AN ECOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED DOORNHOEK FLUORSPAR MINE, ZEERUST AREA, NORTH WEST PROVINCE

An EOH Company

Prepared for: **SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited**

Prepared by: **Exigo Sustainability**

Email info@exigo3.com
Tel +27 012 751 2160
Fax +27 086 607 2406

The Village Office Park (Block E),
309 Glenwood Road, Faerie Glen,
Pretoria, 0043

Postnet Suite 74,
Private Bag X07,
Arcadia, 0007

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www.exigo3.com

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EIA PHASE REPORT

June 2016

Conducted on behalf of:

SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited
TEL NO: 012 361 6083
FAX NO: 012 348 9458
POSTAL ADDRESS: PO Box 35270, Menlo Park, 0102
PHYSICAL ADDRESS: 54 Impy Road, Lynnwood Glen, Pretoria, 0081

Compiled by:

Dr. BJ Henning (PhD plant Ecology; M.Sc Botany - Soil Science related Pr.Sci.Nat)

REPORT DISTRIBUTION LIST

Name	Institution
Mr. A. Saad	SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited
Ms. C. Uys	Exigo Sustainability
	All registered I & Ap's & stakeholders

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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 take into account, 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.

_____

SIGNATURE OF SPECIALIST

Company: Exigo Sustainability (Pty) Ltd.

Date: June 2016

Notations and terms

Alien vegetation Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome - usually international in origin.

Anthropogenic: of human creation

Alluvium (from the Latin, alluvius, from alluere, "to wash against") is loose, unconsolidated (not cemented together into a solid rock) soil or sediments, which has been eroded, reshaped by water in some form, and redeposited in a non-marine setting. Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel. When this loose alluvial material is deposited or cemented into a lithological unit, or lithified, it would be called an alluvial deposit.

Biome A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate.

Biota: living things; plants, animals, bacteria

Bottomland: the lowlands along streams and rivers, on alluvial (river deposited) soil.

Ecologically sensitive ecosystem: One where relatively even minor disturbances may result in substantial and significant changes.

Ecoregion An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".

Ecosystems: Include living (e.g. plants, animals) and non-living (e.g. minerals, soil, water) components, which can be defined in terms of distinguishing characteristics (e.g. a wetland ecosystem, a freshwater ecosystem, a terrestrial ecosystem, a forest ecosystem, etc.).

Endemic or range-restricted species or ecosystem: One whose distribution is confined to a particular and often very limited geographical region.

Environment: Broadly covers our surroundings and the characteristics of those surroundings that influence our health and wellbeing. That is, the environment includes all living organisms (plants, animals and other life), the physical environment (land, water and air), as well as social, economic and cultural conditions. Sometimes we speak of 'the natural environment' and 'the built environment', to differentiate between natural and man-made systems.

Floristic: of flora (plants).

Floodplain: Wetland inundated when a river overtops its banks during flood events resulting in the wetland soils being saturated for extended periods of time.

Habitat: The place or type of site where an organism or population naturally occurs.

Indigenous vegetation Vegetation occurring naturally within a defined area.

Protected species or ecosystem: One that is protected by law from particular activities and land uses.

Seasonally wet soil: soil which is flooded or waterlogged to the soil surface for extended periods (>1 month) during the wet season, but is predominantly dry during the dry season.

Soil horizons: layers of soil that have fairly uniform characteristics and have developed through pedogenic processes; they are bound by air, hard rock or other horizons (i.e. soil material that has different characteristics).

Soil profile: the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991).

Species: A group of plants, animals, micro-organisms or other living organisms that are morphologically similar; that share inheritance from common ancestry; or whose genes are so similar that they can breed together and produce fertile offspring.

Temporarily wet soil: The soil close to the soil surface (i.e. within 50 cm) is wet for periods > 2 weeks during the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.

Terrain unit classes: areas of the land surface with homogenous form and slope. Terrain may be seen as being made up of all or some of the following units: crest (1), scarp (2), midslope (3), footslope (4) and valley bottom (5).

