent ecosystem protection planned	No protection of equivalent ecosystem
Knowledge for biodiversity management	Well researched & documented	Relatively poor	Extremely limited
Ecological service provided	Relatively unimportant	Important	Critically important
Human use service provided	Low intensity	Moderate intensity	High intensity
Biodiversity evaluation			

Conservation status criteria	**Score**
A. A large areas still exist (80%)	3
B. Moderate habitat and species diversity	3
C. Moderately disturbed	3
Conservation status score	9 (LOW)
Functional status score	**Score**
A. No noticeable signs of use	3
B. High functional role	5
C. Forms part of a landscape that has high aesthetic appeal, but which is not widely visible	3
Functional status score	11 (LOW)
Biodiversity value	LOW

8 SENSITIVITY ANALYSIS AND CONSERVATION ANALYSIS TOOLS

There are several assessments for South Africa as a whole, as well as on provincial levels that allow for detailed conservation planning as well as meeting biodiversity targets for the country's variety of ecosystems. These guides are essential to consult for development projects and will form an important part of the sensitivity analysis. Areas earmarked for conservation in the future, or that are essential to meet biodiversity and conservation targets should not be developed and have a high sensitivity as they are necessary for overall functioning. In addition, sensitivity analysis in the field based in much finer scale data can be used to ground truth the larger scale assessments and put it into a more localised context.

8.1 CRITICAL BIODIVERSITY & ECOLOGICAL SUPPORT AREAS OF THE PROJECT AREA

The purpose of the North West Conservation Plan is to develop the spatial component of a bioregional plan (i.e., map of Critical Biodiversity Areas (CBA) and associated land-use guidelines).

The North West Conservation Plan categories for the proposed mining area are presented in Figure 12. The following can be concluded regarding developments:

The mining project is in the following areas:

- The Kroondal Mine is in the CBA 2 area as defined in the North West Conservation Plan.

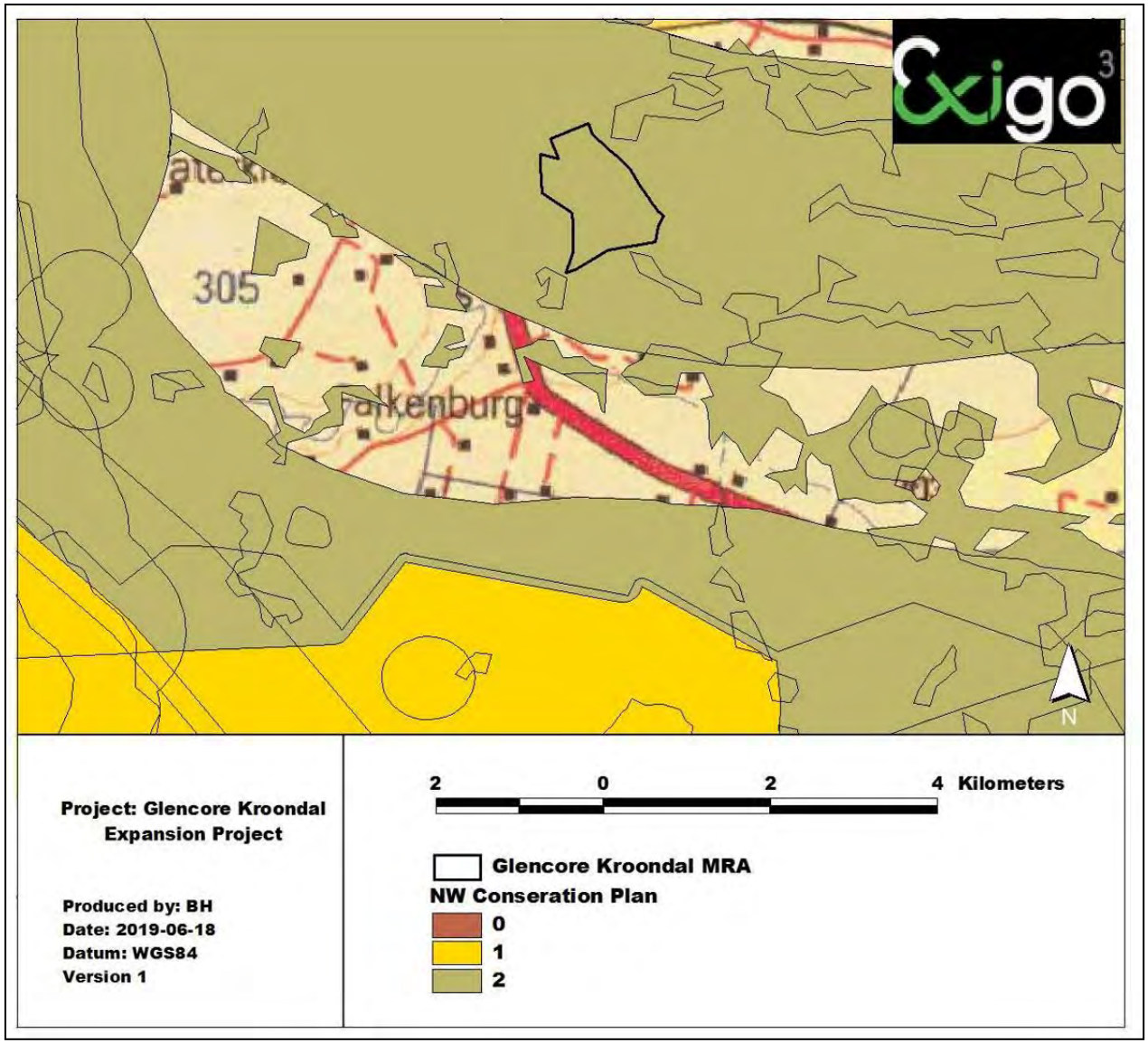


Figure 12: Terrestrial CBA areas of the study area (2014).

8.2 PROTECTED AREAS NETWORK AND NATIONAL PROTECTED AREAS EXPANSION STRATEGY (NPAES)

Officially protected areas, either provincially or nationally that occur close to a project site could have consequences as far as impacts on these areas are concerned. For the proposed development site and associated infrastructure however, the Magaliesberg Protected Environment and Kgaswane Nature Reserve is located to the south and south-west of the project area (Figure 13).

The NPAES are areas designated for future incorporation into existing protected areas (both National and informal protected areas). These areas are large, mostly intact areas required to meet biodiversity targets, and suitable for protection. They may not necessarily be proclaimed as protected areas in the future and are a broad scale planning tool allowing for better development and conservation planning. The project area is not linked to any NPAES, although the area to the south of the Magaliesberg is earmarked for future expansion of this area (Figure 13).

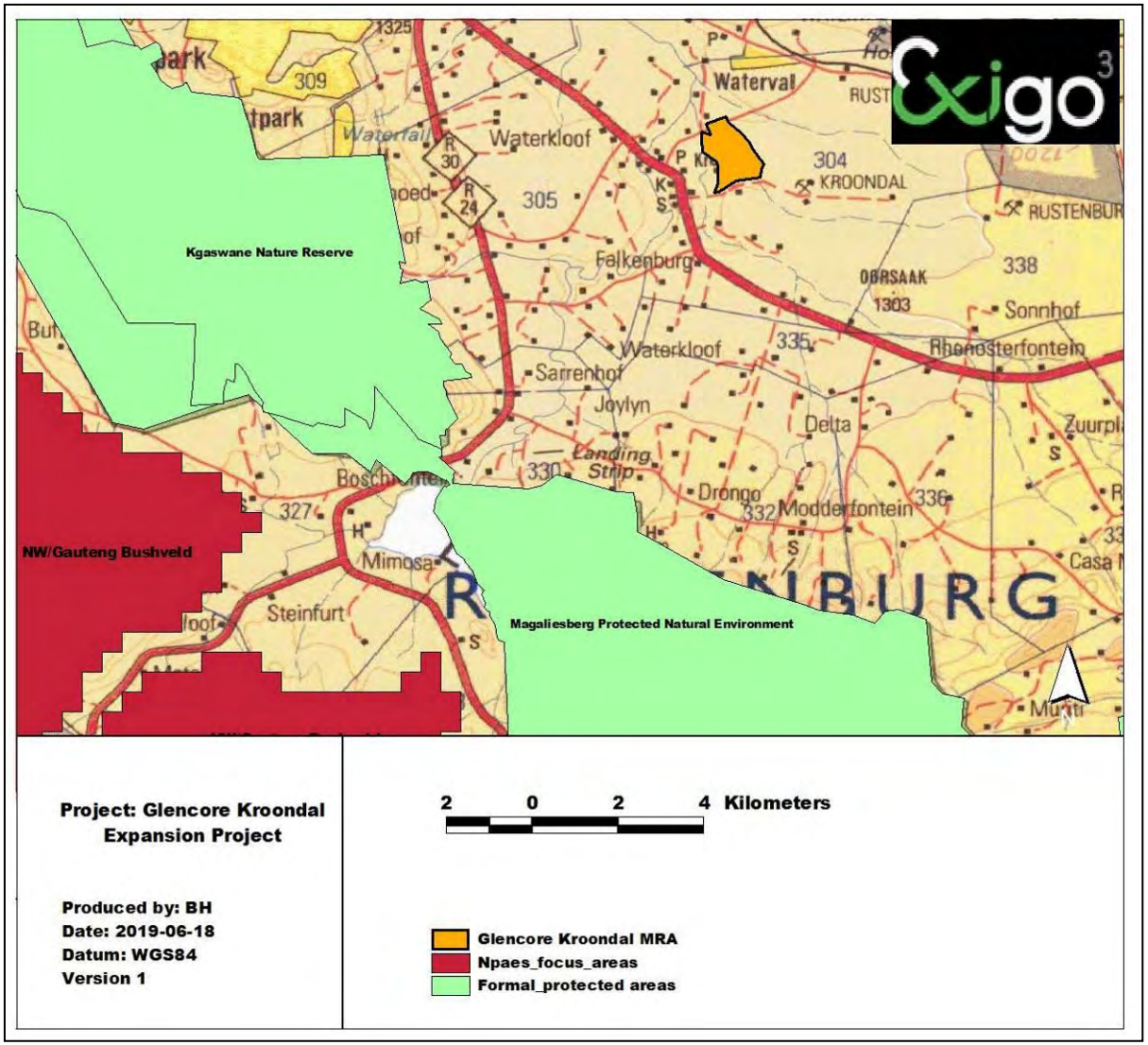


Figure 13: Protected areas in close proximity to the project area.

8.3 IMPORTANT BIRD AREAS

An Important Bird Area (IBA) is an area recognized as being globally important habitat for the conservation of bird populations. Currently there are about 10,000 IBAs worldwide. At present, South Africa has 124 IBA's, covering over 14 million hectares of habitat for our threatened, endemic and congregatory birds. Yet only million hectares of the total land surface covered by our IBA's legally protected. The BirdLife SA IBA programme continues a programme of stewardship which will ultimately achieve formal protection (Birdlife, 2013).

The Magaliesberg IBA is located within the project area, although the actual Magaliesberg habitat is not represented on site (Figure 14).

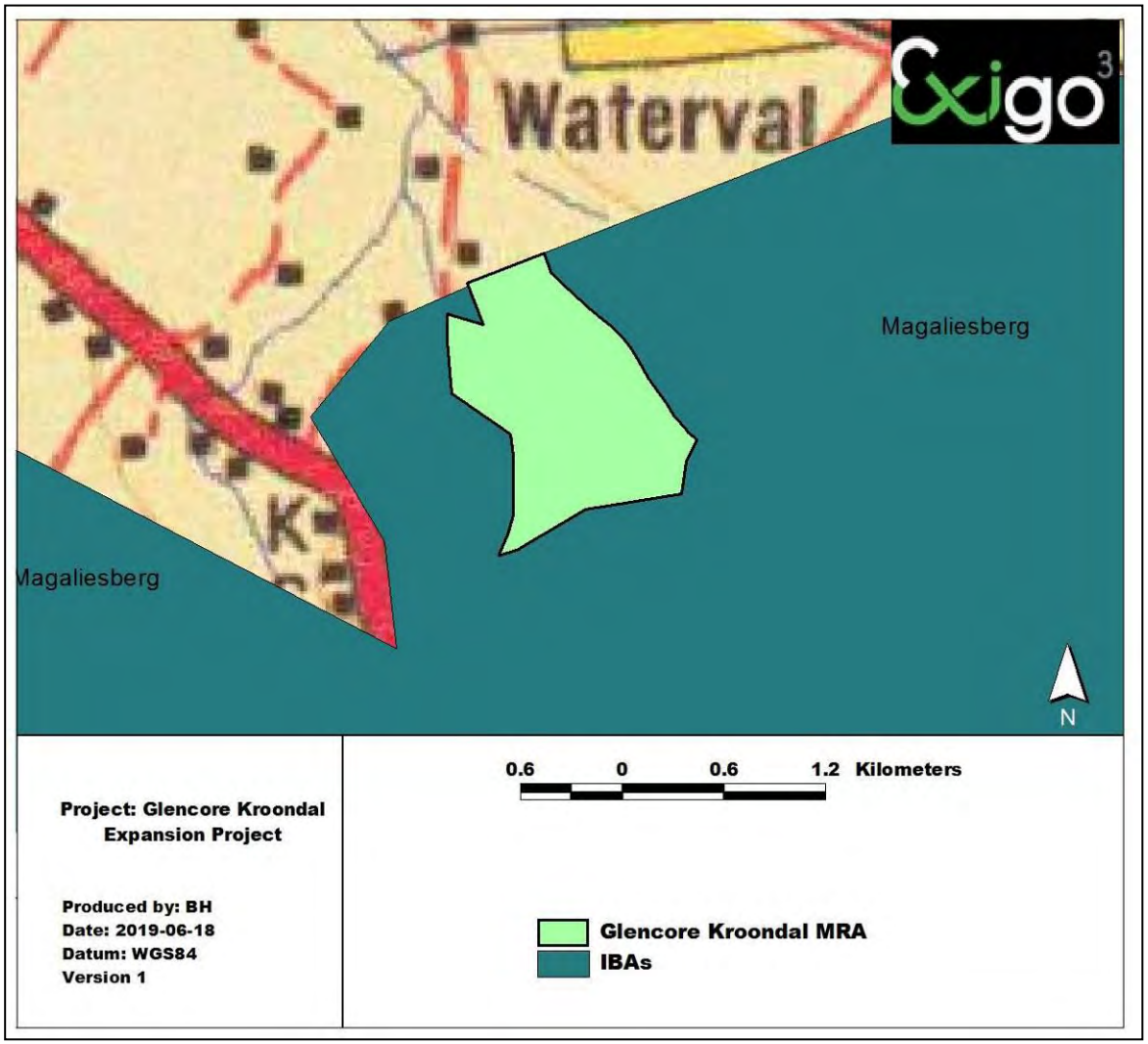


Figure 14: Location of the project area in relation to IBAs.

8.4 NATIONALLY THREATENED ECOSYSTEMS

The list of national Threatened Ecosystems has been gazetted (NEM:BA: National list of ecosystems that are threatened and in need of protection) and result in several implications in terms of development within these areas. Four basic principles were established for the identification of threatened ecosystems. These include:

- The approach must be explicit and repeatable.
- The approach must be target driven and systematic, especially for threatened ecosystems;
- The approach must follow the same logic as the IUCN approach to listing threatened species, whereby several criteria are developed, and an ecosystem is listed based on its highest-ranking criterion; and
- The identification of ecosystems to be listed must be based on scientifically credible, practical and simple criteria, which must translate into spatially explicit identification of ecosystems.

Areas were delineated based on as fine a scale as possible and are defined by one of several assessments: These areas are essential for conservation of the country's ecosystems as well as meeting conservation targets. The Marikana Thornveld vegetation type is a listed threatened vegetation type located within the project area.

8.5 ECOLOGICAL SENSITIVITY CLASSES

Following the ecological surveys, the classification of the study area into different sensitivity classes and development zones was based on information collected at various levels on different environmental characteristics. Factors which determined sensitivity classes were as follows:

- Presence, density and potential impact of development on rare, endemic and protected plant species;
- Conservation status of vegetation units;
- Soil types, soil depth and soil clay content;
- Previous land-use;
- State of the vegetation in general as indicated by indicator species.

Below included is the sensitivity map for the different areas (Figure 15). Only criteria applicable to the specific vegetation units were used to determine the sensitivity of the specific unit.

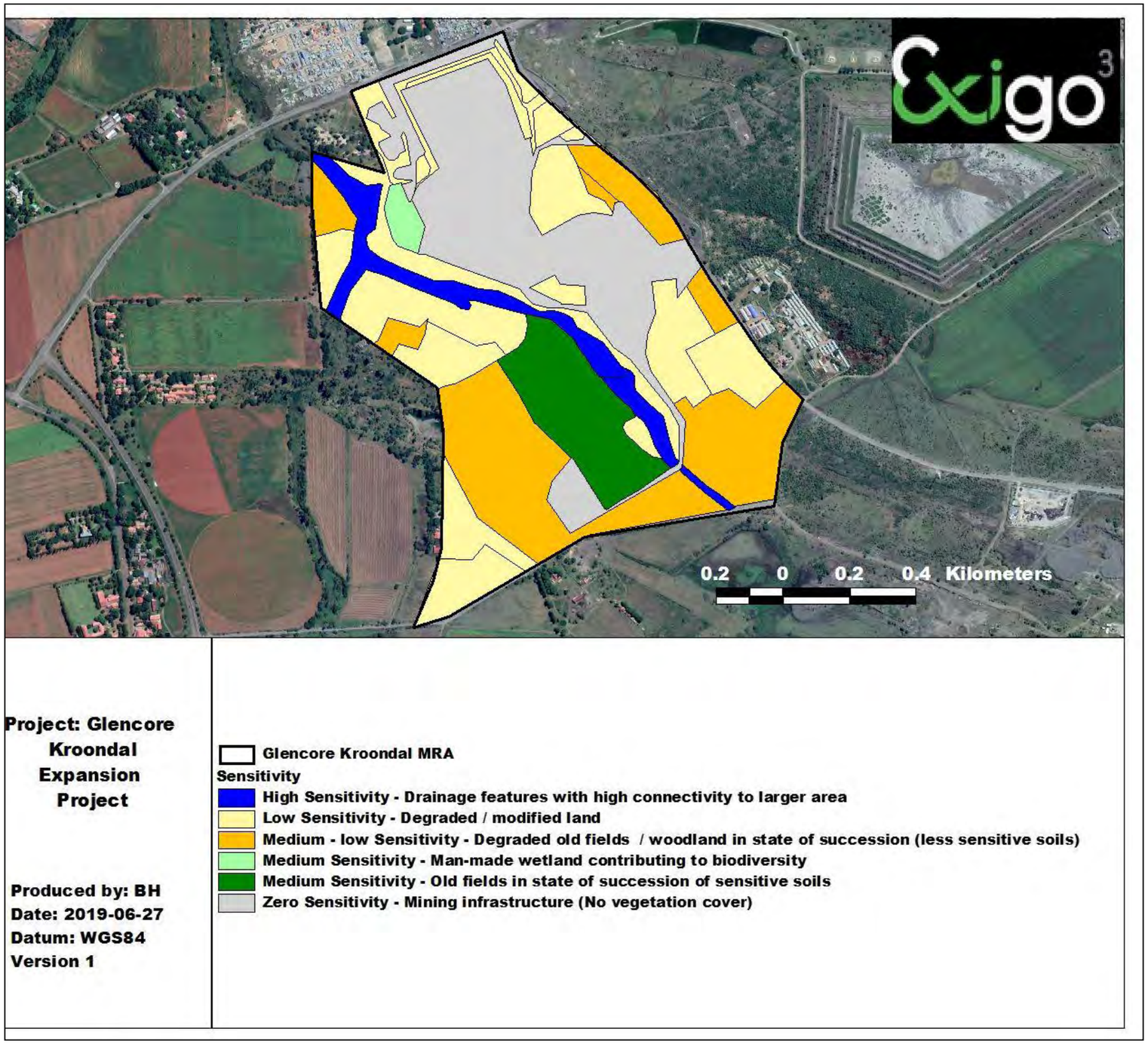


Figure 15: Sensitivity Map of the Glencore Kroondal Mine project area.

9 BIODIVERSITY MANAGEMENT AND ACTION PLAN FOR THE GLENCORE KROONDAL MINE

9.1 DESCRIPTION OF MANAGEMENT AND MITIGATION MEASURES FOR THE PHASES OF THE GLENCORE KROONDAL MINE AND MINING AREA

A management system has been developed to comply with the objectives and principles set out in this document. This system is based on the principle of managing the potential environmental impacts using the best available technology, not entailing excessive cost. In this way, the technology is effective, but does not seriously impair economic stability of the development. Management measures required for the different phases of the mine which relates to biodiversity is presented in Table 19:

Table 19: Ecological Management Plan to be implemented as part of the Environmental Management Programme Report for the Glencore Kroondal Mine.

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
Construction Phase									
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction	Clearing of vegetation	Fauna & Flora	Habitat destruction	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) North West Nature Conservation Ordinance (1983)	• Prevent edge effects • Keep mining development footprint restricted to layout plans • To limit the habitat loss due to the increase of the mining footprint	Keep mining development footprint restricted to layout plans	• The removal of the isolated indigenous trees and shrubs should only occur on the construction footprint area of the development and not over the larger area. Where possible, vegetation should be retained in between infrastructural elements associated with the project; • Conduct flora species search and rescue efforts before ground clearing begins to reduce negative impacts on species of concern; • Remove and relocate any plants of botanical or ecological significance as indicated by the ecologist or Mine Environmental Control Officer (ECO); • Construction should preferably take place in winter to reduce disturbance to breeding fauna and flowering flora; • Vegetation to be removed as it becomes necessary – do not clear the entire footprint simultaneously; • Clearly demarcate the entire development footprint prior to initial site clearance and prevent construction personnel from leaving the demarcated area; • Monitoring should be implemented during the construction activities to ensure that minimal impact is caused to the flora of the area; • The Mine ECO should advise the construction team in all relevant matters to ensure minimum destruction and damage to the environment. The Mine ECO should enforce any measures that he/she deem necessary. Regular environmental training should be provided to construction workers to ensure the protection of the habitat, fauna and flora and their sensitivity to conservation; • Where trenches pose a risk to animal safety, they should be adequately cordoned off to prevent animals falling in and getting trapped and/or injured. This could be prevented by the constant excavating and backfilling of trenches during construction. • Poisons for the control of problem animals should rather be avoided since the wrong use thereof can have disastrous consequences for the raptors occurring in the area. Poisons for the control of rats, mice or other vermin should only be used after approval from an ecologist.	Continuous	Contractor / ECO
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction	Clearing of vegetation	Fauna	Habitat fragmentation	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) North West Nature Conservation Ordinance (1983)	• To limit the impact on wildlife habitat • To limit the loss in carrying capacity • To prevent negative impact on fauna populations through infrastructure development	Keep mining development footprint restricted to layout plans	• Use existing facilities (e.g., access roads, parking lots, graded areas) to the extent possible to minimize the amount of new disturbance. • Ensure protection of important resources by establishing protective buffers to exclude unintentional disturbance. All possible efforts must be made to ensure as little disturbance as possible to the sensitive habitats such as ravines and moist grassland pockets during construction. • During construction, sensitive habitats must be avoided by construction vehicles and equipment, wherever possible, to reduce potential impacts. Only necessary damage must be caused and, for example, unnecessary driving around in the veld or bulldozing natural habitat must not take place. • Construction activities must remain within defined construction areas and the road servitudes. No construction / disturbance will occur outside these areas	Continuous	Contractor / ECO
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction	Topsoil & subsoil stripping	Fauna & Flora	Soil erosion and sedimentation	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983 NEMA Regulation 543 Section 32	• To prevent the loss of soil through the expansion of the WRD • To prevent the loss of topsoil capability during stockpiling • To prevent the contamination of	Management of storm water on site; Minimize time that soil is left exposed after vegetation is cleared that will cause erosion and sedimentation	• Cover disturbed soils as completely as possible, using vegetation or other materials; • Minimize the amount of land disturbance and develop and implement stringent erosion and dust control practices. • Sediment trapping, erosion and storm water control should be addressed by a hydrological engineer in a detailed storm water management plan; • All aspects related to dust and air quality should be addressed by an air quality specialist in a specialist report;	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
					soils due to spillages of reagents • To prevent soil erosion		• Protect sloping areas and drainage channel banks that are susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and Work Areas; • Repair all erosion damage as soon as possible to allow for sufficient rehabilitation growth; • Gravel roads must be well drained to limit soil erosion;		
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction	Heavy machinery & vehicle movement on site	Fauna & Flora	Spillages	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	• To prevent contamination of flora due to the spillages of hydrocarbons and reagents used in the process and during transportation of these substances • To reduce the risk of contamination of soils due to increased fuel deliveries	Active monitoring of potential spillages	• Ensure that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones. • This risk of spillages of reagents and hydrocarbons on the soil during transportation can be reduced with proper maintenance of vehicles. This would include a rigorous and proactive maintenance program • This risk can be further reduced through an adequate program of training of drivers and crews. This would include defensive driver training, basic vehicle maintenance, and emergency control of spills. For the vehicle crews to be adequately able to control any spills at an early stage, the vehicles must be properly equipped with spill containment equipment (booms, sandbags, spades, absorbent pads, etc.). Responsibility for training lies with the transport contractor. Adequate training, maintenance, and equipment of transport crews should be included as a requirement for transport contracts. • All employees will be trained in cleaning up of a spillage. The necessary spill kits containing the correct equipment to clean up spills will be made available at strategic points in the plant area	Continuous	Contractor / ECO
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction			Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Prevent fauna mortalities because of vehicle movement	Control of vehicle speed Control of vehicle movement	• More fauna is normally killed the faster vehicles travel. A speed limit should be enforced as determined by the mine environmental manager. It can be considered to install speed bumps in sections where the speed limit tends to be disobeyed. (Speed limits will also lessen the probability of road accidents and their negative consequences). • Travelling at night should be avoided or limited as much as possible. No travelling at night should be allowed without approval by site manager; • Lights should be positioned 5m from the roads or paved areas.	Continuous	Contractor / ECO
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction	Vegetation clearing, topsoil & subsoil stripping, vehicle movement on site	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	To implement an alien invasive eradication programme to manage and control alien species on the mine	Prevent and control of spreading and establishment of alien invasive species on the mining area and larger region	• Control involves killing the alien invasive plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion. The control of these species should even begin prior to the construction phase considering that small populations of the AIS occur around the sites; • Institute strict control over materials brought onto site, which should be inspected for seeds of noxious plants and steps taken to eradicate these before transport to the site. Routinely fumigate or spray all materials with appropriate low-residual herbicides prior to transport to site or in a quarantine area on site. The contractor is responsible for the control of weeds and invader plants within the construction site for the duration of the construction phase; • Rehabilitate disturbed areas as quickly as possible to reduce the area where invasive species would be at a strong advantage and most easily able to establish; • Institute a monitoring programme to detect alien invasive species early, before they become established and, in the case of weeds, before the release of seeds; • Institute an eradication/control programme for early intervention if invasive species are detected, so that their spread to surrounding natural ecosystems can be prevented; • A detailed plan should be developed for control of noxious weeds and invasive plants that could colonize the area because of new surface disturbance activities at the site. The plan should address monitoring, weed identification, the way weeds spread, and	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							methods for treating infestations.		
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction	Vegetation Clearing, Vehicle movement on site	Flora & Fauna	Habitat degradation due to dust	National Environmental Management Air Quality Act 39 of 2004 Section 32	• To reduce dust emission levels to acceptable norms in terms of aesthetics, health and annoyance • To implement a dust monitoring programme which will enable the mine to determine the impacts associated with its activities • To manage the operations in such a way as to ensure that the impact on the air quality is prevented and reduced.	To limit exposure to sensitive receptors resulting from dust and fumes from, mine vehicles and transportation systems and windborne dust from surface working	• Daily dampening of dust areas or other dust suppression methods such as dust-aside or more environmentally friendly methods. • Re-vegetation of impacted areas is to be conducted on an on-going basis. • Place dust generating activities where maximum protection can be obtained from natural features. • Locating dust generating activities where prevailing winds will blow dust away from users. • Minimize the need to transport and handle materials by placing adequate storage facilities close to processing areas. • Minimize the re-handling of material which obviously has cost benefits as well. • Exposed material should be protected from the wind by keeping it within voids or protecting them by topographical features where possible. • Reduce the drop heights wherever practicable. • Protect activities from wind by erecting a screen or using a natural barrier. • All roads on site should be dampened or treated with a binding agent. • The general vehicle speed should be restricted as there is a direct relationship between the speed and vehicle entrained emissions. • Monitoring, modelling and emission measurements should be regarded as complementary components in any integrated approach to exposure assessment or determining compliance against air quality criteria.	Continuous	Contractor / ECO
Support infrastructure, CDFs, TSF, RWD and WRD, Any future construction	Clearing of vegetation / pipeline construction	Wetlands / water courses	Impediment of natural flow	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) National Water Act Section 21 C and I	• Prevent edge effects • Keep pipeline footprint restricted to layout plans • To limit the habitat loss due to the increase of the mining footprint	Keep pipeline development footprint restricted to layout plans	• Unless authorised by this licence, access and haul roads must not encroach into the extent of the watercourse(s) • No structures to be placed within the 1:100-year floodline and/or the delineated riparian areas unless authorised in this licence • Appropriate design and mitigation measures must be developed and implemented to minimise impacts on the natural flow regime of the watercourse i.e., through placement of structures/supports and to minimise turbulent flow in the watercourse • The diversion and impeding structures may not restrict river flows by reducing the overall river width or obstructing river flow. Any watercourse crossing must minimise its impacts on the watercourse and must be assessed and documented as such and be available for review • The indiscriminate use of machinery within the in-stream and riparian habitat will lead to compaction of soils and vegetation and must therefore be strictly controlled • The clear incision of the banks of the Sandspruit indicates that this feature is highly erodible. The installation of energy dissipating structures, such as gabion wingwalls, to protect the banks of the feature is required as recommended by the submitted reports • Perform scheduled maintenance to be prepared for storms. Ensure that culverts have their maximum capacity, ditches are cleaned, and that channels are free of debris and brush than can plug structures. • Work in rivers, streams and riparian zones should preferably be done during the low flow season; • The construction camp must be located outside the extent of the watercourse(s) and must be recovered and removed within one (1) month after construction has been completed • During the construction phase vehicles must not be allowed to indiscriminately drive through any wetland areas. • Indigenous riparian vegetation, including dead trees, outside the limits of disturbance indicated in the site plans must not be removed from the area	Continuous	Contractor / ECO
OPERATIONAL PHASE									