Threatened species or ecosystem: Species/ Ecosystems that are at risk of going extinct in its natural range. It may be 'critically endangered' at extremely high risk, 'endangered' at very high risk, or 'vulnerable' at high risk. Species or ecosystems at low or no risk are not 'threatened', and fall into the 'near threatened' or 'least concern' categories.

Water regime: When and for how long the soil is flooded or saturated.

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1 EXECUTIVE SUMMARY

Following the investigation and ecological interpretation of the vegetation in the study area, some conclusions can be made.

Mining have a huge impact on the environment since most of the natural vegetation and general environment becomes modified. However, in recent times these mining operations have become sensitive towards the environment with specific mitigation and rehabilitation procedures ensuring that the environment will recover to its former state to a certain extent. The main aim of the mining operation is the development of an opencast and underground mine, process plant and associated infrastructure for the Doornhoek Fluorspar Mine. The mining operation will impact on pristine grassland and woodland areas of the site, with only small pockets of degraded land in the larger area.

The mining activities will completely modify the natural vegetation and faunal habitats, especially in the pristine areas. Specific aspects that were addressed in this EIA phase biodiversity specialist report are as follows:

- Detailed descriptions and analysis of the vegetation of the site on a plant community and species level;
- Detailed description of the fauna habitats and potential fauna that could occur on the proposed mining sites;
- Detailed ecological impacts assessment of the proposed mining footprint on the flora and fauna of the area for the construction, operational, decommissioning and closure phases of the mine;
- Input into the selection and evaluation of project alternatives;
- Mitigation measures and action plans to be implemented to reduce the impacts to a minimum and to optimise the mining development;
- Rehabilitation and monitoring programme.

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 mining development.

Six vegetation units were identified for the proposed mining areas (opencast, TSF, processing plant and associated infrastructure). The sensitivity of these vegetation units are indicated in the table below:

Vegetation units	Sensitivity
1. *Loudetia simplex – Urelytrum agrypyroides* rocky grassland	
a. Undulating terrain	Medium – High Sensitivity
b. Flat plateaus	Medium Sensitivity
2. *Loudetia simplex rocky outcrops*	High Sensitivity
3. Mountainous woodland	
a. *Open Strychnos - Acacia caffra* woodland	High Sensitivity
b. Olea – Strychnos – Combretum woodland	High Sensitivity
c. Strychnos – Combretum woodland;	High Sensitivity
d. *Protea caffra woodland*	Medium – High Sensitivity
4. *Acacia karroo – Ziziphus mucronata - Olea europaea* woodland on valleys / plains	Medium Sensitivity
5. Degraded terrain	Low Sensitivity
6. Drainage features	High Sensitivity

If one considers the location of the study area in relation to the greater surrounding area, the site can be considered a moderate sensitivity area with some isolated and unique sensitive features (drainage channels, wetlands, rocky outcrops and pristine grasslands) considering faunal and floral habitats. The mining activity will completely modify the natural vegetation and faunal habitats of the areas of the planned opencast mining operations. The only areas where potential red data flora species could occur was found on the outcrop areas and pristine grasslands, while red data fauna utilize permanent water sources such as the Klein Marico River . The probability that any red data plant species will occur in the remainder of the vegetation units and on the surrounding plains are low due to the state of the vegetation and physical environment of the larger area mostly not being suitable for any of the red data plant species that may be found in the area. Protected tree species such as camel thorn occur scattered through the area and can only be eradicated after obtaining a permit from DAFF.

The site has an ecological sensitivity that varies from low on the old cultivated fields and degraded bushveld areas; moderate on natural woodland areas; and high on the outcrop areas and floodline zones (natural fauna corridors). The ecosystem as an entity can be considered unique to a certain extent. It is recommended that the ecological sensitivity be considered for the Environmental Impact Assessment (EIA) process undertaken by the Environmental Assessment Practitioner (EAP).