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
Exploitation of tailings resources, Mining, Support infrastructure, TSF and WRD, ROM Ore stockpiles	Laydown areas of stockpiles and WRDs	Flora	Habitat destruction	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 North West Nature Conservation Ordinance (1983)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Final profile lines of rehabilitated areas must fit in with the character of the topography in the area. • Concurrent rehabilitation should occur during the operational phase on all exposed areas created by construction as well as roads, stockpiles and WRD. Only indigenous species should be used for rehabilitation. The following programmes should be implemented as part of the operational phase of the mine: o Concurrent rehabilitation programme o Alien invasive programme o Fire management programme o Educational and training programme on the conservation and ecological systems • Refer to mitigation measures needed during the operational phase that are like the mitigation measures for impacts during the construction phase.	Continuous	Contractor / ECO
	Laydown areas of stockpiles and WRDs	Fauna	Fragmentation of fauna habitats	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 North West Nature Conservation Ordinance (1983)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the operational phase that are like the mitigation measures for impacts during the construction phase.	Continuous	Contractor / ECO
	Laydown areas of WRDs and stockpiles, crushing and stockpiling	Flora	Increased Soil erosion and sedimentation;	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983 NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Rehabilitation: revegetate or stabilise all disturbed areas as soon as possible. Indigenous trees can be planted in the buffer zone of the proposed development to enhance the aesthetic value of the site and stabilize soil conditions; • The vegetative (grass) cover on the soil stockpiles (berms) must be continually monitored to maintain a high basal cover. Such maintenance will limit soil erosion by both the mediums of water (runoff) and wind (dust); • Conservation of topsoil should be prioritized on site and done as follows: o Topsoil should be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify; o Stockpile topsoil separately from subsoil; o Stockpile in an area that is protected from storm water runoff and wind; o Topsoil stockpiles should not exceed 2.0 m in height and should be protected by a mulch cover where possible; o Maintain topsoil stockpiles in a weed free condition; o Topsoil should not be compacted in any way, nor should any object be placed or stockpiled upon it; o Stockpile topsoil for the minimum period possible i.e., strip just before the relevant activity commences and replace as soon as it is completed. • Refer to mitigation measures needed during the operational phase that are like the mitigation measures for impacts during the construction phase.	Continuous	Contractor / ECO
	Laydown areas of WRDs and stockpiles, materials handling and transportation, crushing and stockpiling	Flora	Spillages of harmful substances to the ecosystem;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Vehicle maintenance only done in designated areas – spill trays, sumps to be used and managed according to the correct procedures. • Vehicles and machines must be maintained properly to ensure that oil spillages are kept to a minimum. • Fuel and oil storage facilities should be bunded with adequate storm water management measures. • Operational and Maintenance plan and schedule for management of sewage facilities should be compiled. An emergency plan should be compiled to deal with system failures and should include a down-stream notification procedure • Routine checks should be done on all mechanical instruments for	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							problems such as leaks, overheating, vibration, noise or any other abnormalities. All equipment should be free of obstruction, be properly aligned and be moving at normal speed. Mechanical maintenance must be according to the manufacturer's instructions • Refer to mitigation measures needed during the operational phase that are like the mitigation measures for impacts during the construction phase		
	Laydown areas of WRDs and stockpiles, materials handling and transportation, crushing and stockpiling	Fauna	Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the operational phase that are like the mitigation measures for impacts during the construction phase	Continuous	Contractor / ECO
	Laydown areas of WRDs and stockpiles, materials handling and transportation, crushing and stockpiling	Flora & Fauna	Habitat degradation due to dust;	National Environmental Management Air Quality Act 39 of 2004 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Daily dampening of dust areas. • Re-vegetation of mined areas is to be conducted on an ongoing basis. • Dust fallout monitoring to be conducted according to the requirements of the legislation. • Place dust generating activities where maximum protection can be obtained from natural features. • Locating dust generating activities where prevailing winds will blow dust away from users. • Minimize the need to transport and handle materials by placing adequate storage facilities close to processing areas. • Exposed material should be protected from the wind by keeping it within voids or protecting them by topographical features where possible. • Reduce the drop heights wherever practicable. • Protect activities from wind by erecting a screen or using a natural barrier. • Fine spray or fog suppression can also be used in loading bays. • All roads on site should be dampened or treated with a binding agent. • The general vehicle speed should be restricted as there is a direct relationship between the speed and vehicle entrained emissions. • Monitoring, modelling and emission measurements should be regarded as complementary components in any integrated approach to exposure assessment or determining compliance against air quality criteria • Refer to mitigation measures needed during the operational phase that are like the mitigation measures for impacts during the construction phase	Continuous	Contractor / ECO
	Laydown areas of stockpiles and WRDs	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the operational phase that are like the mitigation measures for impacts during the construction phase		Ecologist / ECO
DECOMMISSIONING PHASE									
Exploitation of tailings resources, Mining TSF and WRD, support infrastructure	Cessation of mining Demolition of mining infrastructure	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	To leave all affected areas in a safe condition Refer to mitigation measures for the construction phase needed during the decommissioning phase that are similar	Continuous	Ecologist / ECO
	Demolition of	Fauna &	Habitat degradation due to dust;	National Environmental	Refer to Construction	Refer to Construction Phase	Refer to mitigation measures for the construction phase needed during	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
	mining infrastructure	Flora		Management Air Quality Act 39 of 2004 Section 32	Phase objectives	criteria	the decommissioning phase that are similar		
	Demolition of mining infrastructure	Fauna	Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the decommissioning phase that are similar	Continuous	Contractor / ECO
	Demolition of mining infrastructure	Fauna & Flora	Spillages of harmful substances to the ecosystem;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the decommissioning phase that are similar	Continuous	Contractor / ECO
CLOSURE PHASE & POST CLOSURE PHASES									
Exploitation of tailings resources, Mining TSF and WRD, support infrastructure	Rehabilitation	Fauna & Flora	Improvement of habitat through revegetation over time	NEMA Regulation 543 Section 32	• To ensure that the mining areas rehabilitated according to prescriptions • To shape and prepare the rehabilitation areas to blend in with the surrounding environment. • To rehabilitate all disturbed areas to a suitable post closure land use • To manage the social impact of closure on personnel who became redundant due to closure • To keep all the post closure monitoring in place and to ensure that the necessary reporting is done to the authorities and interested and affected parties	Rehabilitate within development footprint to ensure revegetation and rehabilitation impacts are kept within the mining footprint areas	• Plant vegetation species for rehabilitation that will effectively bind the loose material and which can absorb run-off from the mining areas. • Rehabilitate all the land where infrastructure has been demolished. • Monitor the establishment of the vegetation cover on the rehabilitated sites to the point where it is self-sustaining. • Protect rehabilitation areas until the area is self-sustaining. • Diversion trenches and storm water measures must be maintained • Water management facilities will stay operational and maintained and monitored until such a stage is reached where it is no longer necessary. • The mining areas will be shaped to make it safe. • All the monitoring and reporting on the management and rehabilitation issues to the authorities will continue till closure of the mine is approved.	Continuous	Ecologist / ECO
	Rehabilitation	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Monitor and manage invader species and alien species on the rehabilitated land until the natural vegetation can outperform the invaders or aliens.	Continuous	Contractor / ECO
	Rehabilitation	Fauna & Flora	Habitat degradation due to dust;	National Environmental Management Air Quality Act 39 of 2004 Section 32	To comply to all the necessary post closure air quality objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the closure phase that are relevant	Continuous	Contractor / ECO
	Rehabilitation	Fauna	Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the closure phase that are relevant	Continuous	Contractor / ECO
	Rehabilitation	Fauna &	Spillages of harmful substances to the	National Environmental	Refer to Construction	Refer to Construction Phase	Refer to mitigation measures for the construction phase needed during	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
		Flora	ecosystem;	Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Phase objectives	criteria	the closure phase that are relevant		

9.2 SPECIES ACTION PLANS

9.2.1 FLORA

South Africa has been recognized as having remarkable plant diversity with high levels of endemism. The major threats to plants in the study area are non-sustainable harvesting, collecting, overgrazing/browsing, mining and agriculture. The study area provide habitat for a few red data (IUCN, red data list) and protected plant species, although none were documented during previous surveys. The potential however still exist that protected trees or flora are documented on future expansion sites. For future reference the management of such species are included below:

9.2.1.1 Red data, protected and endemic species

Threatened species are those that are facing high risk of extinction, indicated by the categories Critically Endangered, Endangered and Vulnerable. Species of Conservation Concern include the Threatened Species, but additionally have the categories Near Threatened, Data Deficient, Critically Rare, Rare and Declining. This is in accordance with the new Red List for South African Plants (Raimondo et al. 2009).

Red data or localized endemic or protected plant species are habitat specific. This makes search and rescue efforts and relocation of these species difficult and often unsuccessful. The following specific management measures and guidelines should however be implemented for red data species found in the quarter degree grids in the as well as protected plants for the Glencore Kroondal Mine site and related areas according to the Northern Cape Nature Conservation Ordinance. This specifically applicable should any development or rehabilitation procedures impede on species or their habitats:

- A detailed species rescue, relocation and re-introduction plan should be developed and implemented by a qualified person before any excavations or disturbances commence or as otherwise specified in the relevant permits. This plan should at the least address the following:
    - Harvesting of seeds from herbaceous and woody vegetation to be used in the ex-situ nursery and future rehabilitation; and
    - Intact removal of protected plant species under permit. Permits should be obtained from the local authorities where red data flora is to be disturbed or relocated.

- Options to be considered for the above-mentioned protected and general floral specimens:
    - Suitable translocation areas such as the Tswalu Game Reserve or other areas on the mining premises;
    - Translocation to suitable areas earmarked for restoration and rehabilitation, both on and off-site.
    - Use of removed plants in an indigenous nursery for future restoration and rehabilitation programs; and
    - Translocation to other areas suitable for survival of the removed specimens.
- Proper habitat suitability assessments before reintroductions to reduce the risk of mortalities in both source and destination populations;
- Compile a Protected Plant policy as part of a Flora Monitoring Plan for the study area. This should list those species under threat, reasons for their demise and measures that must be taken to ensure for their continued existence, including access to adequate and appropriate areas of suitable habitat condition; and
- Conservation initiatives could also be developed between the Glencore Kroondal Mine and conservation institutions to improve the habitat of the endemic plant spies listed.

9.2.1.2 Relocation of indigenous plant species of significance

The relocation of any indigenous plant species should be carefully considered before any relocation is implemented. Consultation with the ECO and qualified ecologist should be conducted to indicate the sustainability of relocation. If sustainable the same principles and guidelines apply for the management and relocation of protected tree species as those stipulated above for red data species. The following steps should be followed for the translocation of indigenous plant species in the area:

1. Tree / plant preparation (not applicable for *Vachellia erioloba*)
    a. The main important aspects to implement would be that the north side of the tree trunk shall be marked prior to removal to facilitate orientation at the new site; and
    b. Pruning of branches if necessary, to improve structure, and to directionally

shape the tree. With smaller diameter branches it may be necessary to reduce the branch to a dormant bud. Formative pruning shall aim to reduce the development of structural weaknesses and to accommodate site constraints and reduce encroachment on utilities or buildings as the tree grows.

2. Root excavation method

    a. Hand Spade Excavated: Prior to digging, the soil around the root system shall be thoroughly moistened to help keep the root ball together. The root ball shall be excavated around the outside of the root trench. All exposed roots shall be pruned flush with the face of the root ball. Sharp secateurs or loppers shall be used to cut roots. Roots shall be cut in a way that will not jar and loosen the soil in the root ball. The depth of the root ball is dependent on each individual tree species. Digging below the root ball shall occur when the number of roots reduce considerably within the root ball trench. This will determine the depth of the root ball. Tension shall be applied by the crane while undercutting the root ball; and

    b. Mechanically Excavated: The root plate shall be mechanically excavated around the outside of the root pruning trench. A qualified operator shall carry out the work. Once the desired depth has been reached, the root plate shall be shaped by hand. All exposed roots shall be pruned flush with the face of the root plate using sharp loppers. Roots shall be cut and removed, ensuring the root plate is not loosened. This technique requires root pruning pre-excavation.

3. Transport

    a. Lifting Technique: Lifting of trees shall be carried out or supervised by a qualified and/or suitably experienced arboriculturist and crane operator using a crane and supports. Appropriate lifting equipment shall be used. Suitable slings shall be attached around a balance point of the trunk and shall provide a support system around the root ball. When a sling is attached to the trunk, padding and protection is required to reduce possible damage. Trees shall not be lifted by the trunk alone. A qualified crane operator shall determine the support system to be used;

    b. Preparation for Transport: Only natural fibre materials that have not been chemically treated shall be used to support the root ball. Synthetic materials shall not be used. Burlap shall be applied before moving the tree to protect the

shape and structure of the root ball during transport. Once the tree is lifted burlap shall be used to cover the base of the root ball; and

c. Transport Vehicle: The transport vehicle shall be adequate to transport the tree without damage.

4. Planting procedure:

a. Preparation of Planting Hole: Excavated soil may be used as backfill if it is free of weeds, deleterious materials and particles larger than 25mm. When backfilling, sedimentary layers in soil shall be observed so topsoil remains above the subsoil. The Contractor shall remove any unsuitable material from site that was brought to the surface during excavation;

i. Hand Spade Excavated Planting Hole: When the planting hole is excavated by spade, the hole shall be 600mm wider than the diameter of the root ball and no deeper than the height of the proposed root ball. If the depth of the hole exceeds the root ball height, compacted soil shall be added to the hole to prevent settling after transplanting. The sides of the hole shall be roughened to create an irregular surface that will facilitate root penetration. The bottom of the hole shall be decompacted to a depth of 150mm and lightly compacted; and

ii. Mechanically Excavated Planting Hole: When the planting hole is excavated by a mechanical excavator, the hole shall be 1000 mm wider than the diameter of the root ball. The hole shall be no deeper than the height of the proposed root ball height. If the depth of the hole exceeds the root ball height, compacted soil shall be added to the hole to prevent settling after transplanting. The sides of the hole shall be vertical and shall be roughened to create an irregular surface that will facilitate root penetration. The bottom of the hole shall be shaped to suit the root ball. The bottom of the hole shall be decompacted to a depth of 150mm and lightly compacted.

b. Orientation: The tree shall be orientated at the new site in the same direction as at the original site;

c. Drainage and Inspection Point: Inspection pipes shall be installed in the 4 corners of the planting hole. Inspection pipes shall be 150mm diameter slotted PVC pipe with a screw inspection lid located within a valve box with lock. The

top of the valve box shall be 50mm below the surface of the mulch and the screw inspection lid shall be 150mm below the finished ground level;

d. Watering Basin: A shallow watering basin (100mm deep) shall be constructed with soil around the perimeter of the root ball. The watering basins holding capability shall be determined by the size of the tree and its root ball. The watering basin shall be always kept intact, unless instructed otherwise by the Superintendent;

e. Backfill: Where in the opinion of the Superintendent excavated material is unsuitable for backfill, imported soil shall be used. Imported soil shall be matched as closely as practicable to the existing site soil. A certified soil laboratory shall be used to determine the soil type. Organic matter shall not be added to the backfill material. Any soil deficiencies shall be rectified prior to placing backfill;

f. Fertiliser and Soil Additives:

    i. The backfill shall be soil injected with a sucrose solution at 20 grams per litre of water and approximately 100 litres of solution applied per tree. Soil injections of Sucrose Solutions have been shown to improve the defence systems of stressed trees and increase the volume of new roots;

    ii. N-Fix: The backfill shall be soil injected with N-Fix at 10ml N-Fix per 1 litre of water applying approximately 100 litres of solution per tree, evenly injected over the available root zone. A qualified arboriculturist shall carry out soil injections; and

    iii. Rooting Hormone: Rooting hormone shall be mixed with the backfill material before the tree is positioned.

5. Tree support: Tree support installation shall be carried out by a qualified arboriculturist

    a. Support Attachment:

        i. Clamping Device: An appropriate clamping device which does not damage the tree shall be secured to the top third of the tree. Once it is determined that the tree has stabilised itself with its new root system the device shall be removed; and

ii. Polypropylene Webbing: Polypropylene webbing loops shall be used around the tree to attach the cable. The polypropylene webbing shall be installed in accordance with the manufacturer's recommendations. All polypropylene used for support shall be replaced after 18 months. Once it is determined that the tree has stabilised itself with its new root system the webbing shall be removed.

6. Mulch: Mulch shall be evenly spread to a depth of 100 - 120mm. Mulch material shall not be placed in contact with the trunk of the tree. The mulch shall be well leached and free from deleterious material such as soil, weeds, sticks and sawdust and shall have a low fines content. Following delivery of mulch to the site, the Superintendent may collect a sample to ensure consistency with the sample provided. If there are any deviations from the accepted sample, the Contractor shall either rectify the fault or remove the mulch from the site, replacing it with mulch that meets the specified requirements;

7. Watering: Immediately following planting, each tree shall be soaked to remove air pockets from the soil. The Contractor shall ensure that trees maintain health and are always free of water stress until Practical Completion. The Contractor shall monitor moisture levels to determine the exact watering requirements to ensure tree survival;

    a. Method of Watering

        i. Hand Watering: Water shall be applied to the entire root area and not just the immediate trunk base; and

        ii. Irrigation System: A radial irrigation system including an inline drip tube shall be constructed over the root plate. Water application shall cover the entire root area. The Contractor shall ensure that the irrigation system is always fully operational and that all trees are receiving the correct amount of water as programmed in the Irrigation Control System.

8. Antitranspirants: Antitranspirants shall be applied in a spray form:

    a. Anti-Stress: Anti-Stress 2000 shall be applied to the foliage in accordance with the manufacturer's instructions and recommended rates;

    b. Stressguard: Stressguard shall be applied to the foliage in accordance with the manufacturer's instructions and recommended rates; and

c. PVA Glue Mix: An antitranspirant made from 1 part PVA glue mixed with 10 parts water shall be applied as a spray. This mix shall be re-applied after rain.

9. Reinstatement of site: The area where the tree was removed shall be reinstated to the condition existing prior to the Contractor commencing work.

Practical completion: Practical Completion shall mean a healthy and upright tree has been achieved by the correct application of the prescribed methods.

9.2.1.3 Invasive alien species and exotic weeds

9.2.1.4 Legal obligations of landowners with regards to listed alien invasive species control

As per the definition clauses, an "Invasive species" means any species whose establishment and spread outside of its natural distribution range:

(a)Threaten ecosystems, habitats or other species or have demonstrated potential to threaten ecosystems, habitats or other species; and

(b) May result in economic or environmental harm or harm to human health;

The obligations contained in the Act do not however apply to all invasive species. A distinction is drawn between "invasive species" and "listed invasive species", which means –

Any invasive species listed in terms of section 70 (1)"

As far as listed invasive species are concerned, the situation is slightly different from that of alien species as the Act places some additional obligations on parties other than permit holders. A person wishing to conduct a restricted activity in relation to a listed invasive species will also require a permit and is subject to the same duty of care as is the case with alien species. However, in addition to those requirements, section 75 (4) mandates the Minister to coordinate and implement programmes for the prevention, control or eradication of listed invasive species. S 75 (4) reads as follows:

"75. Control and eradication of listed invasive species

(4) The Minister must ensure the coordination and implementation of programmes for the prevention, control or eradication of invasive species."

These programmes, referred to in the regulations as "Invasive Species Management Programmes" must be prepared by the governing bodies of all parastatal protected areas and all other organs of state. These programmes may also impact and be carried out on private land, but it is the Department who is responsible for its implementation, not the land owner.

In the context of certain "listed invasive species", specifically those categorised as 1a invasive species in terms of the regulations, the Act does place a limited obligation on the owner of land where listed invasive species occur.

In this regard, section 73 (2) of the Act reads as follows:

"73. Duty of care relating to listed invasive species

(2) A person who is the owner of land on which a listed invasive species occurs must-

(a) Notify any relevant competent authority, in writing, of the listed invasive species occurring on the land;

(b) Take steps to control and eradicate the listed invasive species and to prevent it from spreading; and

(c) Take all the required steps to prevent or minimise harm to biodiversity.

(3) A competent authority may, in writing, direct any person who has failed to comply with subsection (1) or (2), or who has contravened section 71 (1), to take such steps-

(a) As may be necessary to remedy any harm to biodiversity caused by-

(I) the actions of that person; or

(ii) The occurrence of the listed invasive species on land of which that person is the owner; and

(b) As may be specified in the directive"

This provision certainly does place an obligation on a landowner to report the presence of any relevant listed invasive species (As per the regulations, category 1a species) to the competent authority and to rid the property of listed invasive species as well as prevent it from spreading.

9.2.1.5 Alien and Invasive Species Regulations

The categorisation of listed invasive species is significant as the regulations ascribe differing obligations vis-à-vis each category.

The categories and obligations are as follows;

Category 1a invasive species: Category 1 species are those that require compulsory eradication. It is these, and only these, to which section 73 (2) of the Act applies. This means that the property owner must notify the relevant authority of the presence of these species, actively combat and eradicate them as well as prevent their spread. As with category 1b, a property owner must permit an authorised official from the department to enter the property to monitor, assist with and implement the eradication of category 1a invasive species. A permit is also required for any

restricted activities vis-à-vis this category of species. Where an Invasive Species Management Programme exists, the specimens must be eradicated in accordance with that plan.

Category 1b invasive species: Category 1b species must be controlled. In the context of the Act, 'controlled' means eradicated, or where not possible, the spread and propagation of this species must be prevented. This category applies to persons who are in control of a listed invasive species. This section of the regulations does not expressly refer to section 73 (2) of the Act so presumably it does not apply to all landowners where the species occurs. By a 'person in control', the regulations could possibly refer to permit holders or people who are conducting restricted activities. To facilitate this control, a landowner must permit authorised personnel from the Department to enter the property to monitor, assist with or implement the control of the listed category 1b species. There does not however, seem to be any specific obligation on the landowner to eradicate the category 1b invasive species on his own accord, if he is not considered a 'person in control' of this category of listed species. Where an Invasive Species Management Programme exists, the control must be carried out according to the programme. Permits are also required for any restricted activities.

Category 2 invasive species: A category 2 species requires a permit to carry out any restricted activities. As with category 3 species, should any species listed under category 2 occur on a landowner's property, he or she is obliged to control its spread in accordance with any relevant Invasive Species Management Programme (if applicable). Over and above the provisions of any Invasive Species Management Programme, a landowner must ensure that no specimens of the species spread outside of his or her land.

Category 3 invasive species: These listed invasive species are referred to as 'exemptions' because species listed in this category may be exempted from permit requirements in relation to any restricted activities. A landowner is not obligated to eradicate the species nor control its spread except in accordance with any relevant Invasive Species Management Programme (if applicable). However, should any species listed under this category occur in a riparian area (on the banks of a river); it is deemed to be a category 1b listed invasive species.

The categories are summarised in Table 20:

Table 20: Alien invasive species categories and applicable control regulations.

	Compulsory eradication by landowner	Compulsory control by landowner (prevent specie from spreading)	Permit required for restricted activities	Compliance with Invasive Species Management Plan
Category 1a	X	X	X	X
Category 1b			X	X
Category 2		X	X	X (if applicable)
Category 3				X (if applicable)

9.2.1.6 CONTROL of ALIEN INVASIVE SPECIES

9.2.1.6.1.1 Background

Vehicles often transport many seeds and some may be of invader species, which may become established along the disturbed areas inside the mining lease area. The construction phase of developments in the area will almost certainly carry the greatest risk of alien invasive species being imported to the site, and the high levels of habitat disturbance also provide the greatest opportunities for such species to establish themselves, since most indigenous species are less tolerant of disturbance. The biggest risk is that Alien Invasive Species such as the seeds of noxious plants may be carried onto the site along with materials that have been stockpiled elsewhere at already invaded sites.

Continued movement of personnel and vehicles on and off the development sites, as well as occasional delivery of materials required for maintenance, will result in a risk of importation of alien species throughout the life of the project.

Goals for addressing the problem of Alien Invasive Species (AIS) on the site should include:

- Prevention: Keeping AIS from being introduced onto the site ecosystem. Ideally, this usually means keeping alien plants from entering the development site;
- Early detection: Locating AIS before they have a chance to establish and spread. This usually requires effective, site-based inventory and monitoring programmes;
- Eradication: Killing the entire population of AIS. Typically, this can only be accomplished when the organisms are detected early; and
- Control: The process of long-term management of the AIS' population size and distribution when eradication is no longer feasible. This can be done by implementing the following strategies:
    - Institute strict control over materials brought onto site, which should be inspected for potential invasive invertebrate species and steps taken to eradicate these before transport to the site. Routinely fumigate or spray all materials with appropriate low-residual insecticides prior to transport to or in a quarantine area on site. The contractor is responsible for the control of weeds and invader plants within the construction site for the duration of the construction phase;
    - Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and

re-invasion. Weeds and invader plants will be controlled in the manner prescribed for that category by the Conservation of Agricultural Resources Act (Act No. 43 of 1983) or in terms of Working for Water guidelines;

- Rehabilitate disturbed areas as quickly as possible to reduce the area where invasive species would be at a strong advantage and most easily able to establish; and
- Institute a monitoring programme to detect Alien Invasive Species early, before they become established and, in the case of weeds, before the release of seeds;
- Institute an eradication/control programme for early intervention if invasive species are detected, so that their spread to surrounding natural ecosystems can be prevented.

Any control programme for alien vegetation must include the following 3 phases:

- Initial control: drastic reduction of existing population;
- Follow-up control: control of seedlings, root suckers and coppice growth; and
- Maintenance control: sustain low alien plant numbers with annual control.

Scientists and field workers use a range of methods to control invasive alien plants. These include:

- Mechanical methods - felling, removing or burning invading alien plants.
    - Always start at the highest point and work downwards i.e., downhill or downstream;
    - Start from the edge of the infestation and work towards the centre;
    - Take care to prevent the spread of cuttings;
    - Once plants have been removed, banks and slopes should be stabilised by erosion protection measures (such as geotextiles or other suitable materials); and
    - When stacking materials, take note of fire protection measures and remember to always stack the material in rows.
- Chemical methods - using environmentally safe herbicides. The following general principles apply when using this method:

- Chemical control of alien plants is not recommended in aquatic systems due to the risk of pollution, but may be used on the floodplain in conjunction with cutting or slashing of plants;
- Chemicals should only be applied by qualified personnel;
- Only approved chemicals should be applied;
- Follow the manufacturers instructions carefully;
- Appropriate protective clothing must be worn;
- Chemicals to be applied immediately after cutting;
- Only designated spray bottles to be used for applying chemicals;
- Decanting of chemicals and cleaning of equipment should be undertaken at a designated location using drip trays and ground sheets to prevent spillage and contamination of the soil; and
- See next section on the appropriate herbicides to be used for treatment of specific plants.

- Biological control - using species-specific insects and diseases from the alien plant's country of origin. To date 76 bio-control agents have been released in South Africa against 40 weed species. Biological control should be carried out in accordance with the stipulations of the Agricultural Pests Act, 1983 (Act No. 36 of 1983), the Environment Conservation Act, 1989 (Act No. 73 of 1989) and any other applicable legislation. The following general principles apply when using this method:
  - This method is environmentally responsible as it does not cause pollution and affects only the target plant;
  - It is cost –effective;
  - It does not disturb the soil or create large empty areas where other invaders could establish, because it does not kill all the target plants at once; and
  - It allows the natural vegetation to recover gradually in the shelter of the dying weeds.
- Integrated control - combinations of the above three approaches. Often an integrated

approach is required to prevent enormous impacts.

9.2.1.6.1.2 Alien invasive species management

9.2.1.6.1.2.1 Listed alien invasive species and indigenous invasive species on Glencore Kroondal Mine focus areas

Several alien and invasive species were encountered on site or could potentially occur there. These species, their common names, scientific names and photographs are listed in the table below. Although the different AIS listed in the regulations are categorised, the specific species identified on the site for the Glencore Kroondal Mine was further categorized according to the priority to control as follows:

- Priority 1 species: AIS or encroacher species that occur in dense stands in a specific area of the identified areas that needs immediate control;
- Priority 2 species: AIS that occur in moderately dense stands that needs control prior to becoming a serious problem;
- Priority 3 species: AIS that occur in low density stands that are not considered problematic and needs control after priority 1 and 2 species have been eradicated.