A number of ecological potential impacts were identified and assessed. A few of these were assessed as having potentially medium or high significance, including the following:

- Destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular

habitat;

- Impairment of the movement and/or migration of animal species resulting in genetic and/or ecological impacts (habitat fragmentation);
- Increased soil erosion causing habitat degradation;
- Establishment and spread of declared weeds and alien invader plants;
- Habitat degradation as a result of dust;
- Fauna road mortalities;
- Spillages of harmful substances leading to soil and water pollution and ecosystem degradation.

The most important considerations for the project area are as follows:

- The mining activities should take cognisance of the red data or endemic plants in the area, as well as other sensitive habitats such as drainage channels and outcrops. The riparian and wetland areas forming part of floodlines associated with the major water courses in the area have a high sensitivity and no activities can be allowed within these areas without the necessary authorization according to the National Environmental Management Act (NEMA) 107 of 1998 and Section 21 c and i of the National Water Act 36 of 1998.
- Vegetation clearing and topsoil stripping will have the most definite and permanent direct negative impact on the flora and fauna of the area during the construction phase of the mine. The clearance will eradicate all vegetation and displace fauna that will migrate to neighbouring areas;
- The laydown areas of overburden dumps and stockpiles during the operational phase of the mine will have a direct, significant negative impact on the vegetation and fauna habitats, even though most of the vegetation units are in a degraded state and fragmented;
- The indirect impacts such as soil erosion, fauna mortalities, spillages and establishment of alien invasive species are relevant for all mining phases, although with strict implemented of the mitigation measures and action plans for the various components, the impacts can be minimized;
- Considering the cumulative impacts of the mining phases on the fauna and flora of the area, it can be concluded that the current degraded state of the vegetation and fauna habitats caused by the surrounding and on site mining activities, will cause some negative impacts, although the implementation of a rehabilitation and revegetation plan will allow the vegetation to recover over time and the fauna to return to the area;

Monitoring and rehabilitation plans have also been compiled should the proposed application be approved. Provided that all mitigation measures and recommendations in the report are strictly adhered to, the proposed development can be supported.

2 ASSIGNMENT

Exigo Sustainability (Pty) Ltd was appointed by SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited to conduct an EIA phase study on the ecological components (fauna and flora) for the proposed establishment of the Doornhoek Fluorspar Mine. The project involves the development of opencast mining sections, a processing plant as well as associated infrastructure (e.g. access roads, tailings storage facility, overburden dumps etc.).

The proposed activities/infrastructure will be located on portions of the farms 306 JP, Knoflookfontein 310 JP and Rhenosterfontein 304 JP. The farms are currently zoned as agriculture. The project area is located in the Zeerust area, Ditsobotla Local Municipality, Ngaka Modiri Molema District Municipality, Northwest Province (see figure 1).

This report will include detailed impact assessment of the proposed development on the biodiversity of the site. This assessment is essential as it will contribute to meeting the requirements of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998).

The assignment is interpreted as follows: Compile an ecological study on the flora (vegetation units), fauna and general ecology of the site and determine the potential impacts of the proposed development on the fauna and flora of the area as well as proposed mitigation measures. The study will be done according to guidelines and criteria set by the North West Department of Agriculture, Conservation, Environment & Rural Development (DACERD) for biodiversity studies. In order to compile this, the following had to be done:

2.1 INFORMATION SOURCES

1. All relevant topographical maps, aerial photographs and information (previous studies and environmental databases) related to the ecological components in the study area;
2. Requirements regarding the fauna and flora survey as requested by the NWDACERD;
3. Legislation pertaining to the fauna and flora study as relevant;
4. Red data species list from the South African National Biodiversity Institute (SANBI).

2.2 REGULATIONS GOVERNING THIS REPORT

2.2.1 National Environmental Management Act, 1998 (Act No. 107 of 1998) - Regulation No. R982

This report was prepared in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Gazette No. 38282 Government Notice R. 982. Appendix 6 – Specialist reports includes a list of requirements to be included in a specialist report:

1. A specialist report or a report prepared in terms of these regulations must contain:
    a. Details of

i. The specialist who prepared the report; and

ii. The expertise of that specialist to compile a specialist report, including a curriculum vitae;

b. A declaration that the specialist is independent in a form as may be specified by the competent authority;

c. An indication of the scope of, and purpose for which, the report was prepared;

d. The date and season of the site investigation and the relevance of the season to the outcome of the assessment;

e. A description of the methodology adopted in preparing the report or carrying out the specialized process;

f. The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;

g. An identification of any areas to be avoided, including buffers;

h. A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;

i. A description of any assumptions made and any uncertainties or gaps in knowledge;

j. A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;

k. any mitigation measures for inclusion in the EMPr;

l. any conditions for inclusion in the environmental authorisation;

m. any monitoring requirements for inclusion in the EMPr or environmental authorisation

n. a reasoned opinion –

i. As to whether the proposed activity or portions thereof should be authorised and

ii. If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr and where applicable, the closure plan;

o. A description of any consultation process that was undertaken during the course of preparing the specialist report;

p. A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and

q. Any other information requested by the competent authority.

2.2.2 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.

2.2.3 Conservation of Agricultural Resources Act (Act No. 43 of 1983)

This Act regulates 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.

2.2.4 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 report. It:

- Lists ecosystems and species that are threatened or in need of national protection;
- Links to Integrated Environmental Management processes;

2.2.5 The National Forest Act (Act 84 of 1998)

The National Forest Act:

- Promotes the sustainable management and development of forests for the benefit of all;
- Creates the conditions necessary to restructure forestry in State Forests;
- Provide special measures for the protection of certain forests and protected trees;
- Promotes the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes.
- Promotes community forestry.

2.2.6 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 Bill;

To implement the provisions of the Bill; and to provide for matters connected therewith.

2.3 TERMS OF REFERENCE

2.3.1 The Doornhoek Project: Background information

The Doornhoek Project has the potential to contain in excess of 50 million tonnes of fluorspar and is believed to be one of the world's largest fluorspar deposits. The underground ore body has grades more than double that of the adjoining Sallies Witkop Mine and resources sufficient to justify an initial life of mine in excess of 20 years.

The Doornhoek Project is currently in exploration phase and based on a request from the Department of Mineral Resources to quantify the groundwater use and potential exploration impacts on the groundwater resources.

The planned infra-structure for the mining operations is as follows:

- Opencast mining to depths of 90m;
- Overburden dumps;
- Minerals processing plant;
- Tailings facility;
- Haul roads and offices;
- Water supply pipelines;
- Electrical reticulation and sub-stations.

2.3.2 Objectives

1. The primary aim of this project is to investigate options for enhancing and / or maintaining biodiversity to mitigate the impact of the proposed development and related infrastructure 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 floral diversity 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 flora and fauna and their habitats during the construction and operational phases of the developments and;
    d. Rehabilitation to establish plant communities / landscaping that will provide future habitat values.
2. To produce a clear and agreed species and habitat priorities for conservation actions. This includes the following:
    i. Determine the potential ecological impacts and actions the developments will have on the biodiversity on a species and habitat level;
    ii. Conduct a risk analyses of the impacts identified to determine the significance of the impacts on the fauna and flora of the study area;
    iii. Protection and enhancement of vegetation / habitats of high conservation value;
    iv. The retention of a substantial amount of native vegetation / habitat of adequate size and configuration to promote the conservation of the existing flora communities;
    v. The retention and / or creation of vegetation links, wildlife corridors and vegetation buffers wherever possible, subject to the appropriate bush fire risk management; and
    vi. The protection of water quality in the locality so as not to threaten native aquatic flora that rely on the watercourse for survival.
3. Provide recommendations on the ecological mitigation measures to be implemented by the developer and the way forward.

2.3.3 Scope

1. Detailed flora survey – in each vegetation type/plant community on site:
    a. After studying the aerial photograph identify specific areas to be surveyed and confirm location by making use of a Geographical Positioning System (GPS).
    b. Conduct a site visit and list the plant species (trees, shrubs, grasses, succulents and other herbaceous species of special interest) present for plant community and ecosystem delimitation.
    c. Identify potential red data plant species, possible encroacher species, medicinal plants of value and exotic plant species.
    d. Indicate suitable plant species that can be used for the landscaping around the proposed developments.