The species, their priority for control, control methods and priority control areas are presented in Table 21.

9.2.1.6.1.2.2 Priority control areas

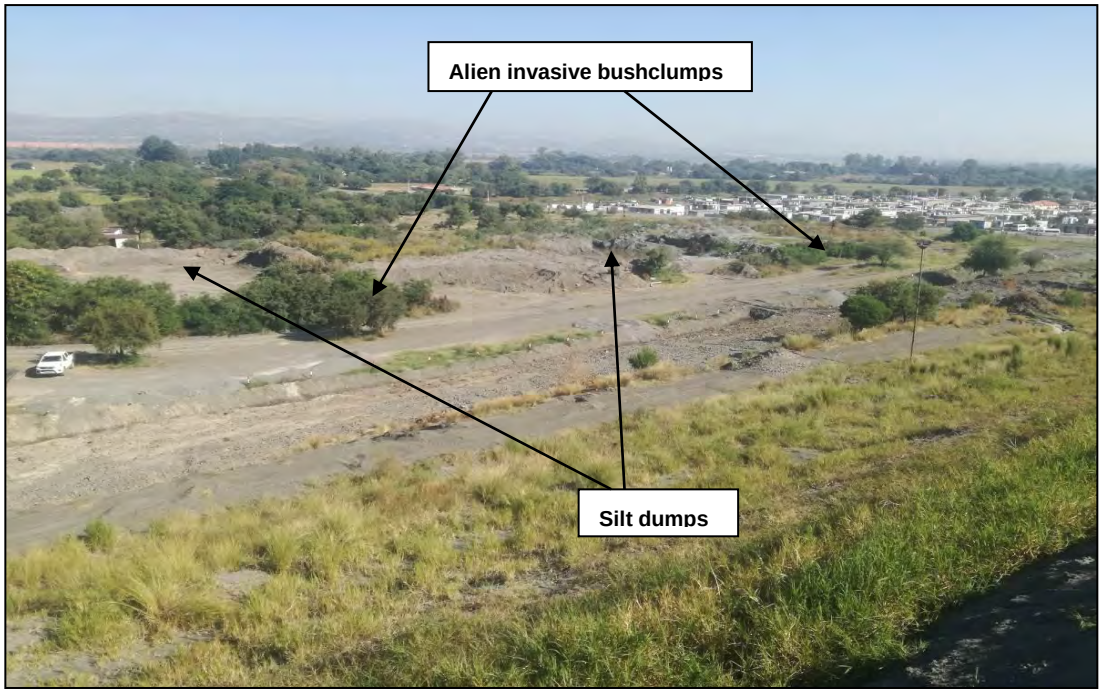
The sites for the Glencore Kroondal mining right area were divided into different priority areas according to the density of alien invasive and weed species. The listed alien invasive species and other exotic weeds occur throughout the site and should be controlled according to the following priority areas as indicated in Figure 16:

1. Priority 1 areas: Areas inside the fenced mining areas with dense stands of exotic weeds that provide a potential source for spreading of seed and establishment of weeds in other areas of the sites (Photograph 16, 17). Occurs in highly degraded, exposed areas.
2. Priority 2 areas: Areas inside the plant or mining areas where some weed species have established but these plants are still young and can be easily controlled before any further spreading (Photograph 18);
3. Priority 3 areas: Areas outside the fenced mining areas with dense stands of alien invasive species that needs to be controlled as a second priority (Photograph 19);
4. Priority 4 areas: Areas outside the plant where some weed species have established but these plants are still young and can be easily controlled before any further spreading

(Photograph 20);

5. Priority 5 areas: Areas inside or outside the dominated by grass species / bare ground with low density alien invasive species that needs to be controlled before further spreading onto the exposed surfaces (Photograph 21-23).

Photograph 16. Priority 1 area with dense stands of Tecoma stans south of the current TSF



Photograph 17. Priority 1 areas: Area south of TSF indicating areas of dense AIS

Photograph 18. Priority 2 areas: Areas in between WRDs and other mining infrastructure with medium dense stands of AIS

Photograph 19. Priority 3 areas outside fenced areas with dense stands of AIS

Photograph 20. Priority 4 areas outside fenced mining area with low to medium density AIS

Photograph 21. Priority 5 areas with low density AIS and weeds inside mining area

Photograph 22.Priority 5 control areas: Natural veld surrounding the mining fenced areas

Photograph 23. Priority 5 control areas at mining offices with gardens / lawns, with low density weeds

9.2.1.6.1.2.3 Species specific control strategy

The alien invasive species listed in the previous section are discussed as priority species for each of the two identified focus areas, namely the Fenced Kroondal Mine and the areas outside the Kroondal Mine that still forms part of the Mine property.

Table 21 indicate specific information with regards to focus areas and different priority AIS, as well as the most suitable control methods.

Table 21: Alien Invasive Species with a distribution centred within the study area and documented during the ecological surveys

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Tecoma stans   	Yellow bells	1b	Priority 1 species	Priority 1 & 2 areas inside mining area and Priority 3 area in riparian woodland	**Mechanical Control:** Maintaining a vigorous ground cover, preventing overgrazing and rehabilitating disturbed areas remains one of the best methods to prevent establishment and invasion of T. stans. Locate seedlings that can be hand-pulled. Larger plants can be uprooted by using a tractor, but resprouting from cut roots can cause rapid reinfestation unless the remaining roots are burnt after drying. Follow-up control to remove the regrowth is necessary for at least a year after initial control. **Chemical Control:** Only repeated applications of foliar-applied herbicides are effective, but this method is usually not economic. More effective are cut-stump application methods using oil-based or oil/water emulsions of 2,4-D and picloram mixtures. These are generously applied to the freshly cut stumps by spraying or painting.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Solanum mauritianum   	Wild tobacco	1b	Priority 1 species	Priority 1 & 2 areas inside mining area and Priority 3 area in riparian woodland	Cultural Control: Cultural control methods, e.g., burning or oversowing with grass species to provide competition, are not normally used against *S. mauritianum*. Indeed, in forestry situations, the burning of leaf litter is discouraged as the forest floor mulch has an inhibiting effect on seed germination (Hinze, 1985). Mechanical Control: Manual control methods, which are largely aimed at the prevention of fruiting, involve the felling of large trees and slashing of smaller plants, ringbarking of trees and hand-pulling of seedlings (Denny, 1999). Seedlings less than 1 m tall can be hand-pulled in soft, moist soil, but roots that break off will coppice. Also, the grubbing out of large plants with mattocks is often unsuccessful as severed roots will initiate regrowth (Hinze, 1985). Felling and slashing by itself is insufficient as the plants will resprout to form multi-stemmed thickets which are more difficult and more expensive to control. As a result, felling and slashing must be accompanied by herbicidal applications. Ringbarking is effective for controlling small infestations, but is labour-intensive (Little, 1980; McGregor, 1999). Chemical Control: Herbicides are currently the most effective means of controlling *S. mauritianum*, since the plant is easily killed with herbicides. Application methods include: (i) foliar sprays for seedlings and regrowth that follows felling or slashing, (ii) basal-stem treatments to the lower stems and root crowns of trees, (iii) cut-stump applications following felling or slashing and (iv) soil applications (Denny and Goodall, 1992; Denny, 1999). In South Africa, several chemicals are registered for use against S. mauritianum and include glyphosate, sulfosate, triclopyr and fluroxypyr for foliar applications, triclopyr and fluroxypyr for basal-stem treatments, triclopyr and imazapyr for cut-stump applications and tebuthiuron for soil applications (Denny, 1999; Grobler et al., 2000). Soil applications are not recommended when the plants are close to crops or plantations, while cut-stump applications of imazapyr are not advised in plantations of Eucalyptus species. The most popular methods are basal-stem and cut-stump applications. Herbicides are best applied during the weed's growing season (Hinze, 1985).

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Leucacena leucopcephala   	Lead Tree Stuipboom	2	Priority 1 species	Priority 1 & 2 areas inside mining area and Priority 3 area in riparian woodland	Mechanical control: Cutting down the trees and digging out the roots. Chemical control very difficult, although some insects use as biocontrol agents

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Tamarix chinensis   	Pink tamarisk	1b	Priority 1 species	Priority 1 & 2 areas inside mining area, especially on dumps and TSF	**Mechanical Control**: Cutting and removal is effective only if the roots are removed or destroyed and without this, T. chinensis may be stimulated to produce new shoots. Cutting followed by some degree of shading (with dark plastic sheeting or by other vegetation) has been more **Chemical Control**: *Tamarix* is 'sensitive' to herbicides and that the best treatments involve cutting followed by herbicide treatment of stumps or cut stump/frill applications. The technique relies on the herbicide being applied within a very short time after cutting and although expensive minimizes potential impacts on non-target species.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Nicotiana glauca   	Mexican tobacco; mustard tree; tree tobacco (English); Jan-tak; tabakboom; wildetabak; volstruisgifboom (Afrikaans), mohlafotha (Sesotho), tabaka bume (Setswana)	1b	Priority 1 species	Priority 1, 2 & 3 areas	**Mechanical:** Hand pulling can remove seedlings and small saplings. For larger more established shrubs, a weed wrench or other woody weed extractor should be used. Care must be taken to remove the entire crown to prevent re-sprouting. Cutting before flowering is also effective at reducing seed production; however, re-sprouting is common. Cutting at the end of the dry season (if applicable) can help prevent re-sprouting. Cutting should also be combined with herbicide treatment, or should be repeated over a few years **Chemical:** Chemical control by herbicides such as triclopyr, imazapyr or glyphosate is effective for controlling (**Garlon suitable** in diesel)

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Conyza bonariensis  	Hairy fleabane, Kleinskraalhans, armoedskruid	Not listed	Priority 2 species - mining area on berms and along haul roads and disturbed areas	Priority 1 Mining area	**Mechanical:** This weed is well controlled through shallow cultivation and is not usually a problem weed in conventional tillage systems. Conyza however, is a serious problem weed in conservation- or no-tillage systems. C. bonariensis establishes from a small seed and the initial rosettes are readily destroyed by tillage. Once established, however, the plant becomes more difficult to control mechanically. **Chemical control:** This weed can be controlled with post-(crop)emergence broadleaf herbicides. Pre-(crop)emergence herbicides can also be used before the weed reaches the rosette stage. Several different herbicides are registered for the control of Conyza in wheat (Table 1 and Table 2). The effectivity of herbicides decrease with an increase in weed size and producers must try and control the weed before it shed its seeds. Time of application is of critical importance, but very often producers are not done harvesting before it is the ideal time to spray Conyza. Follow the specific instructions and dosages on every product that will be used for spraying the different Conyza spp.
Gomphocarpus fruticosus 	Milkweed, Balloon cotton bush (Eng.); gansie, melkbos (Afr.); Lebegane (Sotho); Umsinga-lwesalukazi (Zulu)	Not listed – an indigenous invasive species	Priority 2 species - mining and plant along haul roads and disturbed areas	Priority 4 outside mining area in Sandspruit	**Mechanical control**: Mechanical removal is effective if most of the root system is removed. Repeated cultivation provides some control. If possible, cultivate in autumn to encourage seed germination and lift crowns from the soil. Mowing or slashing in winter is effective if seedlings are also sprayed or slashed as necessary. **Chemical control**: Seedlings can be controlled with 4 L/ha glyphosate (450g/L) or Roundup applied in spring to early summer when the plant is actively growing. For mature plants, spray foliage and a 1 meter buffer area until just wet, with 100 mL Grazon plus 25 mL Pulse® in 10 L of water before flowering when the plants are actively growing in spring to early summer. This will control the parent plant and help control suckering and subsequent germinations.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
					
Datura stramonium  	Downy thorn apple, Ditch weed; jimson weed; stinkwort (English); gewone stinkblaar; olieboom, malpitte (Afrikaans); iloqi (isiZulu); lechoe (Sesotho); umhlavuthwa (Xhosa)	1b	Priority 2 species within mining areas	Largely within Priority 1 and Priority 2 Mining area and scattered outside minig area in Priority3, 4 and 5 areas	**Mechanical control**: Isolated thornapple plants should be hand-pulled before they set seed, whereas larger areas of infestation are readily controlled by tillage when weeds are in the seedling stage. Cultivation becomes less effective as plants mature, because stems become woody and roots may not be completely severed. Seedlings emerge over a long period of time so repeated cultivations may be necessary to reduce the level of infestation **Chemical Control:** Chemical: Herbicide treatment can be done by using 20ml Access and 30ml 2,4 D Eser / 10l water on active growing plants. Care must be taken not to affect other broadleaf herbs and trees.

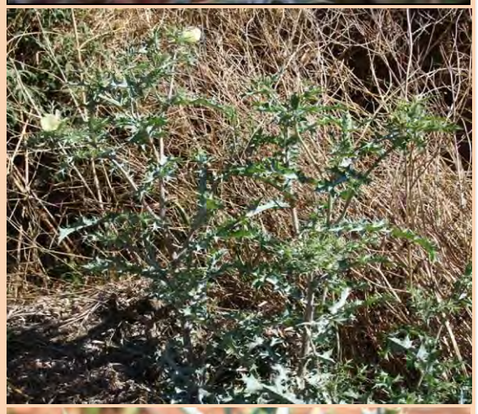
Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
					
Flaveria bidentis 	Smelter bush, Smeltersbossie (Afrikaans), smelter's bush, yellow tops, coastal plain.	1b	Priority 2 species within both plant and mining areas	Largely within Priority 3 & 4 areas in Sandspruit	Mechanical: Remove plants with fruits as soon as possible and dump in front of an active growing rock dump. Dead plants should then be covered with rock as soon as possible. Chemical: Herbicide treatment can be done by using 20ml Access and 30ml 2,4 D Eser / 10l water on active growing plants. Care must be taken not to affect other broadleaf herbs and trees.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
					
Verbena brasiliensis 	Brazilian verbena, Brazilian vervain (English), Gin case (English)	1b	Priority 2 species within both plant and mining areas as well as evaporation dam and return water dams	Largely within Priority 3 & 4 areas in Sandspruit	Controlling the weed before it seeds will reduce future problems. Control is generally best applied to the least infested areas before dense infestations are tackled. Consistent follow-up work is required for sustainable management. Complete clearance of the mature plant before seeding and the use of uncontaminated planting material and farm implements can help to prevent its spread. Small infestations can be cleared by hand pulling and digging. Larger infestations can be treated with herbicide. When using any herbicide always read the label first and follow all instructions and safety requirements. If in doubt consult an expert. Fire can be used as a management tool, but usually in combination with other methods such as chaining. Fire alone may actually increase densities of *Verbena bonariensis* by plant regrowth and enhanced seed germination.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
					
Tagetes minuta 	Khaki bush, khaki weed, African marigold (Eng.); kakiebos, khakibos, langkakiebos, stinkbos, stinkkhakibos, transvaalse kakiebos (Afr.); mbanje (isiNdebele)	Not listed	Priority 2 species within both plant and mining areas as well as evaporation dam and return water dams	Largely within Priority 1 and Priority 2 Mining area & Priority 1 Plant area	Mechanical Control: Tillage and hand pulling is very effective in controlling T. minuta in agricultural fields and in cultivation processes. However, agricultural machines should be cleaned to prevent seed dispersal among fields. Chemical Control: *T. minuta* to be susceptible to acifluorfen, ametryne, bentazon, bifenox, bromacil, cyanazine, dicamba, diphenamid, diquat, diuron, 2,4-D, glyphosate, imazaquin, linuron, metribuzin, molinate, oxadiazon, oxyfluorfen, paraquat and simazine. Currently The effect of these herbicides can be reduced if the herbicide leaches below the germination zone, e.g., in sandy soil.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
 					
Melia azedarach 	Syringa, Persian lilac; bead tree; berry tree; Cape lilac; China berry; China tree; white cedar (English), maksering; sering; bessieboom (Afrikaans), umsilinga (isiZulu)	1b	Priority 2 species	Priority 1-4 area inside and outside mining areas although mostly scattered	**Mechanical**: Seedlings can be pulled out when soils are wet while larger trees can be ringbarked to prevent coppicing. If only single individuals occur the plants can be uprooted. Mechanical control very difficult if not done properly as trees coppices strongly. Follow-up essential. **Chemical control: Basal** Stem: Use Garlon® 4 200ml/10L diesel and painted onto the stem up to a height of 25cm above the soil surface. Cut Stump: Immediately use Chopper® 300ml/10L water.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
					
Ricinus communis 	Castor oil plant	2	Priority 2 species	Priority 1-4 area inside and outside mining areas although mostly scattered	Large plants simply controlled by chopping them out. The weed is generally sensitive to herbicides
Pennisetum setaceum 	Fountain grass	1b	Priority 2 species	Priority 1 & 2 inside mining area, especially on dumps and TSF	**Physical/Mechanical Control:** Seedlings are easily pulled out by hand and larger plants can be dug out using a pick or shovel. It is important to bag or otherwise destroy the seed heads to prevent further seed dispersal (Halvorson and Guertin, 2003). **Chemical Control:** Herbicides containing fluazifop, quizalofop, sethoxydim, fenoxaprop, hexazinone, and glyphosate have been used to control fountain grass (FloraBase, 2012; Halvorson and Guertin, 2003). Some herbicides should not be used near waterways or trees.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Argemone ochroleuca   	White-flowered Mexican poppy, Devil's fig; Texas poppy (English); Witblomboludissels (Afrikaans); ugudluthukela (isiZulu)	1b	Priority 3 species within mining areas	Largely within Priority 1 and Priority 2 Mining area	**Mechanical control**: Plants of *A. ochroleuca* should be destroyed or removed before they produce seeds. Seedlings are readily controlled by light tillage. Long cultivated fallow or vigorous perennial pastures will control large infestations. **Chemical control:** Herbicides which control *A. ochroleuca* include 2,4-D, 2,4-DB, dicamba, diuron, fluroxypyr, hexazinone, isoproturon, karbutilate, MCPA, metribuzin, oxadiazon, picloram and terbutryn

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Opuntia ficus-indica  	Sweet prickly pear, Indian fig; mission prickly pear (English); boereturksvy; grootdoringturksvy (Afrikaans), umthelekisi (isiZulu)	1b	Priority 3 species within plant area	Isolated areas of the priority 3 and 4 areas mostly outside mining area	**Mechanical control:** Hand removal or hoeing for small infestations or seedlings **Chemical control**: For saplings or mature plants, inject either a. MSMA (720g/L) 1L mixed with 1L water at 2ml per injection dose or Touchdown (Glyphosate) (480g/L) 330ml mixed with 10L water at 2ml per dose Any cut portions must be removed and placed on a hard surface to dry out, after which they can be burnt. Standing plants can be left to rot and then burnt

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Bidens pilosa   	black-jack, beggar-ticks, cobbler's pegs, and Spanish needle (English), Knapsekêrel (Afr)	Not listed	Priority 3 species	Throughout all priority areas 1-5 in disturbed areas	*Bidens pilosa* can be controlled by persistent mowing, hoeing and hand pulling in order to prevent seed production. Thorough cultivation discourages growth. Chemical control regimes depend upon the cropping system in which one is working. Details for individual crops can be found in the CABI Invasive Species Compendium. When using any herbicide always read the label first and follow all instructions and safety requirements.
Taraxacum officinale 	Common dandelion, perdeblom	Not listed	Priority 3 species	Priority 1 & 2 mining areas	Young plants are easy to control with post-emergence, systemic, broadleaf herbicides, but once established become more difficult to control on account of their strong tap roots

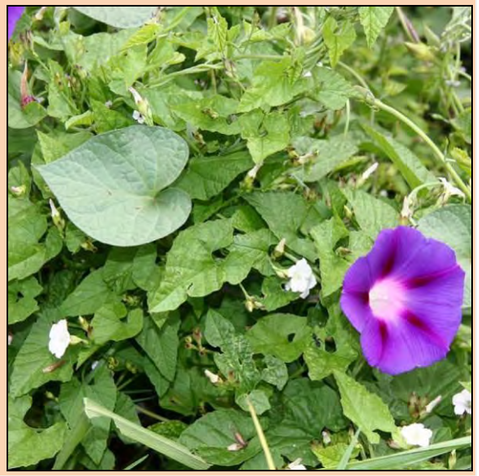
Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
					
Laggera decurrens  	Silky sage, Blue green bitterbush, bitterbos, bloubossie, Wolbos, Pietbos,	Not listed – indigenous invasive species	Priority 3 species	Largely within Priority 1 -4 areas	**Mechanical control:** Mechanical removal is effective if most of the root system is removed. Repeated cultivation provides some control. If possible, cultivate in autumn to encourage seed germination and lift crowns from the soil. Mowing or slashing in winter is effective if seedlings are also sprayed or slashed as necessary. **Chemical control:** Laggera decurrens is controlled by Triclopyr and Picloram.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
					
Eucalyptus camaldulensis 	Blue gum	1b	Priority 3 species	Outside mining areas in Priority 3 areas	When cut down remaining stumps must be treated with herbicide to prevent rapid regrowth. There are registered herbicides for foliar, soil, frill and aerial applications.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Xanthium strumarium 	Large cocklebur	1b	Priority 3 species	Isolated areas along riverine areas and inside plant and at offices	Mechanical: Remove plants with fruits as soon as possible and dump in front of an active growing rock dump. Dead plants should then be covered with rock as soon as possible. Chemical: Herbicide treatment can be done by using 20ml Access and 30ml 2,4 D Eser / 10l water on active growing plants. Care must be taken not to affect other broadleaf herbs and trees.
Tipuana tipu 	Roseweed	3	Priority 3 species	Areas in parking lots and at hangars	No control needed garden ornamental

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Chenopodium album 	White goose foot	Not listed	Priority 3 species	Plant area and bare ground outside plant	*C. album* is easily controlled by cultivation and most of the pre- and post-emergence herbicides broadleaf weed herbicides. *C. album* is sensitive to a range of foliage-applied herbicides, including 2,4-D, MCPA, paraquat, bentazone, dichlofop, isoproturon, metoxuron, methabenzthiazuron, sulfosulfuron, metsulfuron-methyl, chlorotoluron, bromoxynil and dicamba.
Amaranthus spinosus 	Thorny pigweed	Not listed	Priority 3 species	Throughout gardens and on disturbed grassland areas	With the notable exception of bendioxide, all Amaranthus species are susceptible to normal broadleaf herbicides and are easy to remove when young.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Altenanthera pungens 	Khakiweed	Not listed	Priority 3 species	Throughout site – especially disturbed areas with weeds and lawns	This weed is controlled effectively by pre-emergence herbicides but becomes tolerant to post emergence herbicides as it matures. It should be mechanically removed when small
Sonchus oleraceus 	Sowthistle	Not listed	Priority 3 species	Throughout site – especially disturbed areas with weeds	Controlled by clean cultivation, followed by hand weeding of scattered plants. The plants should be destroyed before the seeds are set. They are well controlled by pre- and post-emergence herbicides.

Species	Common names (Afr, Eng)	NEMBA status	Priority species within Kroondal area	Priority area	Control Methods
Ipomoea purpurea 	Morning glory, Gewone purperwinde (Afrikaans)	1b	Priority 3 species	Priority 1 & 2 in mining area, as well as priority 3 outside mining area	Physical/Mechanical Control: Seedlings are frail and easy to pull or hoe. Small infestations can be cut near the base of the plant; the roots require digging out by hand. For larger infestations with many stems, cutting and subsequent applications of herbicides are required (Defelice, 2001). Chemical Control: The herbicides 2,4-D, atrazine, diquat, diuron, glyphosate, oxyfluorfen, pronamide and simazine have been recommended for annual morning-glory. For large infestations, the stems can be cut higher up (breast height) causing the upper growth to die. Then the basal stems can be cut closer to the ground following with an undiluted (or up to 1: 3 dilution) dose of herbicide such as glyphosate onto the stems

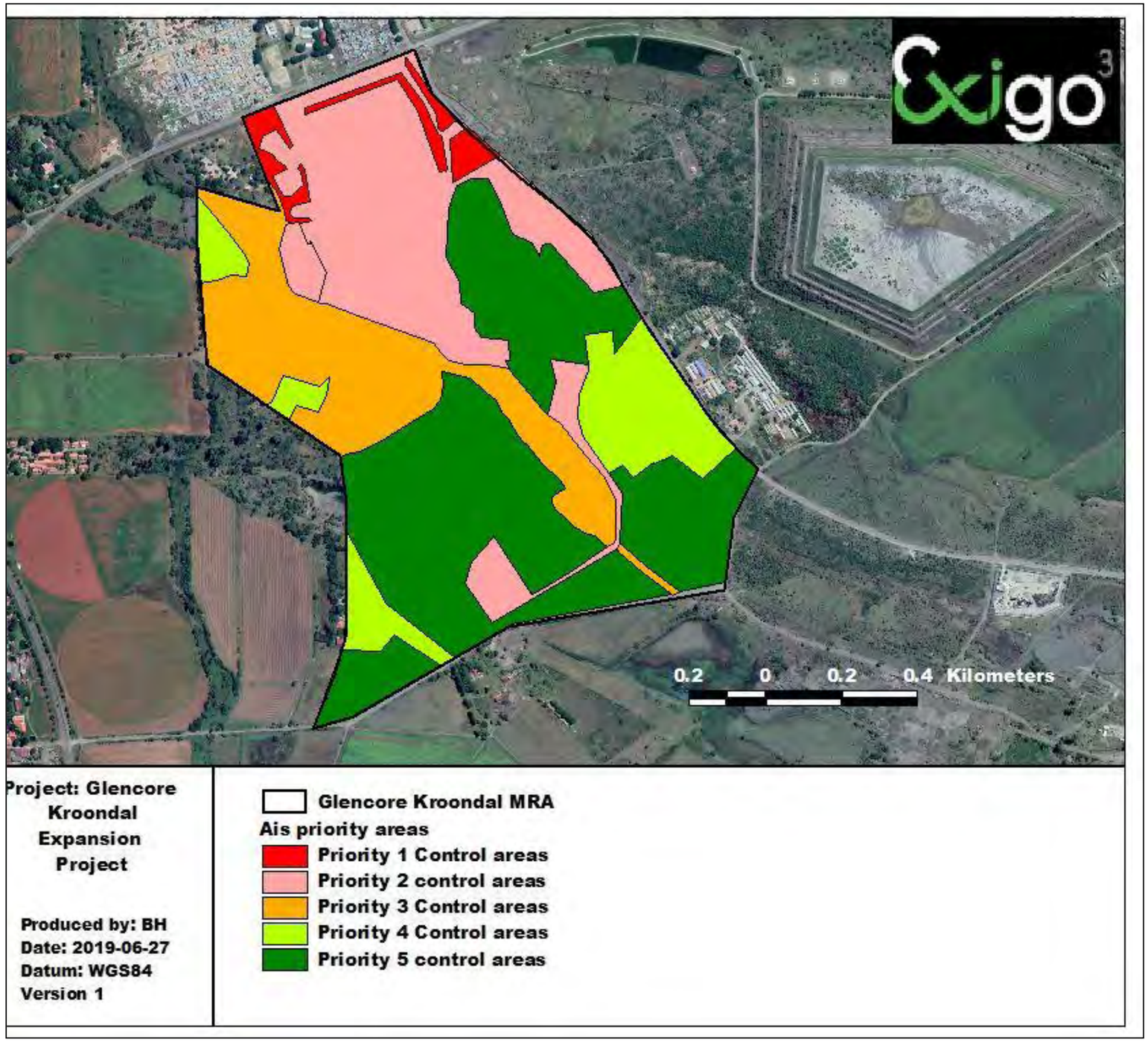


Figure 16: Priority areas for AIS control on the Glencore Kroondal Mine site.

9.2.1.6.1.2.4 Recommended monitoring plan for AIS

The implementation of an AIS monitoring programme is strongly recommended and will be a direct indicator of habitat transformation. This is the only quantifiable means to evaluate the impact of current and possible future management practices on the vegetation of the study area. This includes evaluating the success of rehabilitation activities. The nature of secondary succession in disturbed areas (previously mined and cultivated) should be evaluated to determine whether a favourable succession pathway is occurring towards indigenous vegetation cover.

Plant life will probably resettle, especially after a detailed rehabilitation program on the plant and surrounding areas. The impact life may, however, be of a long-term and permanent nature. The re-vegetation of the disturbed areas will become an integral part of activities during the closure phase. Monitoring and maintenance of alien invasive and grass cover should be done until a self-sustaining plant community is established. Re-establishment of plant cover on disturbed areas should take place as soon as activities have ceased, for example the areas where the buildings and plant area are situated will only be re vegetated once the buildings have been removed during the decommissioning phase. All roads not required for access shall be ripped and planted with endemic vegetation.

Monitoring of alien invasive plants and weeds should be conducted bi-annually on the site for the Glencore Kroondal Mine area as follows:

Phase 1 (2019): As an initial stocktaking exercise, a reconnaissance-type survey should be undertaken to determine:

- The number, distribution and broad categorization of habitat of AIS;
- Whether any obvious signs of dense stands do occur and prioritize control of the specific AIS populations;

Phase 2: Monitoring should be undertaken annually for the first three years, thereafter every third year, to determine:

- The continued presence of AIS in all recorded localities;
- The population density and age of all located populations
- Further control of the AIS populations on site.