2. Plant community delimitation and description
    a. Process data (vegetation and habitat classification) to determine vegetation types on an ecological basis.
    b. Describe the habitat and vegetation.

3. Fauna scoping
    a. List the potential fauna (mammal species, red data birds, reptiles, amphibians, invertebrates) present linked to the specific potential habitats that occur as identified in the vegetation survey.
    b. Analyse the data and identify potential red data fauna species, as well as other endemic or protected species of importance.
    c. Indicate species mitigation measures and management measures to be implemented to prevent any negative impacts on the fauna of the area.

4. General
    a. Identify and describe ecologically sensitive areas. Create a sensitivity map to indicate specific sensitive areas based on various environmental parameters such as natural vegetation in a good condition, rockiness, slopes, flood lines etc.
    b. Identify problem areas in need of special treatment or management, e.g. bush encroachment, erosion, degraded areas, reclamation areas.
    c. Make recommendations, impact ratings and risk assessments for each specific impact.

2.3.4 Limitations and assumptions

- In order to obtain a comprehensive understanding of the dynamics of the flora and fauna of the study area, surveys should ideally be replicated over several seasons and over a number of years. However, due to project time constraints such long-term studies are not feasible and this floral study was conducted over two seasons;
- The large study area did not allow for the finer level of assessment that can be obtained in smaller study areas. Therefore, data collection in this study relied heavily on data from representative, homogenous sections of vegetation units, as well as general observations, aerial photograph analysis, generic data and a desktop analysis;
- Visibility proved to be a constraint in encroached areas where plant species might have been missed beneath the densely overgrown and obstructed by surface vegetation;

Thus, even though it might be assumed that survey findings are representative of the ecosystem of the project area, it should be stated that the possibility exists that individual plants species might have been missed due to the nature of the terrain (dense vegetation). Therefore, maintaining due cognisance of the integrity and accuracy of the ecological survey, it should be stated that the ecological resources identified during the study do not necessarily represent all the ecological resources present on the property.

3 STUDY AREA

3.1 LOCATION

The Doornhoek Fluorspar Mine is located in the Northwest Province of South Africa, approximately 15 km southeast of the town of Zeerust along the R510 provincial road to Koster and falls within the Ditsobotla Local Municipality, Ngaka Modiri Molema District Municipality (Figure 1). Due to poor international market conditions it will be necessary to gradually phase in the mining activities, and to divide the mining activities into two phases. The first phase will take place on portions of Rhenosterfontein 304 JP, and the second phase will take place on portions of the Farm 306 JP. The mine surface infrastructure is proposed to be located on the above farms. Additional mineral resources are also located on surrounding farms within the mining right area. The area is drained to the north by the Klein Marico River and a number of associated tributaries. The aerial image of the project area is included in figure 2, while the detailed layout map alternatives for the plant and TSF are indicated in Figure 4 to 7.

Physical mining will only begin in year 5 after mining license has been granted. Road and plant construction will take place in the years before this. Ore will be mined from year 5-10 from area shown in Figure 4 below, estimated to contain approximately 3.2Mt of ore. Year 10-15, 15-20 and 20-30 mining will take place on the farm 306JP owned by the company (Figure 3).

Labour will be sourced from the local community as far as possible, and is planned to be accommodated in the town of Zeerust.

Envisaged infrastructure will comprise of the following:

- Opencast mine development;
- Overburden and topsoil stockpiles;
- Concentrator (processing) plant and related infrastructure (a alternatives Figure 4-7);
- Haul, maintenance and access roads;
- Storm water management infrastructure (compliance GN704);
- Buildings (admin, offices, change house, stores, workshops etc);
- Diesel storage tanks;
- Water supply pipelines;
- Electricity supply High tension (HT) power lines;
- Tailings disposal facility; and
- Water reservoirs and settling ponds.