The next monitoring exercise should be conducted early 2020.

9.3 FAUNA

9.3.1 BIRDS

Biodiversity value and ecological considerations

1. The observed avifaunal composition on the study site was dominated by unspecialised and widespread species typical of the bushveld region;

2. If one considers the habitat descriptions of the red data species, none of them are limited in range or threatened as a direct result of habitat loss in the southern African sub-region. The impact of the mine on red data species would therefore be less than predicted;

3. The development would not have a significant impact on the red data avifauna since adequate natural habitat/vegetation would be available on the peripheral habitats outside the study area; and

4. The impoundments provide refuge and moulting sites for waterfowl and ephemeral foraging habitat for wader and wading bird species.

9.3.1.1 Waterbirds

The catchment dam and Sandspruit on the site are regarded to be the most important avifaunal habitat types on the study area since they provide ephemeral habitat for a few wetland-dependant stork species. These taxa exhibit opportunistic life-histories and are in general believed to be irregular visitors to the region depending on the presence of favourable conditions (e.g., inundated wetlands; high prey abundances). The waterbirds should be managed according to main threats around the activities:

Main Threats

- Loss and fragmentation of catchment areas and other riparian habitats (including wetlands);
- Pollution of water sources by sewage and other effluents;
- Silting and sedimentation of water sources;
- Poaching of waterbirds; and
- Poor water quality causing chemical pollution.

Conservation actions

- Wetlands restoration and rehabilitation;

- Improvements to floodplain habitat and bypass facilities;
- Reducing development closer to the habitats of waterbirds since it impacts critical habitat and increases flood risk;
- Conservation of wetlands and land adjacent to drainage features through a buffer zone. All efforts should be made to ensure conservation of rainwater runoff through suitable ecological measures, preventing pollution enroute;
- Proper management and treatment of effluents is urgently required. Provisions of the Environment Protection Act and Water Act should be effectively used and enforced for better conservation of water sources. Sanitary and watershed management guidelines should be enforced for all the dams, drainage channels and other water sources on the site. Efforts should be made to see that only rainwater runoff enters such waterbodies / wetlands etc. Vegetation associated with sewage inflow (water hyacinth), should be continuously removed till effluent inflows are controlled;
- Plant activities that increase silting and sedimentation (erosion due to poor catchment status) must be controlled or modified. Assessments of silting and sedimentation as well as measures taken should be made frequently; and
- Periodic assessments of both water quality and quantity need to be carried out. Direct entry of sewage and effluent needs to be prevented and ensuring proper treatment of wastes is very important.

9.3.1.2 LARGE BIRDS OF PREY

The larger of birds of prey frequent the area of the proposed mining activities although at irregular intervals due to the large home ranges. Protected areas contribute to the goal of conserving larger birds of prey such as eagles and falcons, but by themselves will not be enough; wide-ranging raptors must also survive in human-dominated landscapes. By attempting to meet the ecological needs of raptors we can reasonably expect to also save significant portions of biodiversity in the food chain below them.

Main Threats

- Hunting: Millions of diurnal birds of prey have been shot over the past 150 years. As a group, they have been persecuted for killing livestock, poultry, and game birds. In truth, only a few of the larger species occasionally feed on domestic animals;
- Habitat destruction: Deforestation and other habitat destruction is currently the most

serious threat to diurnal birds of prey. Habitat loss not only affects birds in their breeding areas, but also in their wintering areas;

- Pollution: Diurnal birds of prey, like all carnivores, are especially vulnerable to pesticides, insecticides, and other human made toxic chemicals. As chemicals are passed up the food chain from plant to plant-eater and from plant-eater to meat-eater, they become more and more concentrated in the tissues of each succeeding animal. This process is called bioaccumulation. Organochlorines, such as DDT, PCB, and dieldrin are extremely harmful in concentrated amounts. A build-up of organochlorines may cause death in adults and embryos, lead to chronic illness, or cause the thinning and premature breakage of eggshells. Other forms of pollution, such as acid rain and oil spills, cause prey populations to decline, and in turn cause the decline of diurnal birds of prey populations. Discarded trash, like used monofilament line, can entangle and harm individual diurnal birds of prey;

- Poisoning: Accidental poisoning occurs when diurnal birds of prey eat rodents or seed-eating birds that have been poisoned by farmers for pest control. Lead poisoning occurs when diurnal birds of prey eat carcasses or live prey shot with lead bullets. Diurnal birds of prey may also be killed by eating poison-laced carcasses set by ranchers for other predators considered pests. Some carcasses are set deliberately for diurnal birds of prey; and

- Human structures and disturbance: Accidental deaths occur when birds collide with human made structures such as buildings, fences and power lines. Power line electrocution is frequent in larger birds, like eagles, whose wings can touch two wires at once. Many carrion-eating birds are struck by cars while feeding on or near roads. Diurnal birds of prey may abandon territories or nest sites if disturbed by human activity.

Conservation actions

- Increase awareness of the ecological significance of large birds of prey in the control of rodent species and the need for their conservation among the general public;

- Provide support roosting sites along electrical pylons that would allow large raptors to safely roost;

- Retaining nesting sites of large raptors if identified during monitoring of the site. The breeding sites should be sufficiently buffered to prevent disturbing the bird during breeding; and

- Maintaining the territory integrity of the birds of prey through sufficient buffers and corridors. Alternatively, habitats adjacent to the study site should be preserved as protected areas.

Landscape management strategies should be implemented to provide complex habitats in terms of a diverse mix of trees, shrubs and structural conditions. This will provide diverse habitats for many species of birds which are the main source of prey for the raptors.

9.3.1.3 BIRDS ASSOCIATED WITH OPEN WOODLAND

The open woodland habitats of the study area provide habitat for some red data bird species such as secretary birds and southern black korhaan. These species are threatened mostly by the destruction and fragmentation of their habitat types. The conservation of these species is therefore associated more with the conservation of their habitat type and this will be described under the "Habitat Action Plans".

9.3.2 MAMMALS

Biodiversity value and ecological considerations

1. Most of the habitat types on the respective study sites are not intact. Therefore, the expected mammalian richness on these areas is considered LOW;

2. The dominant species composition comprises of widespread taxa with unspecialised life history traits; and

3. The wetland areas provide atypical habitat for a few taxa with high affinities for moist conditions (e.g., Marsh Mongoose A*tilax paludinosus*, taxa pertaining to the genera *Crocidura* and *Otomys* spp.). These species, although regionally widespread in occurrence, are range-restricted on the mining area, and contribute towards the general diversity of the area.

9.3.2.1 SMALL & MEDIUM SIZED RED DATA MAMMAL SPECIES OF CONCERN

The study area would potentially provide habitat to some of the red data and protected mammal species listed, although the probability to encounter any of these species on site is very low. Species such as honey badgers and serval can become habituated to anthropogenic influences, while other species such as brown hyena will rather move away from the activities and will seldom use the area, although a specific management strategy is needed for the red data species potentially occurring on site. The different red data mammals are discussed as groups:

9.3.2.2 BATS

Red data bat species play an important role in our ecosystems, are vital to leading an environmentally friendly lifestyle and save our farmers millions by simply eating insects and pollinating plants.

However, many of the red data bat species will roost and breed in nearby caves, and such habitat structures were mostly absent from the actual footprint areas. It should be realised that many of these species prefer to forage along riparian vegetation and are therefore not considered regular visitors to the mine area.

Threats

- Fragmentation & isolation of habitats through mining or other human activities;
- Degradation of habitats; and
- Pesticides.

Conservation actions and mitigation measures for bats in the area

- The main effort in their conservation is to encourage landowners and farmers to manage their land in ways that benefit the bats. They should be asked to limit the use of ivermectin insecticides, commonly used for treating cattle. The chemical in the insecticide also poisons the cattle's dung, and kills the larvae of dung beetles, one of the horseshoe bat species' principal foods;
- Many scientific and charitable groups contribute to bat monitoring and local education programmes that can help to reduce persecution and raise awareness of the natural assets of the land;
- The ultimate mitigation measure would be to not opencast mine any old adits in the larger project area and for all further mining and development to remain outside of the 500m disturbance buffer. If this cannot be avoided, artificial roosts should be constructed prior to adit destruction to replace the habitat lost. Various forms of artificial bat roosts have been designed throughout the world to suit different species that have different roosting behaviours and require different habitat requirements (NSS, 2013);
    - The most common form of artificial roost from bats is the wooden bat house/ bat box. This would not be suitable for the cave dwelling species, as found in the old underground mine workings at Glencore Kroondal Mine;

- Artificial roosts that have been successful internationally to replace cave or mine adit roosts are described overleaf in the various text boxes. Of these, the most practical one, that NSS recommends for the South African context would be the one using old mine truck tyres, concrete and wire mesh to form tunnels beneath old waste rock dumps. Not only does this replace the habitat lost but it solves the waste disposal problems caused by old mine truck tyres; this is recycling at its best; and

- This artificial roost should be constructed prior to adit destruction and the bats flushed from the adit prior to destruction to prevent unnecessary deaths of bats.

9.3.3 Problem animals

In this specific problem animal management section, consideration will be given to mammals that could potentially have a nuisance factor on the plant premises. Smaller animal species will generally be discussed in the Pest Management Control.

The relevant provincial department as well as the Glencore Kroondal Mine Management should be informed of any problem causing animals. Shooting or other forms of elimination may not take place without the necessary permits from the relevant provincial department. The Management Authority should also liaise with the provincial government not to permit the use of poison to control problem animals in the plant area. The following section deals with specific management of potentially problematic or dangerous animals on site.

9.3.3.1 Venomous Snakes & snake handling

Plant management should acquire the services of a qualified herpetologist capable of handling venomous snakes should any snakes be encountered on the site. The herpetologist should train specific (and interested) individuals on the site with the ability to identify and remove venomous snakes when encountered. This person should be readily available in the event of a snake posing a risk to the work force. The following section deals more with snakebites and specific management aspects to consider should an employee or visitor to Glencore Kroondal Mine get bitten by a snake:

Snakes and snakebites: It is important to remember that most snakes are not venomous, and, when a venomous snake does bite, it will seldom be fatal. However, these bites can cause permanent injuries to the affected part, usually a limb, and occasional loss of life. The mortality rate from snakebite is around one in every 68 bites, resulting in about 15 fatalities a year in South Africa. About 20% of bites will require major treatment. Recovery from a bite is influenced by several factors, including the amount of venom injected, the site and depth of the bite as well as the health, body size and age of the person. The time it takes to receive medical treatment also plays a role.

Preventing snake bites

- Do not try to catch or kill snakes; get in an experienced snake handler;
- Watch where you step. Always use a torch when you walk outdoors at night;
- Wear boots and long trousers in the bush or veld. Step on top of, not over, logs or rocks. Stick to well-cleared footpaths;
- Do not put your hand into holes, above your head onto ledges, or under objects when picking them up;
- Stay away from "dead" snakes - they may be feigning death;
- Always keep your cell phone with you on the plant and keep it charged. If you are going to be in an area without cell reception, consider getting radio communication, and make sure someone knows where you are going and when. Have all the relevant emergency numbers on you, and know which the nearest medical facilities are; and
- Do not be blasé about snakes; many bites (and some deaths) occur because of snake collectors and even experts with many years' experience getting careless.

Symptoms: Symptoms depend on the type of venom injected:

- Most adder venom (such as from puffadders) is toxic to tissue (cytotoxic), especially blood vessels. It causes extreme pain, swelling of the limb and blistering. An untreated bite may cause death due to loss of blood, dehydration and secondary infection. The following is characteristic of adder bites:
    - Generally, two puncture marks at the site of the bite;
    - Bite causes instant pain with immediate swelling, bruising and blistering; and
    - Symptoms can include nausea and dizziness.
- Cobra venom is toxic to the nervous system (neurotoxic). Symptoms include "pins and needles", dizziness, poor co-ordination, slurred speech, excessive salivation and drooping eyelids. This is followed by difficulty in breathing. The following is characteristic of snakebites with neurotoxic venom:
    - Generally, two puncture wounds at the site of the bite;

- Bite can feel more like a sting and there is little or no bruising and swelling; and
- Symptoms include feeling confused, dizziness, slurred speech, difficulty swallowing and breathing.

Not all medical facilities will have antivenom, and they may need to order this in. However, in most cases there will be enough time for a patient on correct supportive care: neurotoxic venom is very fast-acting, but other types of venom take several hours to take effect.

First Aid for snakebite

DON'TS:

- Do not use antivenom except in a hospital environment. Some patients react against antivenom and may go into anaphylactic shock, a serious condition that requires emergency medical treatment. Antivenom also needs to be kept refrigerated, injected correctly (into the bloodstream, not the muscle, and not into the bite site), and given in sufficiently large quantities to be effective;
- Do not cut and suck the wound, or use suction cup devices or electric shocks;
- Do not give the patient anything to eat or drink;
- Do not rub potassium permanganate into the wound or soak the limb in home remedies; and
- Do not try to catch and kill the snake.

DO'S:

- Get everyone well away from the snake;
- Try to obtain a clear description of the snake. However, this is not essential, and you should not waste time looking for it. The symptoms will give the doctor a good idea of the kind of snake (neurotoxic etc.), and the severity of the bite;
- Stay calm and reassure the person who has been bitten. Fear and anxiety cause an increase in heart rate, and thus a more rapid spread of venom throughout the body;
- For neurotoxic snake bites, it may help to wrap a crepe or pressure bandage firmly around the area of the bite, covering the entire limb (from fingertip to armpit; from toe to groin). Apply hand pressure at the site of the bite until a bandage or strips of fabric can be obtained;

- It is important though not to restrict blood flow between the bite and the heart for neurotoxic snakes;
- For cytotoxic snakes such as adders, Immobilise the limb but do not restrict the blood flow;
- Keep the person as still as possible and immobilise the affected limb by binding splints (e.g. straight branches) to either side of the limb;
- If a snake such as a rinkhals spits into someone's eyes, rinse with large amounts of water, preferably by holding the head under a running tap. This will also require treatment at hospital: a drop of antivenom is placed in the eye;
- Observe the person closely and record any symptoms and the time taken for them to appear; and
- If the patient stops breathing, you will need to breathe for them until they can get expert medical help.

9.3.3.2 Feral Cats and Dogs

The feral domestic cat (*Felis catus*) and dogs are predatory invasive species with documented negative effects on native wildlife. Many feral cats and dogs will potentially occur on the Glencore Kroondal Mine premises in future. Although, the feral animals do play an important role in controlling pests such as rodents, they pose the following threats to biodiversity in the area:

- Domestic cats can 'invade' by introducing their DNA into the gene pool of the African wildcat population in the larger area; and
- Feral cats and dogs impact on avifauna and other threatened smaller mammal species that might occur on the premises.

Control: Although various methods of feral cat and dog population control existing there are two basic categories: either eradication or reproductive regulation.

- One option for Glencore Kroondal Mine would be to eradicate the feral cats and dogs through shooting. This is an ethical issue though and should be investigated before implementation; and
- The most suitable control option would be to control the feral animal population effectively on the premises, a suitable and ongoing sterilization programme needs to be implemented. This programme needs to be long-term and overseen by management and

by using a local veterinarian from the area. The feral cat population needs to be maintained at a level that will not negatively affect the resident wildlife populations. This may require some removal of feral cats at the start of a programme. Whatever management actions are followed, a monitoring programme must be put in place to document how effective the actions are.

9.3.3.3 Crocodiles

Nile crocodile is not a species that, under normal circumstances would be expected to occur. However, a large crocodile breeding facility used to occur to the south-east of the borders of the Kroondal Mine and it is entirely possible that escapees may utilise the various waterbodies on site.

A few baby crocodiles were observed in the Catchment Dam and the Silt Trap of the Kroondal Mine during 2019 surveys. The crocodiles hatched from eggs that were left behind when the Crocodile Farm was abandoned recently. The small crocodiles need to be removed from the area by a crocodile specialist from a nearby Crocodile Farm.

9.3.3.4 Pest control & management

- *Bee (Apis mellifera) and stings*

Bees could become a nuisance at infrastructure on the mine and pose a threat to people. The services of a bee-farmer should be rendered to remove and relocate a problem colony when necessary. Under no circumstances should the colony be exterminated or poisoned. The following are basic steps to follow for the treatment of bees on site:

Preparation prior to Treatment: On no account must the entrance to a nest be blocked, this can be dangerous. Keep employees away from the area and close windows of buildings nearby.

Control or treatment: Treatment of the bee nest is sometimes the only solution. The operator will be able to tell you what sort of bees they are, usually either Bumble Bees, Honeybees or a wild species such as masonry or mining bees, there are many sub species of wild bees within these groups. Bees are not aggressive as wasps but will sting if they think the nest is threatened. Honeybees will not hesitate to sting in this situation and can be dangerous just to the large numbers in a nest or swarm. The nests will be treated with Demand CS'* which contains Lambda-cyhalothrin. Demand CS is probably the most modern insecticide available. Also, a powder might be used called Ficam D*. This contains an insecticide in a dust formulation @ 1% w/w Bendiocarb. Both insecticides are biodegradable, almost odourless, non-tainting & do not corrode or stain. They are not highly toxic towards mammals but are extremely so to all forms of crawling and flying public health pests.

What to do afterwards? After treatment the bees may remain in a hyperactive state for a few hours, but activity will usually completely cease within 4 warm days (cold or wet days may prolong activity). Never block the entrance to a nest or make repairs to holes unless you are quite sure the nest is dead e.g.; bees are not flying in and out of the entrance.

The following should be done in the event of a person being stung by a bee or wasp onsite:

In the event of a massed stinger attack:

- Keep calm, cover your head if possible [e.g., with your shirt] and run steadily to safety as most people can outrun them if they do not panic. Bees do not travel very fast, 4mph top speed; and
- Run in a straight line; do not try to zigzag- Get into anything that is sealed in such a way as not to allow insect entry, such as a tent or a car.
- **Do not**
    - Scream as this will only irritate them more and increase the severity of the attack;
    - Run towards other people who will also get attacked;
    - Hide under water [e.g. your pool] as they will still be swarming above - and go for you - when you surface for air; and
    - Rip your clothes off, even if some bees got inside. If the shirt comes off the rest of the bees will have more targets.

Treatment of stings:

- All bee stings include an alarm pheromone which incites their mates to attack, so step one is to get away from a nest/hive with all speed;
- Scrape/pull out stings as soon as possible. A honeybee sting has a pump attached that continues to introduce venom for 1 minute after stinging. A wasp does not leave its stinger;
- Apply an ice pack [e.g., anything frozen wrapped in a kitchen towel] to minimize swelling and pain;
- Lift limb to heart level to reduce swelling;

- Take an antihistamine tablet to reduce swelling and itching;
- Take a pain killer, preferably anti-inflammatory; and
- The swelling and redness may be worse the next day; this is a normal allergic reaction. If, however the swelling is still painful, and a fever is present there may be secondary infection and a hospital visit is advisable.

Severe reactions

If the victim has been stung multiple times, is young or old, or is one of the 1% that is super-sensitive to stings, watch for signs of systemic allergies. These may include:

- Headaches, fever, nausea, vomiting, swelling of the tongue or throat, difficulty in breathing, cramps, drowsiness or unconsciousness. Get medical help;
- Severely allergic people should carry an epinephrine kit and use it, followed by an ice pack and hospital; and
- The clinic at the plant should be able to provide the necessary medication or treatment for bee sting victims.

o *Cockroaches*

Cockroaches are among the most common insect pest found inside buildings. They are especially troublesome where food is prepared, and sanitation is lacking. Cockroaches are repulsive to most people, simply by their presence. They may contaminate food, kitchen utensils and other items, and they leave an unpleasant odour. Because cockroaches move freely from filth to food, they can transfer microorganisms that cause food poisoning and other illnesses.

Control or treatment: The following principles should apply:

- Product used is colorless, odourless and nontoxic to humans;
- The product is carried to the nest by the insects and the nest is destroyed;
- This creates a break in the life cycle of the cockroach and a roach free area can be guaranteed;
- Each area will be visited once every three months; and
- The kitchen, bar, toilets and all other service areas will be treated for cockroaches and other insects.

o *Rodents*

Rodent infestations present a health hazard to humans & animals. The nature of the hazard and the severity of the risk depend on the species of rodent and the geographical position and can include bacterial diseases e.g., Salmonella, Rickettsial diseases, viral diseases, protozoal diseases or fungal diseases. Rodents are intelligent animals that can adapt well to new circumstances, but they are very wary of changes in their territory.

Control or treatment: The following principles should apply:

- Pest Control product is taken in by rodent in the form of treated seed or liquid mix;
- Pest Control product should attack the lungs of the rodent first and then the other organs. This ensures that the rodent leaves the building to die outside; and
- Rodent bait will be placed as required in the certain area;

o *Ants*

Ant infestation can be a nuisance as well as a health threat. Worker ants foraging for food and water become a concern when they infest food or other items in the buildings of the Glencore Kroondal Mine.

Control or treatment: The following principles should apply:

- The areas around the buildings are inspected for evidence of the insects and then treated accordingly;
- The nest is treated and a large amount of poison is pumped into the nest; and
- No drilling is done.

o *Flies*

Flies can be a serious public health nuisance in and around food handling & public areas. They must be prevented from entering buildings. Flies liquefy food by regurgitating digestive juice and their stomach contents on to the food substance. The liquid is then drawn up by the sucking mouthparts and pass through the gut to be deposited as the fly spots. They pick up pathogenic organisms that can be transferred to other surfaces. Reports have been received about flies as major environmental health concern when infestations overspill from breeding sites such as waste disposal sites.

Control or treatment: The following principles should apply:

- Red top fly catchers and residual sprays should be used at the refuse areas; and
- This is done to contain the problem at the source as this is the area where they breed.

9.3.4 Management of wildlife mortalities:

Due consideration should be given to the position of current transmission and distributions lines to prevent unnecessary 'bird-power line' interactions. The drowning of larger birds of prey and smaller animals in reservoirs should be prevented.

The reservoirs need to be modified to ensure that raptors or small mammals can lift themselves free of these reservoirs by installing some sort of perching device. Raptor protection devices (as developed by the Raptor Conservation Group of the Endangered Wildlife Trust) are indicated in Figure 17. The construction of a 'raptor friendly' reservoir involves the use of a plank, ladder or branch extended into the reservoir that is attached to a lever mechanism allowing the raptors safe access to the water.

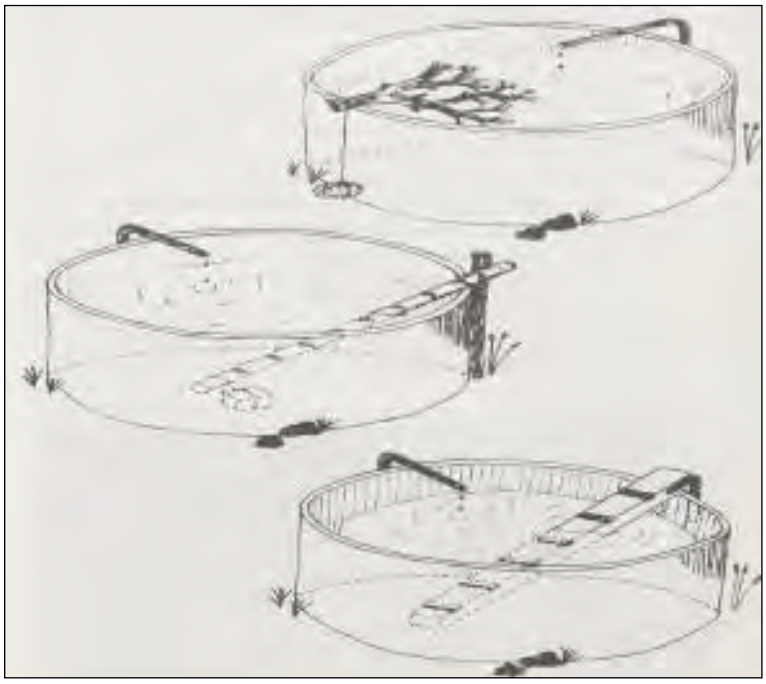


Figure 17: Raptor friendly reservoir design.

9.4 HABITAT ACTION PLANS

The Habitat Action Plan (HAP) has been designed to address biodiversity issues for the whole study area (BMU's). It provides an overview of the status of habitats, examples of work on the ground, issues impacting the habitat and a list of actions to sustain and improve habitat quality and quantity in the future.

To ensure that the activities will not negatively impact on the natural environment the following

general principles should apply for the habitats in the larger area:

- Conserve a full variety of habitat types, focusing on sites close to, or well-connected to, other natural areas;
- Consider actively restoring or allowing the natural recovery of disturbed areas that could function as corridors between natural habitats;
- Where a property forms part of a larger natural area, consider how to protect landscape level processes on the property;
- Minimize edge effects through careful land management;
- Create buffer zones adjacent to natural areas, where the land is free of invasive agricultural weeds;
- Starting at the source of the invasion, clear alien plants from natural areas, especially water catchment and riverine areas; and
- Maintain optimal fire regimes.

9.4.1 Woodland / shrubland habitat type

The Marikana Thornveld vegetation type represents the mixed microphyllous woodland and open microphyllous woodland habitat types in the study area. *Vachellia* dominated, semi-deciduous, fine-leaved woodlands typically occur on nutrient rich, often alluvial, soils in the drier (<650 mm/annum) western regions of the Savanna Biome.

Current Status: Least Threatened

Main Threats to habitat type:

- Cultivation;
- Urban and built-up land;
- Overgrazing and encroachment; and
- The impact of invasive alien plants has a negative impact or effect on the ecosystems which it has penetrated. Seeds of these plants are normally dispersed by agents such as birds, through aquatic ecosystems (rivers / streams) and the introduction of feed during feeding programmes. Although unintentional, alien plants may be distributed to areas which had been free from such invaders through feeding programmes.

Actions for site

- Bush encroachment control. The present legislation under the Conservation of Agricultural Resources Act, 1983 (Act No 43 of 1983) (CARA), regulation 16, states that bush encroachers, which are indigenous plants, require sound management practices to prevent them from becoming problematic. Bush encroachment is a term used for "stands of plants such as sickle bush and various Vachellia species where individual plants are closer to each other than three times the mean crown diameter". Therefore, CARA does not outlaw these plants, but instead prescribes management practices aimed at preventing bush encroachment, and at combating it where it already occurs. If communities of plants from the list of indicators occur in the natural vegetation of an area, the land users must take the necessary precautions to prevent the deterioration of their land to such an extent that bush encroachment takes place. In cases where bush encroachment has already taken place, the land users must remove the cause of deterioration and combat the encroachment of indicator species. Among the prescribed measures are the uprooting, felling or cutting of plants, the judicious application of registered herbicides, livestock reduction and the correct utilization and protection of veld;

- Conservation of fauna habitat through corridor zones in the larger area and the property; and

- Vigilant eradication of alien species must be undertaken if such species are identified on the site. This action will minimize the negative impact of alien species on the natural ecosystem of the larger area. The planting of any alien plant species in and around the infrastructure on the mining site should be discouraged. Any alien plant species currently within the study area should be eradicated as it always can spread and invade the natural ecosystems. Only plants that naturally occur within the ecosystem should be planted, as these will pose no threat to other indigenous plant species.

9.4.2 Wetlands

Main threats to ecosystem

- Siltation of aquatic ecosystem and increased erosion during stormwater events;

- Surface water pollution; and

    - Accidental spillages of sewage water from sewage facilities could happen and could lead to surface water pollution if this washes down to the river during a

rain event; and

- Water falling on areas polluted with oil/diesel or other hazardous substances.

- Spread of exotic weeds and alien invasive plants in the wetlands.

Management actions needed for wetlands and riparian zones:

- Storm water control as described under mitigation measures;
- Enhancements of aquatic ecosystems in dams and smaller water sources on the property;
- Monitoring of water quality to ensure that pollution does not occur during the operation of the plant;
- Alien invasive plant control. This area is prone to alien infestation due to seeds settling in the mud after stormwater events. The introduction of alien species cannot be stopped as seeds from outside the area will always be dispersed through stormwater. Consistent and persistent removal of alien species will therefore always be a management function. The Working for Water Programme should be contacted to become involved on site to clear these plants from the area;
- Coordinate erosion control measures with construction activities, including the staging of works;
    - Programming: Install erosion control measures before construction commences. Schedule construction activities to minimize land disturbance;
    - Land clearing: minimize the extent and duration of land clearing;
    - Stormwater and run-off systems: install temporary drains and minimize concentrated water flows. Control stormwater velocity where necessary with temporary energy dissipater structures. Divert run-off around trench excavations or disturbed areas;
    - Rehabilitation: revegetate or stabilise all disturbed areas as soon as possible. Indigenous trees can be planted in the buffer zone of the proposed development to enhance the aesthetic value of the site and stabilize soil conditions;
    - Services: coordinate the provision of site services to minimize disturbance;

  - Stockpiles: locate stockpiles away from concentrated flows and divert run-off around them;
  - Minimize soil exposure during construction;
  - Re-vegetate quickly and extensively;
  - Manage water effectively on, to, within, and from this site; and
  - Provide suitable access tracks and loading, unloading, maintenance and washdown areas.

- Incorporate effective litter management and "house-keeping" practices. Uncontrolled littering can be a source of pollution to the wetland. The following measures need to be taken to mitigate against littering in wetlands:
  - Litter storage and housekeeping: maintain a high standard of housekeeping. Store all litter carefully so it cannot be washed or blown into the stormwater drainage systems;
  - Rubbish bins: provide bins for construction workers and staff at appropriate location, particularly where food is consumed. These bins should have lids;
  - Daily site clean-up: clean-up site of all litter daily; and
  - Rubbish disposal: dispose of scrap materials (e.g., off-cuts and scrap machinery components) in a responsible manner.

- Employ sediment capture techniques and stormwater attenuation techniques. A regular site maintenance schedule needs to be introduced. Sediment control devices need to be installed to capture mobilised sediment. The following sediment control devices are suggested:
  - Sediment filters: use materials such as fine mesh or geofabric to filter run-off prior to discharge;
  - Sediment traps: temporary sedimentation basins; and
  - Drop inlet filters: e.g., hay bales and silt fences, which prevent sediment entry into the drainage system.

- Pollution prevention: Stored material that has been poorly located or left unprotected

can be a source of pollutants. The following measures need to be taken to prevent pollution to wetlands or riparian zones:

- Stockpile location: locate stockpiles and material storage 30m or more away from drainage lines and identified wetland habitat;
- Stockpile construction: minimize the number and size of stockpiles. Construct stockpiles with a height to width ratio of less than 2:1. Surround unstabilised stockpiles and batters with silt fences or drainage systems that will collect and treat uncontaminated water;
- Stockpile maintenance: cover any stored material to protect it from rainfall. Mulch, roughen and grass seeding can be used on any batter or topsoil stockpile that is to be maintained for longer than 28 days.

- The following management measures should be implemented for building activity associated impacts:
  - Materials storage: store building materials under cover or in contained areas;
  - Site cleaning: clean the repair or construction site daily. Do not use water for cleaning the site;
  - Leakage containment and treatment: ensure that oil, fuel or solvent leakages cannot enter the stormwater system; and
  - Implement clean and dirty water separation practices for example temporary filters: fit temporary inlet pit filters near wash-down areas to prevent pollutant entry into the drainage system.

9.4.3 Environmental awareness plan

The MPRDA requires the mine to develop an environmental awareness plan to inform the employees of any environmental risks which may result from their work. Additionally, environmental awareness training has been identified as a mitigatory measure to prevent and minimise impacts on the receiving environment. Glencore Kroondal Mine recognises the role of the environmental awareness plan in preventing and minimising its impacts from mining operations on the environment.

The objectives of the environmental awareness plan will be:

- To educate employees regarding their role in conserving the environment and the

importance of conserving natural resources;

- To identify environmental training needs for employees and contractors at all levels;
- To ensure that employees whose work could cause significant environmental impact as identified by the plant are competent to perform those tasks to which they are assigned;
- To enable employees to identify environmental impacts or non-conformances of their work activities on the environment;
- To familiarise employees with emergency preparedness and response requirements;
- To be aware of the potential consequences of deviation from specified operating procedures; and
- To conduct their work and manage activities in an environmentally responsible manner.

To determine the existing level of knowledge and to distinguish what the employees need to know, a training needs analysis will need to be compiled.

The following principles will apply to the environmental awareness plan (Safety, health and environment-SHE) training:

- All personnel will undergo SHE training and induction;
- An environmental officer (EO) will be appointed; and
- The EO will identify and record training requirements for the mine personnel and contractors in a training matrix which will identify specific training per group of employees or contractors. The EO will monitor and administer the training matrix.

The training program will include:

1. General awareness training

    a) This will include an overview of the Environmental policy;

    b) Description of the EMP and importance of conformance to its requirements;

    c) Review of significant environmental impacts including information on protected fauna and flora;

    d) Responsibilities of mine personnel regarding the EMP;

e) Review of the emergency and corrective action processes;

f) Training topics will be displayed on notice boards;

g) The EO will conduct the general awareness training. He/she will keep complete training records of all persons attending the training; and

h) Introducing and implementing an induction course.

2. Specific environmental training

a) This training will be in line with the requirements in the training matrix.

b) Personnel whose work can impact on the environment will receive specific awareness training (competency training) in appropriate procedures. Supervisors will also be aware of all these requirements.

Topics can include:

- Waste prevention and control;
- Water management;
- Hydrocarbon and chemical spill reporting and clean-up;
- Storing and handling of chemicals;
- Rehabilitation;
- Dust management;
- Noise management
- Snake management; and
- Air quality.

Training evaluation and re-training

- Effectiveness of environmental training will reflect conformance to EMP requirements, audit results and the environmental performance of the Glencore Kroondal Mine;
- Incidents and non-conformances against the EMP will be assessed by the EO to

determine if it was due to a lack of training;

- Re-training will be done where appropriate; and
- General awareness training should be repeated every year.

10 MONITORING REQUIREMENTS

The next phase in the management of the mine is to decide on a long-term strategy for monitoring the environmental impacts of the mining operation. This will involve the marking out of monitoring grids in the area that can then be measured and recorded on an annual basis. Monitoring provides periodic 'snapshots' of the state of the environment. The results of monitoring allow changes in management procedures to be made. In more formal systems, monitoring should include checks on whether prescribed management tasks have been undertaken, as well as on the states of the systems themselves. More formal monitoring is based on records made on indicators, which should be selected by (or at least in collaboration with) those who will undertake the monitoring. The monitoring of the proposed mining site should therefore be considered a high priority in this project and the following monitoring procedures should be implemented to ensure sustainability of the mining operation during the lifetime of the mine.

Ecological monitoring is required for the area in which the Glencore Kroondal Mine development is taking place (elsewhere referred to as the site) to determine its ecological status. In the initial terms of reference it was stated that ecological monitoring takes place based on identified ecological indicators as relevant for a specific area. Such indicators may include the following:

- Presence and percentage of pioneer species in the floral community;
- Presence/ absence and ratio of exotic versus indigenous species;
- Presence and prevalence of alien invader species;
- Ratio of bare soil patches and ground cover; and
- Presence, absence and trends in the occurrence of identified indicator/ sensitive species.

Indicators used for ecological evaluation may include but is not limited to the abovementioned indicators. Subsequently, however, the consultant was asked to incorporate more information on the fauna diversity to the present studies.

Initially it was thought that a mere quantitative description of the site would suffice for monitoring purposes. However, there are components of possible high conservation priority fauna that have not been addressed before, for example the possible occurrence or not of threatened invertebrates. One had to confirm as far as possible whether any high conservation priority species are on the site and if so, describe the habitat where these would occur, so that these could be monitored when approved developments occur. Therefore, the monitoring was broken down into a twofold approach which is in line with the Biodiversity Act of 2004. Conservation priorities were identified by 1) verifying the presence or not of species and subspecies of high conservation priority and by 2) describing biodiversity in a qualitative and quantitative manner for future references. The first step of this description of biodiversity would be species lists that serve as a biodiversity inventory for future references and planning.

The interim report given here focused on recording fauna and flora at the site to provide:

- Confirmation of larger mammal species present at the site with notes on their reproduction and general status in the area;

- Confirmation of bird species present at the site;
- Confirmation of butterfly species present at the site;
- Confirmation of scorpion species present at the site;
- Additional plant species to the existing species lists at the site;
- Integration of biodiversity information from all the surveys up to date with the aim at formulating possible impacts and constructing a practical ecological management plan; and
- A structure for the final report that would incorporate and summarize the relevant information for an ecological management plan and for partial restoration or rehabilitation.

The monitoring plan will assess, analyse, evaluate, or otherwise substantiate the effects, consequences or results of the mining activities on the terrestrial and aquatic biological and physical elements on the site.

10.1 Objectives

The general objective for terrestrial and physical monitoring is to evaluate the success of sustaining biodiversity by measuring specific indicators or biological / physical elements, and to contribute to adaptive management of the natural environment of the area.

10.2 Proposed monitoring programme

For the purposes of the monitoring plan indicators should be chosen at the species level and landscape scale. The choice of indicators is based on recognized threats to biodiversity. The following indicators will be used for monitoring biodiversity in the study area:

- Extent and condition of wetlands;
- Habitat transformation;
- Distribution and abundance of selected alien plant species;
- Viability of populations of endangered endemic species; and
- Rehabilitation
    - Presence and percentage of pioneer species in the floral community;
    - Presence/ absence and ratio of exotic versus indigenous species;
    - Ratio of bare soil patches and ground cover; and
    - Presence, absence and trends in the occurrence of identified indicator/ sensitive species

Details on the monitoring of each indicator are highlighted below. The indicators should be monitored biannually. The year interval has been chosen to reduce the cost of monitoring and it is a reasonable time interval to assess changes in the above indicators except for the viability of populations of endangered endemic species.

10.2.1 Extent and condition of wetlands and riparian areas

Wetlands and riverine systems are very complex ecosystems and the consequences of management prescriptions are often difficult to predict precisely. Monitoring of the wetland is essential for planning and management. The Sand River and its tributaries exhibit some wetland characteristics, although most of this area should be classified as a riparian zone. Given the interest of the local community, environmental institutions and the location close to the town of Hotazel there is an opportunity to develop a comprehensive monitoring program providing management directions and educational benefit. Many guides and programs on wetland monitoring exist. Biomonitoring forms the basis for wetland or river monitoring and encompasses the following:

10.2.1.1 Biological Monitoring

Biological monitoring techniques have been introduced as part of routine monitoring programmes due to certain shortcomings in standard physical and chemical methods. Because of the difficulty of chemically analysing every potential pollutant in a sample of water, and of interpreting results in terms of the severity of impact, it makes sense to turn to the monitoring of aquatic biota. Results given by biological monitoring are also more cost effective and results can be obtained more rapidly than an extensive chemical analysis.

The main advantage of a biological approach is that it examines organisms whose exposure to water and any pollutants therein is continuous. Thus, species present in riverine ecosystems reflect both the present and history of the water quality at a particular point in the river, allowing detection of disturbances that might otherwise be missed (Eekhout et al., 1996).

10.2.1.1.1 Vegetation

Riparian zone enhancement has been designed to establish open water, shallow water, emergent and wet meadow wetland habitat types using planting and natural succession re-vegetation techniques. Some of these habitat types exist at present in the Sand River and its tributaries in the form of dams or small wetlands, although encroachment by invasive plants and weeds has degraded much of the habitat types. The rehabilitation of the riparian vegetation needs to be prioritized as part of the proposed mining development. Ecologists will evaluate plant communities that are representative of various riparian zones or wetland types. Evaluations will be made of the percent vegetation cover, relative frequency of each plant species, and the wetland frequency indicator value.

10.2.1.1.2 Wildlife

Riparian zone or wetland rehabilitation and restoration should focus on providing diverse habitat for a variety of wildlife. Feeding, nesting and brood-rearing habitat for waterfowl, wading birds, passerine birds as well as mammals, reptiles and amphibians will be targeted in the wetland rehabilitation.

10.2.2 Habitat transformation

Habitat transformation reduces biodiversity. Mining and invasion by alien plants are the main factors that will transform habitats on site. It is therefore important to monitor the percentage of habitat that is transformed on site during the mining operation.

10.2.2.1 Vegetation monitoring

The implementation of a vegetation monitoring programme is strongly recommended and will be a direct indicator of habitat transformation. This is the only quantifiable means to evaluate the impact of current and possible future management practices on the vegetation of the study area. This includes evaluating the success of rehabilitation activities. The nature of secondary succession in disturbed areas (previously mined and cultivated) should be evaluated to determine whether a favourable succession pathway is occurring towards indigenous vegetation cover.

Plant life will probably resettle, especially after a detailed rehabilitation program on the mining areas. The impact life may, however, be of a long-term and permanent nature. The re-vegetation of the disturbed areas will become an integral part of activities during the closure phase. Monitoring and maintenance of vegetation cover should be done until a self-sustaining plant community is established. Re-establishment of plant cover on disturbed areas should take place as soon as activities have ceased, for example the areas where the buildings and plant area are situated will only be re vegetated once the buildings have been removed during the decommissioning phase. All roads not required for access shall be ripped and planted with endemic vegetation.

10.2.2.2 Fauna monitoring

The restoration or rehabilitation actions will need the implementation of a faunal monitoring program as a barometer for the mine management to recognize positive changes and trends in the biodiversity of the mining area during and after closure. Fauna monitoring procedures include pit trapping, Elliot-box trapping, spotlighting, mist-netting, bird monitoring, ant monitoring and microhabitat searches and cage trappings (feral animals). The objectives of such a programme may include:

- Assessment of future improvement/deterioration of the faunal biodiversity of the mine lease area (thus a measure of success of environmental management);
- Increase the accuracy of present status determination (actual species present vs. expected species) of the mine lease area with every survey;
- Determination of both temporal and spatial trends in faunal biodiversity on the mine lease area;
- Assist in future management of the mine lease area by providing recommendations and guidelines regarding future activities and rehabilitation;
- Biodiversity management actions during closure should include controlling and monitoring of numbers of alien invasive fauna numbers by eradication, habitat modification, resource limitation

and public education. Appropriate control measures for the Common Myna should be developed in consultation with local conservation agency and should form part of the mine's biodiversity action plan.

- Young nutrient rich growth may entice herbivores to rehabilitated areas. The increased grazing pressure may decrease the rate of rehabilitation. Herbivore-proof fencing may be required around the rehabilitation zones in the early stages to protect seedlings from grazers if grazing pressure is found to significantly affect growth.
- Revegetation programs will include consideration of the possibility of reconstructing fauna habitats. Old salvage logs from cleared areas will be replaced after mining, where possible, to provide habitat for fauna and
- Key fauna species will be identified and targeted for re-colonisation where appropriate. Edible seed bearing plants, perennial grasses and sedges may be seeded or planted to encourage re-colonisation by native fauna.

10.2.3 Distribution and abundance of selected alien plant species

Alien plants (both woody and herbaceous) are a major threat to biodiversity and ecosystem functioning. It is important to map the distribution of selected woody alien species. Remote sensing can be used as described by Rouget et al. (2003). Two elements of this indicator that should be measured are:

- The proportion of the surface area of the proposed study area covered by alien plants; and
- Which plant species are problematic and should be controlled.

It is also important to monitor the recovery of vegetation in areas cleared of alien plants.

The success of the alien invasive control should be monitored by qualified ecologists and the Working for Water group should be contacted for the actual control of the alien species identified.

10.2.4 Viability of populations of endangered endemic species

Emphasis should also be placed on monitoring threatened and near-threatened species and species that have been subject to elevated levels of utilization (e.g., medicinal plants and species utilised for fuelwood). Fine-scale monitoring of populations of endangered endemic species will be required to assess their viability. Size/age class distributions, reproduction, growth and mortality of individuals will need to be recorded. Matrix modelling can be used to assess the viability of the populations.

10.2.5 Occurrence of disturbances (fire)

The occurrence of common disturbances such as fire and episodic disturbances (e.g., floods) should be recorded since these have huge impacts on ecosystems. However, some plant species require fire for persistence. The extent (size of the area affected), timing (date of occurrence) should be recorded. Causes of disturbances such as fire should be recorded.

10.3 Responsibility for monitoring and expertise needed

The Mine Group should be responsible for the monitoring programme. Monitoring is a rigorous science requiring appropriate statistical design and analyses (Eberhardt and Thomas,1991; Nusser et al., 1998; McDonald, 2003). Data cannot be used for making management decisions if the statistical design is faulty. The mine should therefore work together with conservation agencies, non-governmental organizations, private landowners, universities and independent consultants to monitor biodiversity. Expertise is needed for designing sampling strategies and analyzing data.

10.4 Data analysis and storage

Data analysis and storage is a key component of any monitoring programme. Data should be analysed as soon as possible after collection. Independent consultants can assist the mine in analyzing the data. The monitoring results should be communicated to the mine in the form of tables and maps. The mine in turn can produce reports on the state of biodiversity for the site every year. The yearly reporting interval should coincide with the annual monitoring surveys for the indicators suggested above. The data can be stored in both digital form and in maps. The Environmental section of the mine should be responsible for data analyses and storage.

10.5 Methods

A desktop study will comprise not only of an initial phase, but also it will be used throughout the study to accommodate and integrate all the data that become available during the field observations.

Surveys will be conducted to note key elements of habitats on the site, relevant to the description and conservation of fauna and flora on site. Monitoring differs from survey, the latter often being more of a once only inventory (Goldsmith, 1991). Monitoring is purpose orientated, repeated at regular intervals and often provides the baseline for possible change in the future (Goldsmith, 1991). In the case of this study the purpose of the monitoring is to note the present ecological state and possible future changes.

Observations on fauna will be made throughout to add towards an overall picture of the state of biodiversity on the site. The main objective overall is to compile and inventory of biodiversity so that management plans and management of rehabilitation or partial restoration, should the development be approved, can be enhanced.

10.5.1 Habitat characteristics and vegetation

The habitat is investigated by noting habitat structure (rockiness, slope, plant structure/physiognomy) as well as floristic composition. Transects or quadrant counts are applied where appropriate. Voucher specimens of plant species are only taken where the taxonomy is in doubt and where the plant specimens are of significant relevance for invertebrate conservation. Field guides such as those by Van Oudtshoorn (1999), Van Wyk & Malan (1998) and Van Wyk & Van Wyk (1997) are used to confirm the taxonomy of the species. In this case no plant specimens are needed to be collected as voucher specimens or to be send to a herbarium for identification. For the most recent treatise of scientific plant names and broad

distributions, Germishuizen, Meyer & Steenkamp (2006) are followed to compile the lists of species.

10.5.2 Mammals

Mammals are noted as sight records by day. For the identification of species and observation of diagnostic characteristics Smithers (1986), Skinner & Chimimba (2005), Cillié, Oberprieler and Joubert (2004) and Apps (2000) are consulted. Sites have been walked, covering as many habitats as possible. Signs of the presence of mammal species, such as calls of animals, animal tracks (spoor), burrows, runways, nests and faeces are recorded. Walker (1996), Stuart & Stuart (2000) and Liebenberg (1990) are consulted for additional information and for the identification of spoor and signs. Habitat characteristics are surveyed to note potential occurrences of mammals. Many mammals can be identified from field sightings but, with a few exceptions bats, rodents and shrews can only be reliably identified in the hand, and even then, some species needs examination of skulls, or even chromosomes (Apps, 2000).

10.5.3 Birds

Birds are noted as sight records, mainly with the aid of binoculars (10x30). Nearby bird calls of which the observer is sure of the identity are also recorded. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Ryan (2001) is followed. For information on identification, biogeography and ecology Barnes (2000), Hockey, Dean & Ryan, P.G. (2005), Cillié, Oberprieler & Joubert (2004), Tarboton & Erasmus (1998) and Chittenden (2007) are consulted. Ringing of birds fell beyond the scope of this survey and is not deemed necessary. Sites have been walked, covering as many habitats as possible. Signs of the presence of bird species such as spoor and nests have additionally been recorded. Habitat characteristics are surveyed to note potential occurrences of birds.

10.5.4 Reptiles

Reptiles are noted as sight records in the field. Binoculars (10x30) can also be used for identifying reptiles of which some are wary. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques, Branch (1998), Marais (2004), Alexander & Marais (2007) and Cillié, Oberprieler and Joubert (2004) are followed. Sites are walked, covering as many habitats as possible. Smaller reptiles are sometimes collected for identification, but this practice is not necessary in the case of this study. Habitat characteristics are surveyed to note potential occurrences of reptiles.

10.5.5 Amphibians

Frogs and toads are noted as sight records in the field or by their calls. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Carruthers (2001), Du Preez (1996), Conradie, Du Preez, Smith & Weldon (2006) and the recent complete guide by Du Preez & Carruthers (2009) are consulted. CD's with frog calls by Carruthers (2001) and Du Preez & Carruthers (2009) are used to identify species by their calls when applicable. Sites are walked, covering as many habitats as possible. Smaller frogs are often collected by pitfall traps put out for epigeal invertebrates (on

the soil), but this practice falls beyond the scope of this survey. Habitat characteristics are also surveyed to note potential occurrences of amphibians.

10.6 LIMITATIONS

For the site visited, it should be emphasized that surveys can by no means result in an exhaustive list of the plants and animals present on the site, because of the time constraint. The onsite survey was conducted during June 2019 which is not an optimal time of the year to find animals such as butterflies, other invertebrates as well as habitat sensitive plant species high conservation priority. In general, the weather was not optimal for recording of invertebrates as well as ectothermic ("cold blooded") vertebrates. The focus of the survey remains sensitive habitats and species of conservation priority.

Table 23 indicate the monitoring requirements for the fauna and flora components within the project area.

Table 22: Fauna and Flora Monitoring requirements for the Glencore Kroondal Mine.

Component	Relevant activity	Aspects to be monitored	Objective of monitoring	Current monitoring in place	Changes to monitoring programme	Proposed monitoring	Frequency	Any reporting requirements
Construction Phase								
Mining area, Support infrastructure, TSF and Plant.	Vegetation clearing, vehicle movement & soil stripping.	Flora associated with riparian zone / wetlands	Determine potential negative impacts on wetland vegetation & riparian woodland.	N/a	N/a	Extent and condition of wetlands / riparian zone.	Annual	Ecological Monitoring report
		Flora & Fauna	Determine potential edge effects on natural vegetation and fauna populations.	N/a	N/a	Habitat transformation of site through fauna and flora monitoring.	Annual	Ecological Monitoring report
		Flora & Fauna	Indicate presence of AIS to be eradicated.	N/a	N/a	Distribution and abundance of selected alien plant species and / or alien fauna.	Annual	Ecological Monitoring report
		Flora & Fauna	Indicate presence of endemic / protected species on site.	N/a	N/a	Viability of populations of endangered endemic species.	Annual	Ecological Monitoring report
Operational Phase								
Mining area, Support infrastructure, TSF and Plant.	Laydown areas of WRDs and stockpiles, materials handling and transportation,	Flora associated with riparian zone / wetlands	Determine potential negative impacts on wetland vegetation & riparian woodland.	N/a	N/a	Extent and condition of wetlands / riparian zone.	Annual	Ecological Monitoring report
		Flora & Fauna	Determine potential edge effects on natural vegetation and fauna populations.	N/a	N/a	Habitat transformation of site through fauna and flora monitoring.	Annual	Ecological Monitoring report

Component	Relevant activity	Aspects to be monitored	Objective of monitoring	Current monitoring in place	Changes to monitoring programme	Proposed monitoring	Frequency	Any reporting requirements
	crushing and stockpiling, Stockpiling of ore, disposal of tailings, vehicle movement during construction of infrastructure, access roads and bridges.	Flora & Fauna	Indicate presence of AIS to be eradicated.	N/a	N/a	Distribution and abundance of selected alien plant species and / or alien fauna.		Ecological Monitoring report
		Flora & Fauna	Indicate presence of endemic / protected species on site.	N/a	N/a	Viability of populations of endangered endemic species.	Annual	Ecological Monitoring report
Decommissioning Phase								
Mining area, Support infrastructure, TSF and Plant.	Demolition of infrastructure, cessation of mining.	Flora & Fauna	Indicate presence of AIS to be eradicated.	N/a	N/a	Distribution and abundance of selected alien plant species and / or alien fauna.	Annual	Ecological Monitoring report.
Closure Phase								
Mining area, Support infrastructure, TSF and Plant.	Rehabilitation.	Flora & Fauna	• Presence and percentage of pioneer species in the floral community; • Presence/ absence and ratio of exotic versus indigenous species;	N/a	N/a	Succession of vegetation over time.	Annual	Ecological Monitoring report.

Component	Relevant activity	Aspects to be monitored	Objective of monitoring	Current monitoring in place	Changes to monitoring programme	Proposed monitoring	Frequency	Any reporting requirements
			• Ratio of bare soil patches and ground cover; • Presence, absence and trends in the occurrence of identified indicator/ sensitive species.					
		Flora & Fauna	Indicate presence of AIS to be eradicated.	N/a	N/a	Distribution and abundance of selected alien plant species and / or alien fauna.	Annual	Ecological Monitoring report.

11 REHABILITATION PLAN FOR BIODIVERSITY

Today rehabilitation is an integral part of environmental management associated with mining and forms a tangible measure of corporate responsibility towards sustainable development. Rehabilitation and closure plans thus must accompany all new mining applications, also in countries in the developing world, and existing mines are expected to rehabilitate retrospectively.

All this requires a good understanding of rehabilitation tasks and requirements, legal and regulatory frameworks governing rehabilitation and environmental management. This requires input from many different disciplines.

The final goal of the rehabilitation planning process is a practical, achievable and adequately resourced rehabilitation programme. Rehabilitation of the disturbed areas should be done in such a way to ensure that the rehabilitation on site of the Glencore Kroondal Mine will be sustainable in the long term.

11.1 WHAT IS ECOLOGICAL RESTORATION AND HOW DOES IT RELATE TO BIODIVERSITY?

There is currently no agreed terminology in the rehabilitation of mined land. The term 'reclamation' describes the general process whereby the land surface is returned to some form of beneficial use. Where reclamation is guided by ecological principles and promotes the recovery of ecological integrity the term 'restoration' is used. Hereunder, restoration refers to reinstatement of the original (pre-development) ecosystem in all its structural and functional aspects, 'rehabilitation' is the term used for the progression towards the reinstatement of the original ecosystem, and 'replacement' is the creation of an alternative ecosystem to the original (Bradshaw 1984). Ecological restoration is about a broad set of activities (enhancing, repairing, or reconstructing degraded ecosystems and optimising biodiversity returns. In essence, the restoration of mined land is based around ecosystem reconstruction. It is usually a question of the re-establishment of the capability of the land to capture and retain fundamental resources (energy, water, nutrients, and species). The question then arises as to what to restore. Should it be an exact replica of the biodiversity of the immediate pre-mining ecosystem, an ecologically superior (more pristine?) and perhaps historical standard, or even a future state, which is the condition that natural succession may have produced if no disturbance had occurred.

11.2 ECOLOGICAL PRINCIPLES

- Biological diversity (at all levels) and speed (success) of revitalization are the two key criteria for post-mining landscape rehabilitation;

- The creation of long-term functional ecosystems in the post-mining areas (rest holes, spoil banks) and enhancement of the surrounding ecosystems is a major priority;

- Support for landscape connectivity and population dispersal (migration) for successful colonization of post-mining sites and the establishment of equilibrium diversity. Prevention of further landscape fragmentation and elimination of recent dispersal barriers;

- Permanent landscape elements with long standing continuity constitute fundamental features of the ecological network of the landscape;

- Restoration of small (closed) hydrological cycles in the post-mining landscape. Support for higher water retention and accumulation, based on revitalization of streams and their fluvial plains, creation of new water reservoirs, wetlands and their relatively regular distribution in the landscape;

- Prognosis of the climate is an important consideration when defining the qualitative parameters of new ecosystems (especially species composition). Pre-adaptation of ecosystems to anticipated climate evolution also requires terrain modification leading to the formation of thermal areas capable of sustaining thermophytes;

- An increase in the heterogeneity of post-mining landscapes, mainly heterogeneity of the landscape microstructure. Variety of relief is a key factor; and

- Natural succession is taken to be an ordinary form of post-mining landscape rehabilitation. It should be enabled in areas where it provides outcomes that are at least comparable with the results of landscape management.

11.3 AN OVERVIEW OF ECOLOGICAL RESTORATION PLANNING

Ecological restoration with biodiversity benefits in mind must involve an orderly set of considerations that promote successful procedures and practices. Often these practices, although based on similar general considerations, will need to be innovative because of the unique set of circumstances each area and ecosystem to be restored represents. Restoration planning models recognize that, for most mine reclamation programmes over the last 30 years, an over-riding consideration has been whether the topsoil has been retained or lost (Bradshaw 1984). This will, in all probability, determine how quickly a pre-mining ecosystem can be restored with its biodiversity regained, and whether such a restoration goal is realistic and sustainable. The restoration objectives must be formulated from a detailed knowledge of the basic structural and functional characteristics of natural ecosystems. Ecological restoration may implicitly want all attributes to be achieved (e.g., to claim close

correspondence to the pre-mining ecosystem), but the practical context of any site restoration demands that the following are considered: speed of attainment, economics (or cost-benefit), achievability, and long-term stability with on-going management at reasonable (low) cost (Bradshaw 1984). It is also necessary to consider the potential for acid mine drainage (in metal sulphide mining) and the need to provide appropriate covers to minimize the ingress of water or air into reactive residues. The socio-economic situation will also play a significant role in determining final land use for those mine sites in populated areas. Such practical considerations are necessary for without them unrealistic objectives can be set both in ecological/biodiversity and economic terms.

The development of measurable criteria for judging restoration success has proved difficult but they are usually derived from the community and ecosystem characteristics desired as restoration objectives (Hobbs and Norton 1996). Cairns (1993) provides three general success guidelines that the restored ecosystem should attain: (i) self-regulation for some set period of time, where self-regulation means the structural and functional attributes persist in the absence of whatever "subsidies" (fertilizer, seeding etc.) may have been necessary during the initial phases of implementation; (ii) the design criteria (restoration goal and objectives) established before restoration was undertaken; (iii) no observable adverse effects in the larger ecological landscape.