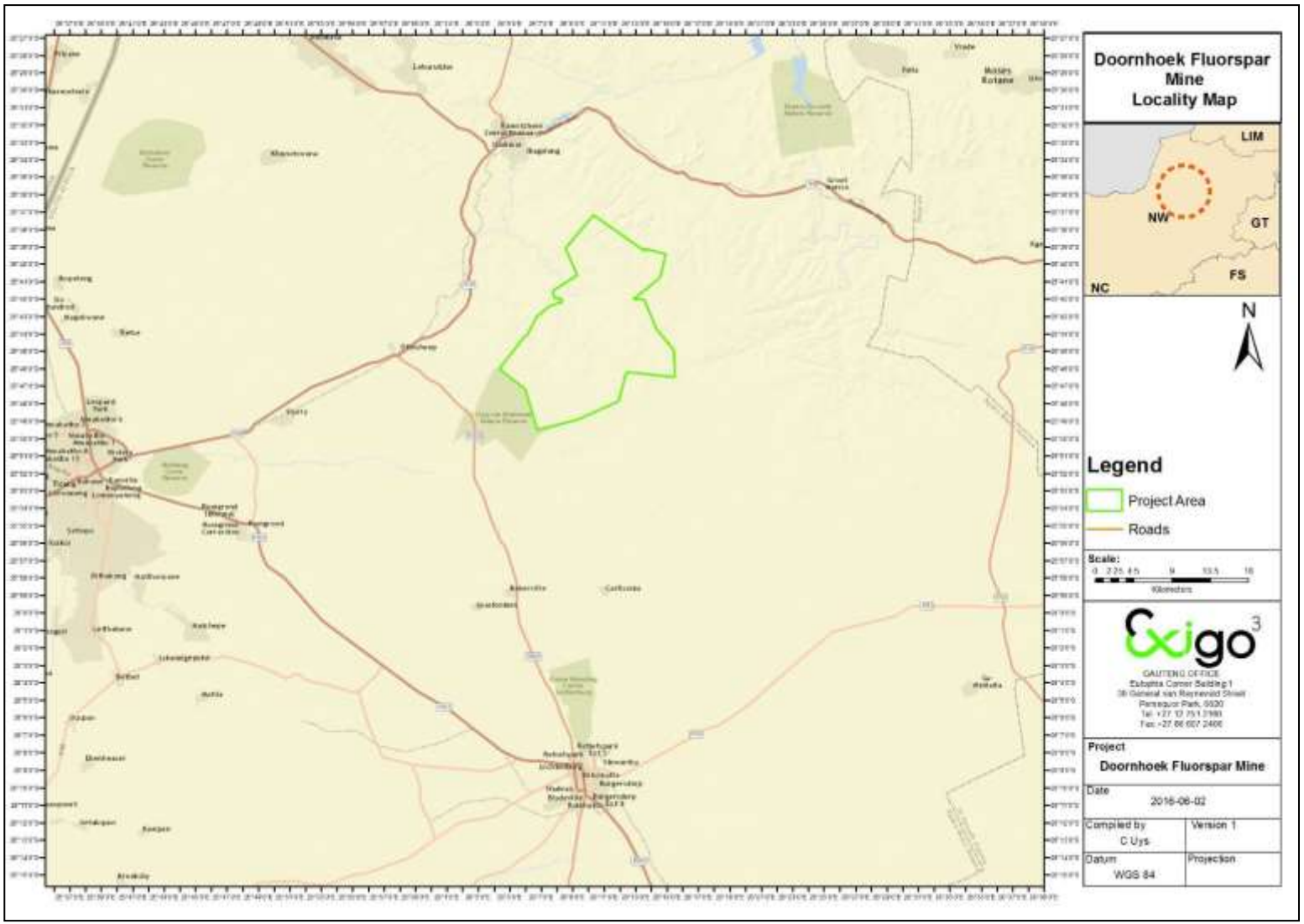

Figure 1. Regional Location Map