From these criteria, it is necessary to have restoration objectives that have unambiguous operational definitions (technically feasible), which are ecologically sound (scientifically valid) and socially relevant, and that are receptive to measurement and prediction (Cairns 1993). The ecosystem characteristics measured are usually those related to the composition, structure, and pattern of the vegetation as a key component of the biodiversity pool (Allen 1992). It is notable that some important structural measurements of biodiversity are usually omitted (Chambers et al. 1994). Measurements concerning the soil biotic community and animal species numbers are not usually made, even though they can often provide important indications of long-term productivity and successional pathways (Chambers and Wade 1992).

Ecosystem characteristics for consideration as ecological restoration objectives (adapted from Hobbs (1999)

1. Composition: species presence and their relative abundance;

2. Structure: vertical arrangement of vegetation and soil components;

3. Pattern: horizontal arrangement of system components;

4. Heterogeneity: a variable composing of characteristics 1–3;

5. Function: performance of basic ecosystem processes (energy capture, water retention, nutrient cycling);

6. Species Interactions, e.g., pollination, seed dispersal etc; and

7. Dynamics and resilience: succession and state-transition processes, ability to recover from normal episodic disturbance events (e.g., floods, drought, fire).

The ecological considerations needed for practical restoration planning must be considered in some detail in relation to situations where topsoil has been lost or retained within the mining and waste disposal operations. In the restoration of sites where the topsoil has been lost, the major ecological challenges are still concerned with plant species–substrate interactions, i.e., re-vegetation. Restoration practice where topsoil has been retained focuses less on vegetation establishment and more on the spatial and temporal factors affecting species colonization and establishment, the criteria for monitoring and assessing success, particularly in the longer term, and the restoration of natural indigenous ecosystems and biodiversity values. Social factors also need to be considered in practical restoration planning for those situations where the mine is not isolated from surrounding communities. In such situations the rehabilitation objectives need to be defined in close consultation with the local communities, as they will have to utilize the rehabilitated land in perpetuity after the mining company has departed.

11.4 ALIEN AND INVADER PLANT SPECIES REHABILITATION

During the rehabilitation of the mine site, the eradication and control of alien invasive species should be an on-going action. An alien eradication plan should be implemented. The specific control measures for specific alien invader plant species occurring on the Glencore Kroondal Mine is discussed under “Species Action Plans” in this report. The alien eradication occurs concurrently (during the operational phase) and as part of closure rehabilitation.

11.5 CONCURRENT REHABILITATION

Removal and management of alien vegetation forms part of the concurrent rehabilitation activities and would thus occur on a regular basis throughout the life of the plant. Vegetation management will entail monitoring of potential regrowth of alien shrubs and creepers. Large alien trees that have been removed will need monitoring for coppice growth, where stumps remain *in situ.* This rehabilitation will be costed for annually. The following management principles should apply:

- All concurrently rehabilitated areas will be monitored for signs of alien vegetation. Alien vegetation should be removed;

- The removal of certain weeds and smaller invasive plants will be by hand and will be carried out to minimise disturbance to the soil and to indigenous vegetation along these surface water channels. Removal of alien vegetation will take place when the alien vegetation is NOT seeding;

- The control of alien vegetation in wetlands should be done in an environmentally sensitive way. To minimise the impact of the herbicide use on the natural environment the following should be considered:

    - Area contamination must be minimised by careful, accurate application with a minimum amount of herbicide to achieve good control;

    - All care must be taken to prevent contamination of any water bodies. This includes due care in storage, application, cleaning equipment and disposal of containers, product and herbicide mixtures;

    - Equipment should be washed where there is no danger of contaminating water sources and washings carefully disposed of in a suitable site;

    - To avoid damage to indigenous or other desirable vegetation, products should be selected that are target specific, and will not impact of poison non-target species;

    - Spraying of herbicides should be avoided, and application directly to the stump of the alien invader is the best method to ensure isolation of the herbicide action to the target plant; and

    - Persons applying the herbicide should be fitted with protective clothing, including gloves and fume masks and should be registered through the relevant authority to do so.

11.6 CLOSURE REHABILITATION

Alien vegetation management will require the most labour and financial input once life of plant is over and long-term rehabilitation of the water sources and site occurs. Financial provision for closure rehabilitation is made within the rehabilitation fund.

11.7 REVEGETATION OF GLENCORE KROONDAL MINE AND INDIGENOUS PLANT SPECIES RECOMMENDED FOR REHABILITATION PURPOSES

Revegetation is the process of vegetation establishment and care, as part of the process of reclamation, rehabilitation or restoration. The biggest challenge of rehabilitation is to establish a sustainable ecosystem that is self-productive and able to survive without

continued anthropogenic interventions (irrigation, fertilization or re-seeding). After the Mining activities has ceased, processes of self-restoration are often slow (decades) and the final community of plants may not be the most desirable. Revegetation may be achieved by three main techniques, namely planting of trees and shrubs, direct seeding, or by self-regeneration. The availability of topsoil is a major consideration in revegetation. Topsoil needs to be used wisely to achieve successful revegetation. Topsoil set aside during the first stages of development may need to be amended for use during rehabilitation. Various materials, such as construction fill, agricultural residues or mining sludge, could serve as sources of nutrients and soil property modifiers. Analysing the chemical properties of the soil can be helpful in directing possible soil amendments and guiding species selection. A well-prepared site will provide the most suitable conditions for plant germination, survival and to promote long-term revegetation success.

11.7.1 Removal of topsoil and subsoil

"Topsoil" can be defined as the upper fertile layer of soil, from which plant roots take nutrients. "Topsoil" can be harvested from the natural surroundings or produced by ameliorating a suitable medium ("growth medium") which conforms to certain minimum requirements where after it can uphold vegetation in an ecologically sustainable manner (Subsoil or suitable mining residue should be referred to as a growth medium). Most soils or mediums can be ameliorated to fulfil this purpose, but the utilisation thereof is dependent on the financial cost / benefit. A growth medium is always needed as a component of an imported dedicated cover layer to create an acceptable environment for vegetation when at risk of not achieving a sustainable ecological system.

Topsoil is the most important factor in revegetation and should receive substantial attention in rehabilitation strategies at Glencore Kroondal Mine during revegetation of areas.

11.7.2 Erosion control

Because the soil on the plant site has a sandy to loamy nature and the permeation factor is high, surface runoff is reduced. Nevertheless, some mitigation is necessary to prevent possible erosion. The following management measures are proposed for the rehabilitation process:

- Visual inspection of all exposed surfaces should be conducted for signs of erosion. If erosion channels are discovered, the environmental manager will compile and implement a plan to determine the cause of erosion, reducing erosion in the identified areas and preventing future erosion (refer to erosion prevention methodology in management plan tables). Inspection of soil depth if erosion has

taken place over a constant period is necessary. If the depth has deteriorated to less than 15cm it must be rectified to ensure sustainable root development;

- Erosion can be repaired or minimised using gabions, reno-mattresses and planting of indigenous grasses;
- Erosion control mechanisms must be established as soon as possible. Further financial provision should be continued over the subsequent years to allow for maintenance of the gabions, reno mattresses, and associated structures;
- A stormwater plan must be developed with the aid of an engineer to ensure that water runoff is diverted off the site without pooling and stagnation or erosion. Financial provision for closure will include the estimated costs for erosion control post-mining;
- If compaction occurs, rectification can be done by application and mixing of manure, vegetation mulch or any other organic material into the area. Use of well cured manure is preferable as it will not be associated with the nitrogen negative period associated with organic material that is not composted;
- It will be necessary to do an annual soil analyses during the first three to four growing seasons to determine deficiencies and do rectifications when necessary. It will also become essential if signs of vegetation degradation become evident or no apparent reason;
- Vehicle traffic should not be allowed on the rehabilitated areas, except on allocated roads, must not be allowed. It will have a negative impact due to the dispersive/compaction characteristics of soils and its implications on the long term; and
- Foot and hoof action should be prevented during the establishment phase of vegetation on the rehabilitated areas, especially the first two seasons.

11.7.3 Soil analysis

Soil properties are determined through sampling soils in the designated revegetation area. Samples should be taken at the same depth for all samples. The samples should be mixed, using a standard soil sampling method, and one master sample should be taken for laboratory analysis.

Soil nutrient analysis is available through external laboratories. The soil analyses will guide the types and amount of fertilizer required to amend the soils for the selected plant types.

Recommendations previously indicate that goat manure could be sourced from local communities and farmers and worked into the soil and applied at a rate of 30kg/ha at the same time as seeding the grass seed. Fertilizers should be worked into the soil well before the revegetation process is initiated to prevent the fertilizing agents from burning the plants.

11.7.4 Seedbed preparation

Soil amendments such as lime, organic material and fertilizers should be added to the soil to achieve the optimum growing results.

11.7.5 Direct seeding

Direct seeding should be done using a seed mix developed for the rehabilitation area and should contain indigenous grass and tree species. Seeding is mostly successful for grass species, while trees and shrubs should be cultivated in a controlled environment before they are planted out in the field.

11.7.6 Indigenous grasses:

The availability of seed dictates the combination of seed mixtures. The seed of indigenous woody species is practically unobtainable. Periodically, seed of a variety of indigenous grass species including *Enneapogon cenchroides* as well as other grass species are available from "Seeds 4 Africa" (Contact Number (+27) 828888643). In the compilation of a seed mixture the following is taken into consideration:

- Availability of seed;
- Size of the seed;
- Germination rate;
- Species composition of the environment surrounding the plant;
- Topography of the area to be rehabilitated; and
- Climatic conditions of the area.

Based on the abovementioned criteria, the following grass seed mixture is recommended for Glencore Kroondal Mine (Table 23):

Table 23: Recommended grass seed mixture.

Species	Habit	Kg/ha
Enneapogon cenchroides	Annual	4
Panicum maximum	Perennial	3
Cenchrus ciliaris	Perennial	5
Digitaria eriantha	Perennial	3
Anthephora pubescens	Perennial	3
Aristida adscensiones	Annual	2
Cynodon dactylon	Perennial	2
Urochloa panicoides	Annual	2
Heteropogon contortus	Perennial	2
Tragus bertertronianus	Annual	1
Schmidtia pappophoroides	Perennial	2
Pogonarthria squarrosa	Annual	1

The recommended seed mixture will probably have to be amended from time to time based on the availability of seed.

11.8 POST-OPERATION LAND USE

It is important at this stage to know the post-operation land use planned for the area to be revegetated. This will largely determine the plant species to be grown on this land. From the existing documentation it is gathered that the end land use will be game farming.

11.9 MAINTENANCE AND MONITORING

Several methods exist to monitor rehabilitated areas to scientifically prove that a self-sustainable ecosystem has developed or show a positive trend towards successful rehabilitation. This will prove that environmental degradation and biological diversity have been mitigated and restored where it has been negatively impacted upon. The important aspect to keep in mind is that it is not only a visual inspection, but measurable information gathering e.g., water samples, soil samples, vegetation diversity, biomass, basal cover, species composition etc. The monitoring data must be of such a standard that meaningful conclusions can be made, and a trend indicated. Good record keeping is essential. All illegal invader plants and weeds shall be eradicated as required in terms of Sections 119 to 126 of The Environmental Management Act.

Watering and fertilizing of trees should continue until the trees are strong enough to survive without human aid. Monitoring should take place on regular time intervals to establish if the revegetation strategy was successful. Any trees that did not survive the transplanting process should be replaced. Soil sampling and analysis should be done every five years to monitor the development of the soil and need for supplementary fertilization.

11.10 CONCURRENT RE-VEGETATION OF SITE

The rehabilitation plan requires that indigenous vegetation be planted annually during concurrent rehabilitation. These will provide visual screening of the operation from adjacent landowners and will also allow for the return to indigenous vegetation on site. The indigenous trees will substitute where alien tree species have been removed from the site. Indigenous trees utilised much less water than alien trees and stabilise the soil against erosion.

In addition to vegetation, indigenous grasses must be planted. Indigenous grasses will stabilise the soil against erosion and will also prevent the resurgence of alien weeds on the site. Introduction of indigenous grasses and shrubs will provide aesthetic value to the site.

11.11 MANAGEMENT ACTIONS TO CONSIDER FOR FAUNA DURING REHABILITATION

- Care should be taken during the closure phase of the plant not to impact on the habitat of fauna species along the periphery. Rehabilitation should be done to ensure that fauna which occurred in the plant return to the area. The reduction of operational activities and vehicles on the site should allow faunal populations to utilize the rehabilitated area once again

- If pesticides or herbicides are used, the products should be chosen responsibly to act in accordance with the sensitive environment and associated ecology. Storage, administering and disposal must be done according to the prescribed methods. Care should be taken to prevent any of the pollution from ending up in the wetlands;

- The restoration or rehabilitation actions will need the implementation of a faunal monitoring program as a barometer for the plant management to recognize positive changes and trends in the biodiversity of the mining area during and after closure. Fauna monitoring procedures include pit trapping, Elliot-box trapping, spotlighting, mist-netting, bird monitoring, ant monitoring and microhabitat searches and cage trappings (feral animals). The objectives of such a programme may include:

    - Assessment of future improvement/deterioration of the faunal biodiversity of the lease area (thus a measure of success of environmental management);

- Increase the accuracy of present status determination (actual species present vs. expected species) of the lease area with every survey;
- Determination of both temporal and spatial trends in faunal biodiversity on the mine lease area; and
- Assist in future management of the mine lease area by providing recommendations and guidelines regarding future activities and rehabilitation.

- Biodiversity management actions during closure should include controlling and monitoring of numbers of alien invasive fauna numbers by eradication, habitat modification, resource limitation and public education. Appropriate control measures for the Common Myna should be developed in consultation with local conservation agency;
- Young nutrient rich growth may entice herbivores to rehabilitated areas. The increased grazing pressure may decrease the rate of rehabilitation. Herbivore-proof fencing may be required around the rehabilitation zones in the early stages to protect seedlings from grazers if grazing pressure is found to significantly affect growth;
- Revegetation programs will include consideration of the possibility of reconstructing fauna habitats. Old salvage logs from cleared areas will be replaced after mining, where possible, to provide habitat for fauna; and
- Key fauna species will be identified and targeted for re-colonisation where appropriate. Edible seed-bearing plants, perennial grasses and sedges may be seeded or planted to encourage re-colonisation by native fauna.

11.12 REHABILITATION OF WETLANDS AND STORMWATER CANALS

The wetland and stormwater canals on site should also be vegetated with indigenous grass and forb species to encourage better water quality and to protect the watercourse from erosion once the plant has closed. Once all operations have ceased on site, the wetlands and canals will need to be re-profiled to ensure the unobstructed flow of surface water through the channel. The banks of the canals will require contouring to reduce the risk of soil erosion. The site will then need to be treated with fertilizer, compost and topsoil, followed by the planting of indigenous vegetation. The small dams will require that appropriate indigenous wetland vegetation be planted.

Rehabilitation could increase the yield to the Catchment Dam should the area be

rehabilitated to such a standard that al the water falling on the site will be allowed to enter the drainage lines.

The following rehabilitation and management actions should be implemented for drainage canals and dams on the site during the decommissioning and closure of the Glencore Kroondal Mine:

- Erosion should be prevented and controlled at all cost to prevent the wash-away of valuable topsoil and sedimentation of streams. Water runoff from the plant closure activities should be controlled as far as possible to prevent adverse effects. The rivers should be protected from an increased inflow of poor quality water. Where required, sediment traps will be utilised to reduce the potential for sediments to be transported off-site and for increasing sediment loads in surrounding surface water systems;

- The following should be done with regards to returning drainage channels on the plant property to its original state after closure:

  - Remove all coffer walls;

  - Remove all unnatural building material;

  - Re-instate damaged stormwater canals; and

  - Re-vegetate riverbanks with original vegetation types.

- Drainage should be consistent with post-operational land use and natural drainage patterns should be re-established where appropriate. Existing drainage will be re-established wherever possible through the re-instatement of existing contours;

- The quality of water leaving the site should be such as to cause no significant deterioration of water quality to the downstream beneficial use(s) or water quality objectives of the receiving waters;

- Surface water runoff will be monitored as required until relinquishment. It is noted that the nature of the soils in the plant operational areas means that these areas will drain very quickly, particularly during the dry season. Surface water sampling programs will necessarily focus upon opportunistic surface sampling after periods of heavy rainfall; and

- Production of polluted water should be minimized and trends should indicate

improvement.

In addition to the rehabilitation actions, the following principles should be applied for the maintenance of the water control structures:

- Maintain the designed freeboard and alignment of contour walls. Re-align contour walls where subsidence has taken place or clear the contour furrow where it has been blocked. Maintain the capacity of all water control structures e.g., contour furrows behind contour walls by regularly cutting grass and removing it from flow area;

- Remove all trees and shrubs from water control structures, e.g., both the flow area of contour furrows and the earth walls of contour walls and dam walls;

- Inspect gabion waterways if applicable and repair damages as soon as possible, especially where subsidence or undermining through tunnel erosion has caused the misalignment of the waterway. Inspect the lacing of gabion baskets and make sure that all baskets are still securely fastened to each other.

- Inspect the waterways for obstacles before the rain season and after storm events. Remove all obstacles that can obstruct the flow of water.

- Ensure the discharge of free draining water control structures to avoid the accumulation of water.

- Keep the water control structures on access roads intact and maintain capacity by removing silted material. Reinstate the wall height where it had been damaged by traffic.

- Long-term phasing out of contour maintenance can be implemented when an acceptable veldt condition is reached and after a recommendation by a specialist; and

- Monitor the trampling of open standing water sources on rehabilitated areas to determine damage to the cover layer.

The following cannot be allowed:

- Do not allow excessive traffic on the gabion or grassed waterways and over contour walls.

- Do not allow trees and shrubs to get established on or near reinforced (gabions and

concrete) waterways; and

- Do not alter the design requirements of any waterway after rehabilitation by adding surface run-off from other areas to the waterway without redesigning the structure.

11.13 REHABILITATION ACTIONS AND CRITERIA FOR SPECIFIC COMPONENTS OF THE GLENCORE KROONDAL MINE

Table 24 indicate specific objectives, action and criteria for ecological stability and sustainability during and after the rehabilitation of different components on the Glencore Kroondal Mine:

Table 24: Objectives, criteria and actions for the specific sustainable rehabilitation of the Glencore Kroondal Mine.

Aspect	Objective	Criteria for ecological stability and sustainability / action
Dismantling and demolition of structures	• Mitigate safety hazard that structures may pose to humans and animals; • Reinstate area to the land function of a natural area.	• Building rubble: Building rubble needs to be disposed of on an authorised disposal site approved in terms of the National Environmental Management Waste Act. Further approval will be required in terms of the EIA regulations promulgated in terms of NEMA; • A few permitted disposal sites must therefore be identified by Glencore Kroondal Mine (DWS minimum requirements) before building rubble is disposed on these sites. All waste must however be classified before commencing with the disposal thereof; • Rehabilitation of disposal sites: The cover layer over the disposal site must be at least 300mm thick. The disposal site may not have any slopes exceeding 12° and must blend in with the surrounding topography. If required, contour walls must be constructed to manage surface runoff to control erosion Revegetate according to guidelines stipulated in this report.
Roads	• Alleviation of surface compaction to enhance water infiltration and root development; • Removal of all permanent road construction structures example kerbing, signposting, drains and culverts; • Implement surface water runoff control; • Removal and disposal of asphalt in the correct manner and placing of a thin cover of natural topsoil where filling is needed.	• All road surfaces need to be ripped up deeply to alleviate compaction to a minimum depth of 300mm where possible. (Including road shoulders); • Reshape the surface area to emulate the surrounding topography. (e.g. Cuttings and fillings); • Reinstate the natural surface drainage lines where possible – roads typically form preferential drainage paths which lead to erosion; • Remove all structures e.g., Drainage pipes, culverts etc.; • Slope lengths on rehabilitated roads must be reduced by including surface runoff control measures at critical positions. • Slope angles must be lowered to below 10°; • Grade natural bordering soil over the road or import a thin cover layer over the road to raise the level back to NGL and disguise the colour difference; • Ameliorate the topsoil according to soil analyses of the specific soil; • Revegetate according to guidelines stipulated in this report.

Aspect	Objective	Criteria for ecological stability and sustainability / action
Stormwater and return water dams	• Structural and ecological stability; • Compliance with post closure land use being wilderness; • Minimise aesthetic impact; • No aftercare (walk away).	• Storm-water control. Prevent storm water from accumulating in the pond depression – free draining; • Correction of chemical imbalances according to soil analyses where revegetation must be implemented; • Growth medium must sustain vegetation indefinitely. (Sufficient fines, buffering against salts and acceptable nutritional status); • Moisture retention in the growth medium to sustain vegetation; • Erosion control; • Compaction alleviation; • A diversity of indigenous species adapted to the region to be used during re-vegetation.
Denuded Areas	• Reinstate area to the land function of a natural area	• Compacted areas need to be ripped, soil samples taken and ameliorated according to a program recommended by soil scientist. This will be followed by the sowing of indigenous grass species and shrubs occurring in the surrounds. The project can be started with the aim of the collection of indigenous seeds and can be implemented as a social program. The seeds cannot be stored indefinitely as they will lose their ability to germinate and must be utilised yearly during concurrent rehabilitation.

12 CONCLUSION

Due to the nature of the mining industry, the operation of the Glencore Kroondal Mine can cause degradation of habitats and impact directly or indirectly on the biodiversity of an area. The Biodiversity Management and Action Plan were compiled according to guidelines provided by legislation and the IUCN Integrated Biodiversity Management System (IBMS). The document was compiled based on work of previous reports, plans and frameworks with ground truthing where necessary. This gave a better understanding to the current state of the environment and biodiversity on the site of the Glencore Kroondal Mine, mining area and its direct surroundings. The report provides a guideline for management team of the Glencore Kroondal Mine relating to biodiversity management on site to make informed strategic recommendations for strategic and biodiversity management for the site.

The Biodiversity Management and Action Plan guideline provide specific areas that have both operational and reputational elements, namely:

- Rehabilitation/restoration actions including biodiversity offsets;
- Conservation actions/initiatives;
- Research opportunities;
- Partnerships with conservation / academic / government organisations;
- Promotion of awareness of biodiversity with employees and external parties; and
- Provide a framework for action, monitoring and review and have a consolidated biodiversity document for engagement with internal and external stakeholders.

Following the field investigation and ecological interpretation conducted as part of the Biodiversity Management and Action Plan for the Glencore Kroondal Mine, some conclusions was made.

The study area was surveyed to determine the sensitive nature of the vegetation, fauna populations and the ecological sensitivity. State of the vegetation communities; sense of place, potential red data species habitat (fauna and flora), geology and soils (erosion risk; dust pollution etc.), previous land-use and topography (rockiness, slopes) are the main determinants of the sensitivity of the area proposed for the development site.

The collection of site-level biodiversity information ensured that sites were classified correctly with regards to their biodiversity importance category and that the potential impacts of the operations on biodiversity were accurately assessed.

If one considers the location of the study area in relation to the greater surrounding area, the site

can be considered as having Low or Medium Sensitivity area with the area characterised by slightly degraded vegetation with small pockets of areas (wetlands) supporting red data fauna. The natural wetlands have a High Sensitivity due to the connectivity to the larger area.

A risk-based approach was used to integrate biodiversity into all stages of operations, from planning to site closure, with differentiated biodiversity management options based on the value of and expected impacts to biodiversity at each stage. This approach will ensure that the level of management is commensurate with the level of risk. All aspects relating to the impact of the Glencore Kroondal Mine and mining area on biodiversity and related components was addressed in this report for the construction, operational, decommissioning and closure phase. Impact rating was also done for each of the biodiversity impacts.

The document further provides specific management and mitigation measures for each of the biodiversity and related components for the plant operational and closure phases, as well as species and habitat action plans during future management of the plant. The BAP links to documents, data, tools and guidance to ensure Glencore Kroondal Mine address and progressively implement biodiversity into site-level management, through the development of an appropriately focused management plan.

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APPENDIX A. PLANT SPECIES IN QDS

Family	Species	IUCN	Ecology
Euphorbiaceae	*Acalypha glabrata*	LC	Indigenous
Crassulaceae	*Adromischus umbraticola*		Indigenous; Endemic
Lamiaceae	*Aeollanthus buchnerianus*	LC	Indigenous
Rubiaceae	*Afrocanthium gilfillanii*	LC	Indigenous
Loranthaceae	*Agelanthus natalitius*		Indigenous
Apiaceae	*Alepidea setifera*	LC	Indigenous
Poaceae	*Alloteropsis semialata*	LC	Indigenous
Asphodelaceae	*Aloe greatheadii*	LC	Indigenous
Cyatheaceae	*Alsophila dregei*	LC	Indigenous
Anacampserotaceae	*Anacampseros subnuda*		Indigenous
Apocynaceae	*Ancylobotrys capensis*	LC	Indigenous
Poaceae	*Andropogon chinensis*	LC	Indigenous
Bryaceae	*Anomobryum julaceum*		Indigenous
Melastomataceae	*Antherotoma debilis*	LC	Indigenous
Rubiaceae	*Anthospermum hispidulum*	LC	Indigenous
Icacinaceae	*Apodytes dimidiata*	LC	Indigenous
Iridaceae	*Aristea angolensis*	LC	Indigenous
Poaceae	*Aristida aequiglumis*	LC	Indigenous
Poaceae	*Aristida congesta*	LC	Indigenous
Poaceae	*Aristida junciformis*	LC	Indigenous
Poaceae	*Aristida spectabilis*	LC	Indigenous
Poaceae	*Aristida stipitata*	LC	Indigenous
Poaceae	*Arundinella nepalensis*	LC	Indigenous
Cyperaceae	*Ascolepis capensis*	LC	Indigenous
Asparagaceae	*Asparagus angusticladus*	LC	Indigenous
Aspleniaceae	*Asplenium friesiorum*	LC	Indigenous
Aspleniaceae	*Asplenium inaequilaterale*	LC	Indigenous
Aytoniaceae	*Asterella bachmannii*		Indigenous
Aytoniaceae	*Asterella muscicola*		Indigenous
Asteraceae	*Athrixia elata*	LC	Indigenous
Polytrichaceae	*Atrichum androgynum*		Indigenous
Iridaceae	*Babiana bainesii*	LC	Indigenous
Pottiaceae	*Barbula eubryum*		Indigenous
Acanthaceae	*Barleria pretoriensis*	LC	Indigenous; Endemic
Asteraceae	*Berkheya carlinopsis*	LC	Indigenous; Endemic
Asteraceae	*Berkheya seminivea*	LC	Indigenous; Endemic
Apiaceae	*Berula repanda*	LC	Indigenous
Blechnaceae	*Blechnum attenuatum*		Indigenous
Blechnaceae	*Blechnum punctulatum*		Indigenous
Bryaceae	*Brachymenium acuminatum*		Indigenous

Family	Species	IUCN	Ecology
Bryaceae	*Bryum apiculatum*		Indigenous
Bryaceae	*Bryum argenteum*		Indigenous
Bryaceae	*Bryum pycnophyllum*		Indigenous
Scrophulariaceae	*Buddleja saligna*	LC	Indigenous
Scrophulariaceae	*Buddleja salviifolia*	LC	Indigenous
Cyperaceae	*Bulbostylis burchellii*	LC	Indigenous
Cyperaceae	*Bulbostylis contexta*	LC	Indigenous
Fabaceae	*Burkea africana*	LC	Indigenous
Burmanniaceae	*Burmannia madagascariensis*		Indigenous
Leucobryaceae	*Campylopus introflexus*		Indigenous
Leucobryaceae	*Campylopus pyriformis*		Indigenous
Leucobryaceae	*Campylopus sp.*		
Rubiaceae	*Canthium suberosum*	LC	Indigenous
Apocynaceae	*Carissa bispinosa*	LC	Indigenous
Scrophulariaceae	*Chaenostoma leve*	LC	Indigenous
Pteridaceae	*Cheilanthes hirta*	LC	Indigenous
Pteridaceae	*Cheilanthes viridis*	LC	Indigenous
Amaranthaceae	*Chenopodium schraderianum*		notIndigenous; Naturalised
Thelypteridaceae	*Christella gueinziana*		Indigenous
Ranunculaceae	*Clematis brachiata*	LC	Indigenous
Cleomaceae	*Cleome maculata*	LC	Indigenous
Cleomaceae	*Cleome monophylla*	LC	Indigenous
Euphorbiaceae	*Clutia pulchella*	LC	Indigenous; Endemic
Euphorbiaceae	*Clutia pulchella*	LC	Indigenous
Cucurbitaceae	*Coccinia adoensis*	LC	Indigenous
Combretaceae	*Combretum molle*	LC	Indigenous
Commelinaceae	*Commelina africana*	LC	Indigenous
Commelinaceae	*Commelina modesta*	LC	Indigenous
Crassulaceae	*Cotyledon orbiculata*	LC	Indigenous
Acanthaceae	*Crabbea angustifolia*		Indigenous; Endemic
Crassulaceae	*Crassula setulosa*	NE	Indigenous; Endemic
Crassulaceae	*Crassula swaziensis*		Indigenous
Linderniaceae	*Craterostigma wilmsii*	LC	Indigenous; Endemic
Fabaceae	*Crotalaria sphaerocarpa*	LC	Indigenous
Euphorbiaceae	*Croton gratissimus*	LC	Indigenous
Cucurbitaceae	*Cucumis melo*	LC	Indigenous
Araliaceae	*Cussonia transvaalensis*		Indigenous; Endemic
Poaceae	*Cymbopogon marginatus*	LC	Indigenous
Orchidaceae	*Cynorkis kassneriana*	LC	Indigenous
Cyperaceae	*Cyperus cyperoides*	LC	Indigenous
Cyperaceae	*Cyperus leptocladus*	LC	Indigenous
Cyperaceae	*Cyperus margaritaceus*	LC	Indigenous

Family	Species	IUCN	Ecology
Lobeliaceae	*Cyphia stenopetala*	LC	Indigenous
Aizoaceae	*Delosperma sp.*		
Asteraceae	*Dicoma anomala*	LC	Indigenous
Asteraceae	*Dicoma anomala*		Indigenous
Asteraceae	*Dicoma anomala*	LC	Indigenous
Poaceae	*Diheteropogon amplectens*	LC	Indigenous
Ebenaceae	*Diospyros lycioides*		Indigenous
Ebenaceae	*Diospyros lycioides*		Indigenous
Ditrichaceae	*Ditrichum difficile*		Indigenous
Malvaceae	*Dombeya rotundifolia*	LC	Indigenous
Salicaceae	*Dovyalis zeyheri*	LC	Indigenous
Hyacinthaceae	*Drimia altissima*		Indigenous
Droseraceae	*Drosera collinsiae*	LC	Indigenous
Dumortieraceae	*Dumortiera hirsuta*		Indigenous
Rubiaceae	*Empogona lanceolata*		Indigenous; Endemic
Onagraceae	*Epilobium hirsutum*	LC	Indigenous
Onagraceae	*Epilobium salignum*	LC	Indigenous
Poaceae	*Eragrostis acraea*	LC	Indigenous
Poaceae	*Eragrostis curvula*	LC	Indigenous
Poaceae	*Eragrostis gummiflua*	LC	Indigenous
Poaceae	*Eragrostis racemosa*	LC	Indigenous
Poaceae	*Eragrostis sclerantha*	LC	Indigenous
Poaceae	*Eragrostis stapfii*	LC	Indigenous
Poaceae	*Eragrostis superba*	LC	Indigenous
Ericaceae	*Erica woodii*	LC	Indigenous
Fabaceae	*Eriosema cordatum*	LC	Indigenous
Fabaceae	*Eriosema squarrosum*	LC	Indigenous
Hyacinthaceae	*Eucomis montana*		Indigenous
Orchidaceae	*Eulophia streptopetala*	LC	Indigenous
Fabroniaceae	*Fabronia pilifera*		Indigenous
Rubiaceae	*Fadogia homblei*	LC	Indigenous
Proteaceae	*Faurea saligna*	LC	Indigenous
Moraceae	*Ficus ingens*		Indigenous
Moraceae	*Ficus thonningii*		Indigenous
Fissidentaceae	*Fissidens bryoides*		Indigenous
Fissidentaceae	*Fissidens curvatus*		Indigenous
Fissidentaceae	*Fissidens ovatus*		Indigenous
Fissidentaceae	*Fissidens plumosus*		Indigenous
Fissidentaceae	*Fissidens rufescens*		Indigenous
Fissidentaceae	*Fissidens sciophyllus*		Indigenous
Fissidentaceae	*Fissidens sp.*		
Commelinaceae	*Floscopa glomerata*	LC	Indigenous

Family	Species	IUCN	Ecology
Fossombroniaceae	*Fossombronia crispa*		Indigenous
Fossombroniaceae	*Fossombronia gemmifera*		Indigenous
Fossombroniaceae	*Fossombronia straussiana*		Indigenous
Iridaceae	*Freesia grandiflora*	LC	Indigenous
Aizoaceae	*Frithia pulchra*	LC	Indigenous; Endemic
Cyperaceae	*Fuirena stricta*	LC	Indigenous
Funariaceae	*Funaria hygrometrica*		Indigenous
Funariaceae	*Funaria rottleri*		Indigenous
Asteraceae	*Geigeria burkei*	NE	Indigenous
Colchicaceae	*Gloriosa modesta*		Indigenous
Thymelaeaceae	*Gnidia sericocephala*		Indigenous
Apocynaceae	*Gomphocarpus glaucophyllus*	LC	Indigenous
Celastraceae	*Gymnosporia buxifolia*	LC	Indigenous
Celastraceae	*Gymnosporia polyacantha*	LC	Indigenous; Endemic
Celastraceae	*Gymnosporia tenuispina*	LC	Indigenous
Amaryllidaceae	*Haemanthus humilis*	LC	Indigenous
Orobanchaceae	*Harveya pumila*	LC	Indigenous
Asteraceae	*Helichrysum acutatum*	LC	Indigenous
Asteraceae	*Helichrysum aureonitens*	LC	Indigenous
Asteraceae	*Helichrysum callicomum*	LC	Indigenous
Asteraceae	*Helichrysum cerastioides*		Indigenous
Asteraceae	*Helichrysum cerastioides*	LC	Indigenous
Asteraceae	*Helichrysum epapposum*	LC	Indigenous
Asteraceae	*Helichrysum kraussii*	LC	Indigenous
Asteraceae	*Helichrysum lepidissimum*	LC	Indigenous
Asteraceae	*Helichrysum mundtii*	LC	Indigenous
Asteraceae	*Helichrysum nudifolium*	LC	Indigenous
Asteraceae	*Helichrysum rugulosum*	LC	Indigenous
Asteraceae	*Helichrysum setosum*	LC	Indigenous
Malvaceae	*Hermannia burkei*	LC	Indigenous
Malvaceae	*Hermannia floribunda*	LC	Indigenous
Malvaceae	*Hermannia lancifolia*	LC	Indigenous; Endemic
Iridaceae	*Hesperantha coccinea*	LC	Indigenous
Malvaceae	*Hibiscus sp.*		
Apocynaceae	*Huernia transvaalensis*	LC	Indigenous; Endemic
Aquifoliaceae	*Ilex mitis*	LC	Indigenous
Fabaceae	*Indigastrum burkeanum*	LC	Indigenous
Fabaceae	*Indigofera arrecta*	LC	Indigenous
Fabaceae	*Indigofera melanadenia*	LC	Indigenous
Convolvulaceae	*Ipomoea magnusiana*	LC	Indigenous
Poaceae	*Ischaemum fasciculatum*	LC	Indigenous
Cyperaceae	*Isolepis fluitans*	LC	Indigenous

Family	Species	IUCN	Ecology
Acanthaceae	*Justicia betonica*		Indigenous
Crassulaceae	*Kalanchoe lanceolata*		Indigenous
Aizoaceae	*Khadia acutipetala*	LC	Indigenous; Endemic
Achariaceae	*Kiggelaria africana*	LC	Indigenous
Asphodelaceae	*Kniphofia ensifolia*	LC	Indigenous
Thymelaeaceae	*Lasiosiphon caffer*	LC	Indigenous
Hyacinthaceae	*Ledebouria atrobrunnea*		Indigenous; Endemic
Hyacinthaceae	*Ledebouria ovatifolia*		Indigenous; Endemic
Poaceae	*Leersia hexandra*	LC	Indigenous
Leskeaceae	*Lindbergia haplocladioides*		Indigenous
Leskeaceae	*Lindbergia sp.*		
Orchidaceae	*Liparis bowkeri*	LC	Indigenous
Cyperaceae	*Lipocarpha chinensis*	LC	Indigenous
Verbenaceae	*Lippia javanica*		Indigenous
Fabaceae	*Listia heterophylla*	LC	Indigenous
Lophiocarpaceae	*Lophiocarpus tenuissimus*	LC	Indigenous
Lophocoleaceae	*Lophocolea sp.*		
Asteraceae	*Lopholaena coriifolia*	LC	Indigenous
Poaceae	*Loudetia simplex*	LC	Indigenous
Aytoniaceae	*Mannia capensis*		Indigenous
Celastraceae	*Maytenus undata*	LC	Indigenous
Malvaceae	*Melhania acuminata*	LC	Indigenous
Sapotaceae	*Mimusops zeyheri*	LC	Indigenous
Anemiaceae	*Mohria vestita*	LC	Indigenous
Poaceae	*Monocymbium ceresiiforme*	LC	Indigenous
Lobeliaceae	*Monopsis decipiens*	LC	Indigenous
Geraniaceae	*Monsonia angustifolia*	LC	Indigenous
Myricaceae	*Morella pilulifera*		Indigenous
Fabaceae	*Mundulea sericea*	LC	Indigenous
Myrothamnaceae	*Myrothamnus flabellifolius*	DD	Indigenous
Myrsinaceae	*Myrsine africana*	LC	Indigenous
Myrsinaceae	*Myrsine pillansii*	LC	Indigenous
Celastraceae	*Mystroxylon aethiopicum*	LC	Indigenous; Endemic
Asteraceae	*Nidorella hottentotica*	LC	Indigenous
Stilbaceae	*Nuxia congesta*	LC	Indigenous
Urticaceae	*Obetia tenax*		Indigenous
Ochnaceae	*Ochna holstii*	LC	Indigenous
Ochnaceae	*Ochna pretoriensis*	LC	Indigenous
Ochnaceae	*Ochna pulchra*	LC	Indigenous
Calymperaceae	*Octoblepharum albidum*		Indigenous
Rubiaceae	*Oldenlandia herbacea*	LC	Indigenous
Rubiaceae	*Oldenlandia tenella*	LC	Indigenous

Family	Species	IUCN	Ecology
Oleaceae	*Olea capensis*	LC	Indigenous
Oleaceae	*Olea europaea*		Indigenous
Oleandraceae	*Oleandra distenta*	LC	Indigenous
Asteraceae	*Oocephala staehelinoides*		Indigenous; Endemic
Ophioglossaceae	*Ophioglossum polyphyllum*	LC	Indigenous
Apocynaceae	*Orbea lutea*	LC	Indigenous
Osmundaceae	*Osmunda regalis*	LC	Indigenous
Santalaceae	*Osyris lanceolata*	LC	Indigenous
Rubiaceae	*Otiophora calycophylla*	LC	Indigenous; Endemic
Anacardiaceae	*Ozoroa paniculosa*	LC	Indigenous
Anacardiaceae	*Ozoroa paniculosa*	LC	Indigenous
Rubiaceae	*Pachystigma macrocalyx*	LC	Indigenous
Poaceae	*Panicum natalense*	LC	Indigenous
Poaceae	*Paspalum urvillei*	NE	notIndigenous; Naturalised
Rubiaceae	*Pavetta zeyheri*	LC	Indigenous
Malvaceae	*Pavonia clathrata*	LC	Indigenous
Fabaceae	*Pearsonia sessilifolia*	LC	Indigenous
Fabaceae	*Pearsonia uniflora*	LC	Indigenous
Geraniaceae	*Pelargonium luridum*	LC	Indigenous
Poaceae	*Pennisetum macrourum*	LC	Indigenous
Apocynaceae	*Pentarrhinum insipidum*	LC	Indigenous
Piperaceae	*Peperomia tetraphylla*		Indigenous
Cucurbitaceae	*Peponium caledonicum*	LC	Indigenous
Polygonaceae	*Persicaria madagascariensis*		Indigenous
Bartramiaceae	*Philonotis dregeana*		Indigenous
Bartramiaceae	*Philonotis hastata*		Indigenous
Rhamnaceae	*Phylica paniculata*		Indigenous
Pittosporaceae	*Pittosporum viridiflorum*	LC	Indigenous
Pteridaceae	*Pityrogramma argentea*	LC	Indigenous
Aytoniaceae	*Plagiochasma rupestre*		Indigenous
Aytoniaceae	*Plagiochasma rupestre*		Indigenous
Lamiaceae	*Plectranthus aliciae*	LC	Indigenous; Endemic
Lamiaceae	*Plectranthus hereroensis*	LC	Indigenous
Lamiaceae	*Plectranthus ramosior*	LC	Indigenous; Endemic
Poaceae	*Pogonarthria squarrosa*	LC	Indigenous
Polytrichaceae	*Pogonatum capense*		Indigenous
Caryophyllaceae	*Pollichia campestris*		Indigenous
Asteraceae	*Polydora poskeana*	LC	Indigenous
Polygalaceae	*Polygala hottentotta*	LC	Indigenous
Polygalaceae	*Polygala rehmannii*	LC	Indigenous
Polytrichaceae	*Polytrichum commune*		Indigenous
Portulacaceae	*Portulaca grandiflora*		Indigenous; Endemic

Family	Species	IUCN	Ecology
Portulacaceae	*Portulaca quadrifida*		Indigenous
Urticaceae	*Pouzolzia mixta*		Indigenous
Proteaceae	*Protea caffra*	LC	Indigenous
Proteaceae	*Protea caffra*		Indigenous
Proteaceae	*Protea welwitschii*	LC	Indigenous
Pteridaceae	*Pteris friesii*	LC	Indigenous
Pteridaceae	*Pteris vittata*	LC	Indigenous
Celastraceae	*Pterocelastrus echinatus*	LC	Indigenous
Lamiaceae	*Pycnostachys reticulata*	LC	Indigenous
Racopilaceae	*Racopilum capense*		Indigenous
Apocynaceae	*Raphionacme velutina*	LC	Indigenous
Vitaceae	*Rhoicissus tridentata*		Indigenous
Fabaceae	*Rhynchosia confusa*	NE	Indigenous
Fabaceae	*Rhynchosia hirsuta*	LC	Indigenous
Fabaceae	*Rhynchosia totta*		Indigenous
Ricciaceae	*Riccia albolimbata*		Indigenous
Ricciaceae	*Riccia atropurpurea*		Indigenous
Ricciaceae	*Riccia cavernosa*		Indigenous
Ricciaceae	*Riccia crystallina*		Indigenous
Ricciaceae	*Riccia okahandjana*		Indigenous
Ricciaceae	*Riccia volkii*		Indigenous
Bryaceae	*Rosulabryum capillare*		Indigenous
Rubiaceae	*Rothmannia capensis*	LC	Indigenous
Rosaceae	*Rubus cuneifolius*		notIndigenous; Naturalised; Invasive
Celastraceae	*Salacia rehmannii*	LC	Indigenous; Endemic
Poaceae	*Schizachyrium jeffreysii*	LC	Indigenous
Poaceae	*Schizachyrium sanguineum*	LC	Indigenous
Hyacinthaceae	*Schizocarphus nervosus*		Indigenous
Cyperaceae	*Schoenoplectus brachyceras*	LC	Indigenous
Salicaceae	*Scolopia mundii*	LC	Indigenous
Anacardiaceae	*Searsia discolor*		Indigenous
Anacardiaceae	*Searsia magalismontana*		Indigenous
Anacardiaceae	*Searsia pyroides*		Indigenous
Anacardiaceae	*Searsia rigida*		Indigenous
Gentianaceae	*Sebaea bojeri*	LC	Indigenous
Selaginellaceae	*Selaginella dregei*		Indigenous
Sematophyllaceae	*Sematophyllum brachycarpum*		Indigenous
Sematophyllaceae	*Sematophyllum sphaeropyxis*		Indigenous
Asteraceae	*Senecio othonniflorus*	LC	Indigenous
Asteraceae	*Senecio pleistocephalus*	LC	Indigenous
Fabaceae	*Senegalia caffra*	LC	Indigenous
Fabaceae	*Senna occidentalis*	NE	notIndigenous; Naturalised; Invasive

Family	Species	IUCN	Ecology
Poaceae	*Setaria sphacelata*	LC	Indigenous
Malvaceae	*Sida dregei*	LC	Indigenous
Solanaceae	*Solanum giganteum*	LC	Indigenous
Sphagnaceae	*Sphagnum capense*		Indigenous
Sphagnaceae	*Sphagnum truncatum*		Indigenous
Fabaceae	*Sphenostylis angustifolia*	LC	Indigenous
Poaceae	*Sporobolus congoensis*	LC	Indigenous
Poaceae	*Sporobolus pectinatus*	LC	Indigenous; Endemic
Orobanchaceae	*Striga bilabiata*	LC	Indigenous
Orobanchaceae	*Striga gesnerioides*	LC	Indigenous
Loganiaceae	*Strychnos usambarensis*	LC	Indigenous
Pallaviciniaceae	*Symphyogyna brasiliensis*		Indigenous
Pallaviciniaceae	*Symphyogyna podophylla*		Indigenous
Pottiaceae	*Syntrichia laevipila*		Indigenous
Anacampserotaceae	*Talinum caffrum*		Indigenous
Targioniaceae	*Targionia hypophylla*		Indigenous
Thelypteridaceae	*Thelypteris confluens*	LC	Indigenous
Santalaceae	*Thesium magalismontanum*	LC	Indigenous; Endemic
Santalaceae	*Thesium resedoides*	LC	Indigenous
Santalaceae	*Thesium sp.*		
Pottiaceae	*Tortella xanthocarpa*		Indigenous
Poaceae	*Trachypogon spicatus*	LC	Indigenous
Cannabaceae	*Trema orientalis*	LC	Indigenous
Bruchiaceae	*Trematodon intermedius*		Indigenous
Bruchiaceae	*Trematodon longicollis*		Indigenous
Malpighiaceae	*Triaspis glaucophylla*	LC	Indigenous; Endemic
Poaceae	*Tricholaena monachne*	LC	Indigenous
Poaceae	*Trichoneura grandiglumis*	LC	Indigenous
Pottiaceae	*Trichostomum brachydontium*		Indigenous
Malvaceae	*Triumfetta pilosa*	LC	Indigenous
Asteraceae	*Ursinia nana*	LC	Indigenous
Asteraceae	*Ursinia sp.*		
Lentibulariaceae	*Utricularia welwitschii*	LC	Indigenous
Fabaceae	*Vachellia nilotica*	LC	Indigenous
Valerianaceae	*Valeriana capensis*	LC	Indigenous
Santalaceae	*Viscum verrucosum*		Indigenous
Campanulaceae	*Wahlenbergia denticulata*	LC	Indigenous
Campanulaceae	*Wahlenbergia lycopodioides*	LC	Indigenous
Campanulaceae	*Wahlenbergia magaliesbergensis*	LC	Indigenous; Endemic
Pottiaceae	*Weissia latiuscula*		Indigenous
Convolvulaceae	*Xenostegia tridentata*		Indigenous
Velloziaceae	*Xerophyta viscosa*		Indigenous; Endemic

Family	Species	IUCN	Ecology
Xyridaceae	*Xyris congensis*		Indigenous
Scrophulariaceae	*Zaluzianskya elongata*	LC	Indigenous
Rutaceae	*Zanthoxylum capense*	LC	Indigenous

APPENDIX B. PLANT SPECIES FOUND ON SITE

Plant species lists for site
Woody species
Celtis africana
Dichrostachys cinerea
Jacaranda mimosifolia
Melia azedarach
Morus alba
Schotia brachypetala
Senegalia galpinni
Senegalia sieberiana
Solanum mauritianum
Tecoma stans
Vachellia karroo
Vachellia nilotica
Vachellia tortilis
Vachellia xanthophloea
Ziziphus mucronata
Grass species
Aristida congesta
Aristida stipitata
Botriochloa insculpta
Brachiaria deflexa
Chloris virgata
Cymbopogon pisposchilli
Cynodon dactylon
Digitaria eriantha
Enneapogon cenchroides
Enneapogon scoparius
Eragrostis curvula
Eragrostis viscosa
Heteropogon contortus
Hyparrhenia hirta
Hyperthelia dissoluta
Ishaemum fasciculatum
Melinis repens
Panicum coloratum
Panicum maximum
Pogonarthria squarrosa
Sporobolus africanus
Tragus bertertranonianus
Urochloa mosambicense
Forbs and succulents
Guilulemnia densa

Plant species lists for site
Amaranthus hybridus
Cereus jamacaru
Chenopodium album
Convolvulis sagittatus
Conyza bionariensis
Cyperus sexangularis
Datura oligotrocha
Datura stramonium
Dicerocarium eriocaprum
Flaveria bidentis
Gomphocarpus fruticosus
Gomphrena celasoides
Harrissia spp.
Kalanchoe paniculata
Laggera decurrens
Lantana rugose
Lippia javanica
Malva parvifolia
Nidorella anomala
Opuntia ficus indica
Pellaea calomelanos
Rhoicissus tridentata
Schkuria pinnata
Schoenoplectus corymbosus
Sida cordifolia
Solanum panduriforme
Stoebe vulgaris
Tagetes minuta
Tithonia rotundifolia *Aloe marlothii*
Vigna vexillata
Zansevieria hyacinthoides
Tapinanthus spp.
Tribulis terrestris
Vernonia oligocephala
Zinnia peruviana

APPENDIX C. BIRD SPECIES LIST FOR QDS

Common_name	***Taxon_name***
Ostrich, Common	*Struthio camelus*
Grebe, Great Crested	*Podiceps cristatus*
Grebe, Little	*Tachybaptus ruficollis*
Cormorant, White-breasted	*Phalacrocorax carbo*
Cormorant, Reed	*Phalacrocorax africanus*
Darter, African	*Anhinga rufa*
Heron, Grey	*Ardea cinerea*
Heron, Black-headed	*Ardea melanocephala*
Heron, Goliath	*Ardea goliath*
Heron, Purple	*Ardea purpurea*
Egret, Great	*Egretta alba*
Egret, Little	*Egretta garzetta*
Egret, Yellow-billed	*Egretta intermedia*
Egret, Cattle	*Bubulcus ibis*
Heron, Squacco	*Ardeola ralloides*
Heron, Green-backed	*Butorides striata*
Heron, Black	*Egretta ardesiaca*
Bittern, Dwarf	*Ixobrychus sturmii*
Bittern, Little	*Ixobrychus minutus*
Night-Heron, Black-crowned	*Nycticorax nycticorax*
Hamerkop, Hamerkop	*Scopus umbretta*
Stork, Abdim's	*Ciconia abdimii*
Stork, Black	*Ciconia nigra*
Stork, White	*Ciconia ciconia*
Ibis, African Sacred	*Threskiornis aethiopicus*
Ibis, Glossy	*Plegadis falcinellus*
Ibis, Hadeda	*Bostrychia hagedash*
Spoonbill, African	*Platalea alba*
Goose, Spur-winged	*Plectropterus gambensis*
Goose, Egyptian	*Alopochen aegyptiacus*
Shelduck, South African	*Tadorna cana*
Duck, Knob-billed	*Sarkidiornis melanotos*
Shoveler, Cape	*Anas smithii*
Duck, African Black	*Anas sparsa*
Duck, Yellow-billed	*Anas undulata*
Teal, Red-billed	*Anas erythrorhyncha*
Teal, Cape	*Anas capensis*
Duck, White-faced	*Dendrocygna viduata*
Pochard, Southern	*Netta erythrophthalma*
Duck, Maccoa	*Oxyura maccoa*

Common_name	***Taxon_name***
Duck, White-backed	*Thalassornis leuconotus*
Secretarybird, Secretarybird	*Sagittarius serpentarius*
Vulture, Cape	*Gyps coprotheres*
Vulture, White-backed	*Gyps africanus*
Falcon, Peregrine	*Falco peregrinus*
Falcon, Lanner	*Falco biarmicus*
Falcon, Amur	*Falco amurensis*
Kestrel, Rock	*Falco rupicolus*
Kestrel, Lesser	*Falco naumanni*
Hawk, African Cuckoo	*Aviceda cuculoides*
Kite, Yellow-billed	*Milvus aegyptius*
Kite, Black-shouldered	*Elanus caeruleus*
Honey-buzzard, European	*Pernis apivorus*
Eagle, Verreaux's	*Aquila verreauxii*
Eagle, Tawny	*Aquila rapax*
Eagle, Wahlberg's	*Aquila wahlbergi*
Eagle, Long-crested	*Lophaetus occipitalis*
Eagle, Martial	*Polemaetus bellicosus*
Buzzard, Lizard	*Kaupifalco monogrammicus*
Snake-eagle, Brown	*Circaetus cinereus*
Snake-eagle, Black-chested	*Circaetus pectoralis*
Fish-eagle, African	*Haliaeetus vocifer*
Buzzard, Jackal	*Buteo rufofuscus*
Buzzard, Steppe	*Buteo vulpinus*
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*
Sparrowhawk, Ovambo	*Accipiter ovampensis*
Sparrowhawk, Little	*Accipiter minullus*
Sparrowhawk, Black	*Accipiter melanoleucus*
Shikra, Shikra	*Accipiter badius*
Goshawk, Gabar	*Melierax gabar*
Harrier-Hawk, African	*Polyboroides typus*
Osprey, Osprey	*Pandion haliaetus*
Francolin, Coqui	*Peliperdix coqui*
Francolin, Crested	*Dendroperdix sephaena*
Francolin, Red-winged	*Scleroptila levaillantii*
Francolin, Orange River	*Scleroptila levaillantoides*
Spurfowl, Natal	*Pternistis natalensis*
Spurfowl, Swainson's	*Pternistis swainsonii*
Quail, Common	*Coturnix coturnix*
Guineafowl, Helmeted	*Numida meleagris*
Rail, African	*Rallus caerulescens*
Crake, Black	*Amaurornis flavirostris*

Common_name	***Taxon_name***
Flufftail, Red-chested	*Sarothrura rufa*
Swamphen, African Purple	*Porphyrio madagascariensis*
Moorhen, Common	*Gallinula chloropus*
Coot, Red-knobbed	*Fulica cristata*
Korhaan, White-bellied	*Eupodotis senegalensis*
Jacana, African	*Actophilornis africanus*
Plover, Kittlitz's	*Charadrius pecuarius*
Plover, Three-banded	*Charadrius tricollaris*
Lapwing, Crowned	*Vanellus coronatus*
Lapwing, Blacksmith	*Vanellus armatus*
Lapwing, African Wattled	*Vanellus senegallus*
Snipe, African	*Gallinago nigripennis*
Stint, Little	*Calidris minuta*
Sandpiper, Common	*Actitis hypoleucos*
Greenshank, Common	*Tringa nebularia*
Sandpiper, Wood	*Tringa glareola*
Stilt, Black-winged	*Himantopus himantopus*
Thick-knee, Spotted	*Burhinus capensis*
Courser, Temminck's	*Cursorius temminckii*
Courser, Bronze-winged	*Rhinoptilus chalcopterus*
Gull, Grey-headed	*Larus cirrocephalus*
Tern, Whiskered	*Chlidonias hybrida*
Pigeon, Speckled	*Columba guinea*
Olive-pigeon, African	*Columba arquatrix*
Dove, Red-eyed	*Streptopelia semitorquata*
Turtle-dove, Cape	*Streptopelia capicola*
Dove, Laughing	*Streptopelia senegalensis*
Dove, Namaqua	*Oena capensis*
Wood-dove, Emerald-spotted	*Turtur chalcospilos*
Green-pigeon, African	*Treron calvus*
Go-away-bird, Grey	*Corythaixoides concolor*
Cuckoo, Red-chested	*Cuculus solitarius*
Cuckoo, Black	*Cuculus clamosus*
Cuckoo, Great Spotted	*Clamator glandarius*
Cuckoo, Levaillant's	*Clamator levaillantii*
Cuckoo, Jacobin	*Clamator jacobinus*
Cuckoo, Klaas's	*Chrysococcyx klaas*
Cuckoo, Diderick	*Chrysococcyx caprius*
Owl, Barn	*Tyto alba*
Grass-owl, African	*Tyto capensis*
Owl, Marsh	*Asio capensis*
Scops-owl, African	*Otus senegalensis*

Common_name	***Taxon_name***
Scops-owl, Southern White-faced	*Ptilopsus granti*
Owlet, Pearl-spotted	*Glaucidium perlatum*
Eagle-owl, Cape	*Bubo capensis*
Eagle-owl, Spotted	*Bubo africanus*
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*
Nightjar, Fiery-necked	*Caprimulgus pectoralis*
Nightjar, Freckled	*Caprimulgus tristigma*
Swift, Common	*Apus apus*
Swift, African Black	*Apus barbatus*
Swift, White-rumped	*Apus caffer*
Swift, Horus	*Apus horus*
Swift, Little	*Apus affinis*
Swift, Alpine	*Tachymarptis melba*
Palm-swift, African	*Cypsiurus parvus*
Mousebird, Speckled	*Colius striatus*
Mousebird, White-backed	*Colius colius*
Mousebird, Red-faced	*Urocolius indicus*
Kingfisher, Pied	*Ceryle rudis*
Kingfisher, Giant	*Megaceryle maximus*
Kingfisher, Half-collared	*Alcedo semitorquata*
Kingfisher, Malachite	*Alcedo cristata*
Pygmy-Kingfisher, African	*Ispidina picta*
Kingfisher, Woodland	*Halcyon senegalensis*
Kingfisher, Brown-hooded	*Halcyon albiventris*
Kingfisher, Striped	*Halcyon chelicuti*
Bee-eater, European	*Merops apiaster*
Bee-eater, White-fronted	*Merops bullockoides*
Bee-eater, Little	*Merops pusillus*
Bee-eater, Swallow-tailed	*Merops hirundineus*
Roller, European	*Coracias garrulus*
Roller, Lilac-breasted	*Coracias caudatus*
Roller, Purple	*Coracias naevius*
Hoopoe, African	*Upupa africana*
Wood-hoopoe, Green	*Phoeniculus purpureus*
Hornbill, African Grey	*Tockus nasutus*
Hornbill, Southern Yellow-billed	*Tockus leucomelas*
Barbet, Black-collared	*Lybius torquatus*
Barbet, Acacia Pied	*Tricholaema leucomelas*
Tinkerbird, Yellow-fronted	*Pogoniulus chrysoconus*
Barbet, Crested	*Trachyphonus vaillantii*
Honeyguide, Greater	*Indicator indicator*
Honeyguide, Lesser	*Indicator minor*

Common_name	***Taxon_name***
Honeybird, Brown-backed	*Prodotiscus regulus*
Woodpecker, Golden-tailed	*Campethera abingoni*
Woodpecker, Cardinal	*Dendropicos fuscescens*
Woodpecker, Bearded	*Dendropicos namaquus*
Wryneck, Red-throated	*Jynx ruficollis*
Lark, Rufous-naped	*Mirafra africana*
Lark, Sabota	*Calendulauda sabota*
Lark, Flappet	*Mirafra rufocinnamomea*
Lark, Spike-heeled	*Chersomanes albofasciata*
Sparrowlark, Grey-backed	*Eremopterix verticalis*
Lark, Red-capped	*Calandrella cinerea*
Swallow, Barn	*Hirundo rustica*
Swallow, White-throated	*Hirundo albigularis*
Swallow, Pearl-breasted	*Hirundo dimidiata*
Swallow, Red-breasted	*Hirundo semirufa*
Swallow, Greater Striped	*Hirundo cucullata*
Swallow, Lesser Striped	*Hirundo abyssinica*
Cliff-swallow, South African	*Hirundo spilodera*
Martin, Rock	*Hirundo fuligula*
House-martin, Common	*Delichon urbicum*
Martin, Sand	*Riparia riparia*
Martin, Brown-throated	*Riparia paludicola*
Martin, Banded	*Riparia cincta*
Cuckoo-shrike, Black	*Campephaga flava*
Tit, Ashy	*Parus cinerascens*
Drongo, Fork-tailed	*Dicrurus adsimilis*
Oriole, Black-headed	*Oriolus larvatus*
Crow, Pied	*Corvus albus*
Crow, Cape	*Corvus capensis*
Tit, Southern Black	*Parus niger*
Babbler, Arrow-marked	*Turdoides jardineii*
Bulbul, African Red-eyed	*Pycnonotus nigricans*
Bulbul, Dark-capped	*Pycnonotus tricolor*
Thrush, Kurrichane	*Turdus libonyanus*
Thrush, Groundscraper	*Psophocichla litsipsirupa*
Rock-thrush, Cape	*Monticola rupestris*
Rock-thrush, Short-toed	*Monticola brevipes*
Wheatear, Mountain	*Oenanthe monticola*
Wheatear, Capped	*Oenanthe pileata*
Chat, Familiar	*Cercomela familiaris*
Cliff-chat, Mocking	*Thamnolaea cinnamomeiventris*
Chat, Anteating	*Myrmecocichla formicivora*

Common_name	***Taxon_name***
Stonechat, African	*Saxicola torquatus*
Robin-chat, Cape	*Cossypha caffra*
Robin-chat, White-throated	*Cossypha humeralis*
Scrub-robin, Kalahari	*Cercotrichas paena*
Scrub-robin, White-browed	*Cercotrichas leucophrys*
Warbler, Garden	*Sylvia borin*
Warbler, Icterine	*Hippolais icterina*
Warbler, Willow	*Phylloscopus trochilus*
Eremomela, Yellow-bellied	*Eremomela icteropygialis*
Eremomela, Burnt-necked	*Eremomela usticollis*
Reed-warbler, Great	*Acrocephalus arundinaceus*
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*
Reed-warbler, African	*Acrocephalus baeticatus*
Warbler, Marsh	*Acrocephalus palustris*
Warbler, Sedge	*Acrocephalus schoenobaenus*
Rush-warbler, Little	*Bradypterus baboecala*
Wren-warbler, Barred	*Calamonastes fasciolatus*
Grassbird, Cape	*Sphenoeacus afer*
Crombec, Long-billed	*Sylvietta rufescens*
Apalis, Bar-throated	*Apalis thoracica*
Camaroptera, Grey-backed	*Camaroptera brevicaudata*
Cisticola, Zitting	*Cisticola juncidis*
Cisticola, Desert	*Cisticola aridulus*
Cisticola, Cloud	*Cisticola textrix*
Cisticola, Wing-snapping	*Cisticola ayresii*
Neddicky, Neddicky	*Cisticola fulvicapilla*
Cisticola, Wailing	*Cisticola lais*
Cisticola, Rattling	*Cisticola chiniana*
Cisticola, Levaillant's	*Cisticola tinniens*
Cisticola, Lazy	*Cisticola aberrans*
Prinia, Tawny-flanked	*Prinia subflava*
Prinia, Black-chested	*Prinia flavicans*
Flycatcher, Spotted	*Muscicapa striata*
Tit-flycatcher, Grey	*Myioparus plumbeus*
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*
Flycatcher, Marico	*Bradornis mariquensis*
Flycatcher, Pale	*Bradornis pallidus*
Flycatcher, Southern Black	*Melaenornis pammelaina*
Flycatcher, Fiscal	*Sigelus silens*
Batis, Chinspot	*Batis molitor*
Flycatcher, Fairy	*Stenostira scita*
Paradise-flycatcher, African	*Terpsiphone viridis*

Common_name	***Taxon_name***
Wagtail, African Pied	*Motacilla aguimp*
Wagtail, Cape	*Motacilla capensis*
Wagtail, Yellow	*Motacilla flava*
Pipit, African	*Anthus cinnamomeus*
Pipit, Long-billed	*Anthus similis*
Pipit, Plain-backed	*Anthus leucophrys*
Pipit, Buffy	*Anthus vaalensis*
Pipit, Striped	*Anthus lineiventris*
Longclaw, Cape	*Macronyx capensis*
Shrike, Lesser Grey	*Lanius minor*
Fiscal, Common (Southern)	*Lanius collaris*
Shrike, Red-backed	*Lanius collurio*
Boubou, Southern	*Laniarius ferrugineus*
Shrike, Crimson-breasted	*Laniarius atrococcineus*
Puffback, Black-backed	*Dryoscopus cubla*
Tchagra, Brown-crowned	*Tchagra australis*
Tchagra, Black-crowned	*Tchagra senegalus*
Bush-shrike, Orange-breasted	*Telophorus sulfureopectus*
Bokmakierie, Bokmakierie	*Telophorus zeylonus*
Bush-shrike, Grey-headed	*Malaconotus blanchoti*
Shrike, Magpie	*Urolestes melanoleucus*
Helmet-shrike, White-crested	*Prionops plumatus*
Brubru, Brubru	*Nilaus afer*
Myna, Common	*Acridotheres tristis*
Starling, Wattled	*Creatophora cinerea*
Starling, Violet-backed	*Cinnyricinclus leucogaster*
Starling, Cape Glossy	*Lamprotornis nitens*
Starling, Red-winged	*Onychognathus morio*
Starling, Pied	*Spreo bicolor*
Oxpecker, Red-billed	*Buphagus erythrorhynchus*
Sunbird, Malachite	*Nectarinia famosa*
Sunbird, Marico	*Cinnyris mariquensis*
Sunbird, Greater Double-collared	*Cinnyris afer*
Sunbird, White-bellied	*Cinnyris talatala*
Sunbird, Amethyst	*Chalcomitra amethystina*
Sparrow-weaver, White-browed	*Plocepasser mahali*
Sparrow, House	*Passer domesticus*
Sparrow, Cape	*Passer melanurus*
Petronia, Yellow-throated	*Petronia superciliaris*
Finch, Scaly-feathered	*Sporopipes squamifrons*
Masked-weaver, Lesser	*Ploceus intermedius*
Weaver, Red-headed	*Anaplectes rubriceps*

Common_name	***Taxon_name***
Weaver, Village	*Ploceus cucullatus*
Weaver, Cape	*Ploceus capensis*
Masked-weaver, Southern	*Ploceus velatus*
Weaver, Thick-billed	*Amblyospiza albifrons*
Quelea, Red-billed	*Quelea quelea*
Bishop, Southern Red	*Euplectes orix*
Bishop, Yellow-crowned	*Euplectes afer*
Widowbird, Red-collared	*Euplectes ardens*
Widowbird, White-winged	*Euplectes albonotatus*
Widowbird, Long-tailed	*Euplectes progne*
Finch, Red-headed	*Amadina erythrocephala*
Finch, Cut-throat	*Amadina fasciata*
Mannikin, Bronze	*Spermestes cucullatus*
Waxbill, Swee	*Coccopygia melanotis*
Pytilia, Green-winged	*Pytilia melba*
Firefinch, African	*Lagonosticta rubricata*
Firefinch, Jameson's	*Lagonosticta rhodopareia*
Firefinch, Red-billed	*Lagonosticta senegala*
Waxbill, Orange-breasted	*Amandava subflava*
Waxbill, Blue	*Uraeginthus angolensis*
Waxbill, Violet-eared	*Granatina granatina*
Waxbill, Black-faced	*Estrilda erythronotos*
Waxbill, Common	*Estrilda astrild*
Quailfinch, African	*Ortygospiza atricollis*
Whydah, Pin-tailed	*Vidua macroura*
Whydah, Shaft-tailed	*Vidua regia*
Indigobird, Dusky	*Vidua funerea*
Indigobird, Purple	*Vidua purpurascens*
Indigobird, Village	*Vidua chalybeata*
Paradise-whydah, Long-tailed	*Vidua paradisaea*
Finch, Cuckoo	*Anomalospiza imberbis*
Canary, Yellow-fronted	*Crithagra mozambicus*
Canary, Black-throated	*Crithagra atrogularis*
Canary, Yellow	*Crithagra flaviventris*
Seedeater, Streaky-headed	*Crithagra gularis*
Bunting, Lark-like	*Emberiza impetuani*
Bunting, Cinnamon-breasted	*Emberiza tahapisi*
Bunting, Cape	*Emberiza capensis*
Bunting, Golden-breasted	*Emberiza flaviventris*
Dove, Rock	*Columba livia*
Duck, Mallard	*Anas platyrhynchos*
Peacock, Common	*Pavo cristatus*

Common_name	***Taxon_name***
Korhaan, Northern Black	*Afrotis afraoides*
Thrush, Karoo	*Turdus smithi*
White-eye, Orange River	*Zosterops pallidus*
White-eye, Cape	*Zosterops virens*
Lark, Eastern Clapper	*Mirafra fasciolata*
Lark, Eastern Long-billed	*Certhilauda semitorquata*
Hornbill, Red-billed	*Tockus erythrorhynchus*
Coucal, Burchell's	*Centropus burchellii*
Korhaan, Southern Black	*Afrotis afra*
Sparrow, Southern Grey-headed	*Passer diffusus*
Goose, Domestic	*Anser anser*
Duck, Hybrid Mallard	*Anas hybrid*

APPENDIX D MAMMAL SPECIES LIST FOR QDS

Family	Scientific name	Common name	Red list
Bovidae	*Aepyceros melampus*	Impala	Least Concern (2016)
Bovidae	*Alcelaphus buselaphus*	Red hartebeest	Least Concern (2016)
Bovidae	*Antidorcas marsupialis*	Springbok	Least Concern (2016)
Bovidae	*Connochaetes taurinus taurinus*	Blue wildebeest	Least Concern (2016)
Bovidae	*Damaliscus lunatus lunatus*	(Southern African) Tsessebe	Vulnerable (2016)
Bovidae	*Damaliscus pygargus phillipsi*	Blesbok	Least Concern (2016)
Bovidae	*Hippotragus niger niger*	Sable antelope	Vulnerable (2016)
Bovidae	*Kobus ellipsiprymnus ellipsiprymnus*	Waterbuck	Least Concern (2016)
Bovidae	*Oreotragus oreotragus*	Klipspringer	Least Concern (2016)
Bovidae	*Oryx gazella*	Gemsbok	Least Concern (2016)
Bovidae	*Redunca fulvorufula*	Mountain Reedbuck	Least Concern (2016)
Bovidae	*Sylvicapra grimmia*	Grey duiker	Least Concern (2016)
Bovidae	*Syncerus caffer*	African Buffalo	Least Concern (2016)
Bovidae	*Taurotragus oryx*	Common Eland	Least Concern (2016)
Bovidae	*Tragelaphus angasii*	Nyala	Least Concern (2016)
Bovidae	*Tragelaphus scriptus*	Bushbuck	Least Concern (2016)
Bovidae	*Tragelaphus strepsiceros*	Greater Kudu	Least Concern (2016)
Canidae	*Canis mesomelas*	Black-backed Jackal	Least Concern (2016)
Cercopithecidae	*Chlorocebus pygerythrus*	Vervet Monkey	Least Concern (2016)
Cercopithecidae	*Papio ursinus*	Chacma Baboon	Least Concern (2016)
Emballonuridae	*Taphozous (Taphozous) mauritianus*	Mauritian Tomb Bat	Least Concern (2016)
Equidae	*Equus quagga*	Plains Zebra	Least Concern (2016)
Felidae	*Caracal caracal*	Caracal	Least Concern (2016)
Felidae	*Leptailurus serval*	Serval	Near Threatened (2016)
Felidae	*Panthera pardus*	Leopard	Vulnerable (2016)
Giraffidae	*Giraffa camelopardalis camelopardalis*	Giraffe	Least Concern (2016)
Herpestidae	*Atilax paludinosus*	Marsh Mongoose	Least Concern (2016)
Herpestidae	*Herpestes sanguineus*	Slender Mongoose	Least Concern (2016)
Hyaenidae	*Hyaena brunnea*	Brown Hyena	Least Concern (2016)
Hystricidae	*Hystrix africaeaustralis*	Cape Porcupine	Least Concern (2016)
Leporidae	*Lepus saxatilis*	Scrub Hare	Least Concern (2016)
Leporidae	*Pronolagus randensis*	Jameson's Red Rock Hare	Least Concern (2016)
Macroscelididae	*Elephantulus myurus*	Eastern Rock Elephant Shrew	Least Concern (2016)
Muridae	*Aethomys ineptus*	Tete Veld Aethomys	Least Concern (2016)
Muridae	*Aethomys namaquensis*	Namaqua Rock Mouse	Least Concern (2016)
Muridae	*Lemniscomys rosalia*	Single-Striped Lemniscomys	Least Concern (2016)
Muridae	*Mastomys sp.*	Multimammate Mice	Least Concern (2016)
Muridae	*Rhabdomys pumilio*	Xeric Four-striped Grass Rat	Least Concern (2016)
Mustelidae	*Mellivora capensis*	Honey Badger	Least Concern (2016)

Family	Scientific name	Common name	Red list
Orycteropodidae	*Orycteropus afer*	Aardvark	Least Concern (2016)
Procaviidae	*Procavia capensis*	Cape Rock Hyrax	Least Concern (2016)
Sciuridae	*Paraxerus cepapi*	Tree squirrel	Least Concern (2016)
Suidae	*Phacochoerus africanus*	Common Warthog	Least Concern (2016)
Vespertilionidae	*Scotophilus dinganii*	Yellow-bellied House Bat	Least Concern (2016)

APPENDIX E HERPETOFAUNA LIST FOR QDS

Reptiles

Family	Scientific name	Common name	Red list
Agamidae	*Acanthocercus atricollis*	Southern Tree Agama	Least Concern (SARCA 2014)
Agamidae	*Agama atra*	Southern Rock Agama	Least Concern (SARCA 2014)
Chamaeleonidae	*Chamaeleo dilepis*	Common Flap-neck Chameleon	Least Concern (SARCA 2014)
Colubridae	*Crotaphopeltis hotamboeia*	Red-lipped Snake	Least Concern (SARCA 2014)
Colubridae	*Philothamnus natalensis occidentalis*	Western Natal Green Snake	Least Concern (SARCA 2014)
Colubridae	*Telescopus semiannulatus semiannulatus*	Eastern Tiger Snake	Least Concern (SARCA 2014)
Cordylidae	*Cordylus vittifer*	Common Girdled Lizard	Least Concern (SARCA 2014)
Gekkonidae	*Lygodactylus capensis capensis*	Common Dwarf Gecko	Least Concern (SARCA 2014)
Gekkonidae	*Pachydactylus affinis*	Transvaal Gecko	Least Concern (SARCA 2014)
Gerrhosauridae	*Gerrhosaurus flavigularis*	Yellow-throated Plated Lizard	Least Concern (SARCA 2014)
Lamprophiidae	*Lycodonomorphus rufulus*	Brown Water Snake	Least Concern (SARCA 2014)
Lamprophiidae	*Psammophis brevirostris*	Short-snouted Grass Snake	Least Concern (SARCA 2014)
Scincidae	*Mochlus sundevallii*	Sundevall's Writhing Skink	Least Concern (SARCA 2014)
Scincidae	*Panaspis wahlbergi*	Wahlberg's Snake-eyed Skink	Least Concern (SARCA 2014)
Scincidae	*Trachylepis capensis*	Cape Skink	Least Concern (SARCA 2014)
Scincidae	*Trachylepis punctatissima*	Speckled Rock Skink	Least Concern (SARCA 2014)
Scincidae	*Trachylepis varia sensu lato*	Common Variable Skink Complex	Least Concern (SARCA 2014)
Testudinidae	*Kinixys lobatsiana*	Lobatse Hinged Tortoise	Least Concern (SARCA 2014)

Amphibians

Family	Scientific name	Common name	Red list
Bufonidae	*Poyntonophrynus fenoulheti*	Northern Pygmy Toad	Least Concern
Bufonidae	*Schismaderma carens*	Red Toad	Least Concern
Bufonidae	*Sclerophrys capensis*	Raucous Toad	Least Concern
Bufonidae	*Sclerophrys gutturalis*	Guttural Toad	Least Concern
Bufonidae	*Sclerophrys poweri*	Power's Toad	Least Concern
Hyperoliidae	*Kassina senegalensis*	Bubbling Kassina	Least Concern
Phrynobatrachidae	*Phrynobatrachus natalensis*	Snoring Puddle Frog	Least Concern
Pipidae	*Xenopus laevis*	Common Platanna	Least Concern
Pyxicephalidae	*Amietia delalandii*	Delalande's River Frog	Least Concern
Pyxicephalidae	*Amietia poyntoni*	Poynton's River Frog	Not evaluated
Pyxicephalidae	*Cacosternum boettgeri*	Common Caco	Least Concern
Pyxicephalidae	*Tomopterna cryptotis*	Tremelo Sand Frog	Least Concern
Pyxicephalidae	*Tomopterna natalensis*	Natal Sand Frog	Least Concern

APPENDIX F PES SCORES OF THE WETLANDS ON SITE

Criteria and Attributes	Relevance	Sandspruit & tributary
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	1
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	2
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.	1
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	2
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	3
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or changes wetland habitat directly in inundation patterns.	2
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	3
Indigenous Vegetation Removal	Transformation of habitat for farming, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and in increases potential for erosion.	2
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	2
Alien Fauna	Presence of alien fauna affecting faunal community structure	2
Over utilisation of Biota	Overgrazing, overfishing, etc.	2
Total		22
Mean		2
Category		**Class D**
Ecological Management Class		**Largely Modified**

Scoring guidelines per attribute: natural, unmodified = 5; Largely natural = 4, Moderately modified = 3; largely modified = 2; seriously modified = 1; Critically modified = 0.

APPENDIX G PES SCORES OF THE WETLANDS ON SITE

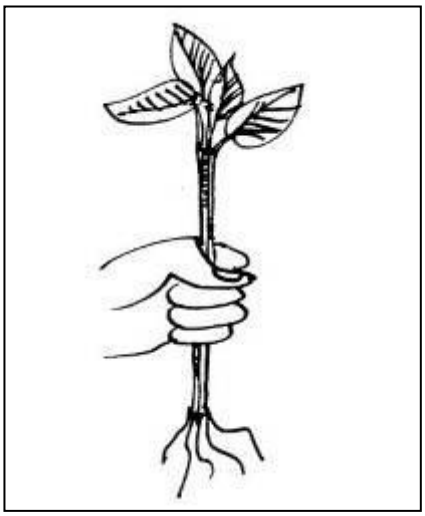
Determinant	
PRIMARY DETERMINANTS	
1. Rare & Endangered Species	0
2. Populations of Unique Species	0
3. Species/taxon Richness	1
4. Diversity of Habitat Types or Features	1
5. Migration route/breeding and feeding site for wetland species	1
6. Sensitivity to Changes in the Natural Hydrological Regime	1
7. Sensitivity to Water Quality Changes	1
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	3
MODIFYING DETERMINANTS	
9. Protected Status	0
10. Ecological Integrity	1
TOTAL*	9
MEDIAN	0.9
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**Low**

APPENDIX H. CONTROL METHODS

The diiferent control methods are discussed in the following section of this management plan as stipulated by the Nature Conservation Corporation (2008):

1. **Mechanical Methods**
    a. **Hand pulling**

- Hand pulling is most effective where plants are small (30cm), immature or shallow rooted; and
- Use the following method:
    - Use a pair of gloves and grip the plant firmly around the stem just above the root (see figure below)



- Pull hard and remove the plant, roots & all;
- Kicking around the root area of the plant may assist in loosening root system, making it easier to pull out;
- Shake the excess sandy material from the plant, this makes the plant easier to stockpile and lighter to transport;
- Stack removed material into piles or spread out evenly if it is not going to be a fire hazard, or
- Stack the seedlings on brush piles or rows along contour lines, to facilitate easy follow-up.

b. Chopping/ cutting/ slashing

- This method is most effective for plants in the immature stage, or for plants that have relatively woody stems/ trunks;
- This is an effective method for non-resprouters or in the case of resprouters (coppicing), if done in conjunction with chemical treatment of the cut stumps;
- Use implements such as pangas (slashers), handsaws, bow-saws, chainsaws, brush cutters and axes. Remember to wear protective clothing;
- Use the following method:
  - Cut/slash the stem of the plant as near as possible to ground level;
  - Paint resprouting plants (i.e. black wattle, lantana and port jackson) with an

appropriate herbicide immediately after they have been cut; and

- Stockpile removed material into piles of 2m high, 3m wide windrows/stacks.

c. Grubbing/ hoeing/ digging out/ tree poppers

- Grubbing, hoeing, or digging involves the use of a hoe, stick, tree popper or spade;
- The entire plant and root must be removed;
- Use the following method:
  - Dig around the plant making sure the sand is loosened around the root system;
  - Dig down, under the roots, applying pressure, and wrench the entire plant out;
  - Kicking the plant may help to dislodge it, however, care should be taken if the plant is seeding, as dry seeds may be dislodged; and
  - Stockpile removed material into piles of 2m high, 3m wide windrows/stacks.

d. Basal bark

- Application of suitable herbicide in diesel can be carried out to the bottom 250mm of the stem. Applications should be by means of a low pressure, coarse droplet spray from a narrow angle solid cone nozzle or by using a paintbrush. If multi stemmed, then each stem needs to be treated.

e. Ring barking

- Remove the bark and cambium around the trunk of the tree for a continuous band around the tree at least 25cm wide, starting as low as possible;
- Where clean de-barking is not possible due to crevices in the stem or where exposed roots are present, a combination of bark removal and basal stem treatments should be carried out; and
- For better control of aggressively coppicing species pull off the bark below the cut to ground level (bark stripping), to avoid the use of herbicide.

Note: that since this method means that the tree is left standing, it is only recommended for single trees, not for stands. Slashers or axes should be used for debarking.

f. Frill

- Using an axe or bush knife, make a series of overlapping cuts around the trunk of the tree, through the bark into the softwood (approximately 500mm from ground level). The thickness of the blade should force the bark open slightly, ensuring access to the cambium layer;
- Ensure to affect the cuts around the entire stem; and
- Immediately apply the registered herbicide to the cuts by spraying into the frill'. The frill' needs to be deep enough to retain the herbicide.

g. Bark stripping

- Where bark stripping is used, then all the bark shall be stripped from the trunk between the ground level and 1 meter above ground level;
- Application of suitable herbicide can also be used with this method; and
- Applications should be by means of a low pressure, coarse droplet spray from a narrow angle solid cone nozzle or by using a paintbrush.

2. Chemical control

a. Injection

- Drill or punch downward slanting holes into the tree around the entire circumference of the stem; and
- Inject the chemical directly into the plant.

b. Foliar spray

- This method is not recommended, but may be used under certain circumstances. Best results are obtained if the solution is sprayed on a large leaf area on an actively growing plant;
- Use a solid cone nozzle that ensures an even coverage on all leaves and stems to the point of run off;
- Do not spray just before rain (a rainfall-free period of 6 hours is recommended) or before dew falls;

- Avoid spraying in windy weather as the spray may encounter non target plants; and
- Spraying dormant or drought stressed plants is not effective as they do not absorb enough of the herbicide.

c. Cut stump application

- This is a highly effective and appropriate control method for larger woody vegetation that has already been cut off close to the ground;
- The appropriate herbicide should be applied to the stump using a paintbrush within 30 min of being cut;
- Stems should be cut as low as practical as stipulated on the label. Herbicides are applied in diesel or water as recommended for the herbicide; and
- Applications in diesel should be to the whole stump and exposed roots and in water to the cut area as recommended on the label.

d. Stacking

- Stacking the cut material in heaps, or in windrows along mountain contours to reduce erosion, facilitates easy access for follow up;
- It also assists in containing the resulting fuel load and therefore the risk of uncontrolled fire;
- Keep stacks well apart to prevent fires from crossing easily, not less that fire meters apart, this is naturally dependant on the size of the stack & the resulting fire intensity when they burn;
- Stockpile removed material into piles of 2m high, 3m wide windrows/stacks;
- Stack light branches separately from heavy timber (75mm and more). Preferably remove heavy branches to reduce long burning fuel loads that can result in soil damage from intensely hot fire; and.
- Do not make stacks under trees, power and telephone lines, within 30 meters of a fire belt or near watercourses, houses and other infrastructure.

e. Safety

- Always wear the appropriate safety clothing when working with herbicides;

- Mix all herbicides on a drip groundsheet when working in the veld. Keep away from watercourses; and

- Do not rinse herbicide equipment in veld. ALWAYS READ THE HERBICIDE LABEL and observe instructions for safe use of herbicide.

3. Biological Control

a. What is biological control?

Biological control is an attempt to introduce the plant's natural enemies to its new habitat, with the assumption that these natural enemies will remove the plant's competitive adv antage until its vigour is reduced to a level comparable to that of the natural vegetation. Natural enemies that are used for biological control are called bio control agents. In the control of invasive plant s, the bio control agents used most frequently are insects, mites and pathogens (disease-causing organisms such as fungi). Bio control agents target specific plant organs, such as the vegetative parts of the plant (its leaves, stems or roots) or the reproductive parts (flowers, fruits or seeds).

The choice of bio control agents depends on the aim of the control project. If the aim is to get rid of the invasive plant species, scientists select the types of bio control agents causing the most damage that are available. In such projects, scientists may use agents that affect the vegetative parts of the plant as well as agents that reduce seed production. However, if the target plant is useful in certain situations but becomes a pest when uncontrolled, conflict of interests arises regarding biological control. This conflict is usually resolved by avoiding bio control agents that have the ability of causing damage to the useful part of the plant, and instead using only seed-reducing agents. These reduce the reproductive potential of the plants, curb their dispersal and reduce the follow-up work needed after clearing, while still allowing for the continued utilisation of the plant. For instance, trees are normally grown for their wood, but the seeds are seldom utilised. If seeds are needed to replant a plantation, a seed orchard can be specially protected against the bio control agents in the same way as other crops are protected against insect pests. If, on the other hand, the pods are the most valuable part of the tree, as in the case of mesquite (Prosopis spp.), no bio control agents can be selected that will prevent pod production. The seed-feeding beetles that were introduced against mesquite prevent only the germination of seeds from the animal droppings, without significantly reducing the nutritional value of the pods. They do not prevent pod or seed production. Bio control agents are mostly introduced from the country of origin of the plant.

b. How effective is biological control?

Probably without exception, bio control agents do not completely exterminate populations of their host plants. At best, they can be expected to reduce the weed density to an acceptable level or to reduce the vigour and/or reproductive potential of individual plants. The fact that a few host plants always survive, despite the attack by a bio control agent, ensures that the agent does not die out because of a lack of food. The small population of bio control agents that persists will disperse onto any regrowth or newly-emerged seedlings of the weed. For this reason, bio control can be regarded as a sustainable control method. Biological control works relatively slowly. On average, at least five years should be allowed for a bio control agent to establish itself successfully before causing significant damage to its host plant.

Unfortunately, not all growth of invasive plant species can be curbed purely by biological control. It could occur that effective bio control agents do exist, but cannot be released in South Africa because they are not sufficiently host-specific. Alternatively, the invasive plant might be a man-made hybrid between two or more species, and is no longer an acceptable host to the natural enemies of either of the parent plants. It could also happen that the natural enemies of some plants are not adapted to all the climatic regions in which the plant is a problem in South Africa, or that the habitat already contains predators or parasitoids that attack the bio control agents. In such cases, biological control will have to be replaced or supplemented by chemical or other control measures.

c. Advantages of biological control

Bio control is:

- Environmentally friendly because it causes no pollution and affects only the target (invasive) plant;
- Self-perpetuating or self-sustaining and therefore permanent; and
- Cost-effective.

Does not disturb the soil or create large empty areas where other invaders could establish, because it does not kill all the target plants at once. Instead, it allows the natural vegetation of the area to recover gradually in the shelter of the dying weeds.