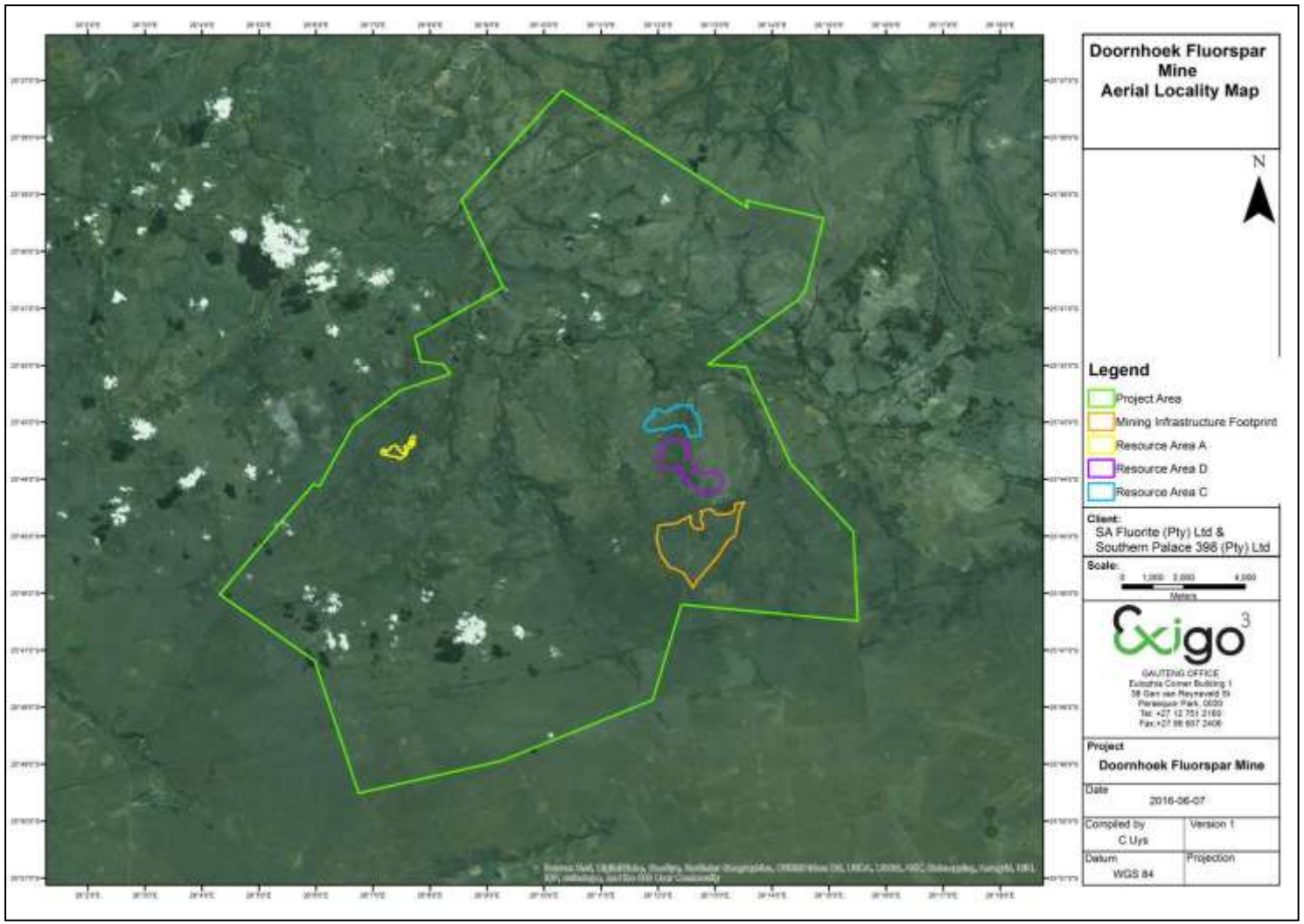

Figure 2. Satelite image showing the project area (Google Pro, 2010)

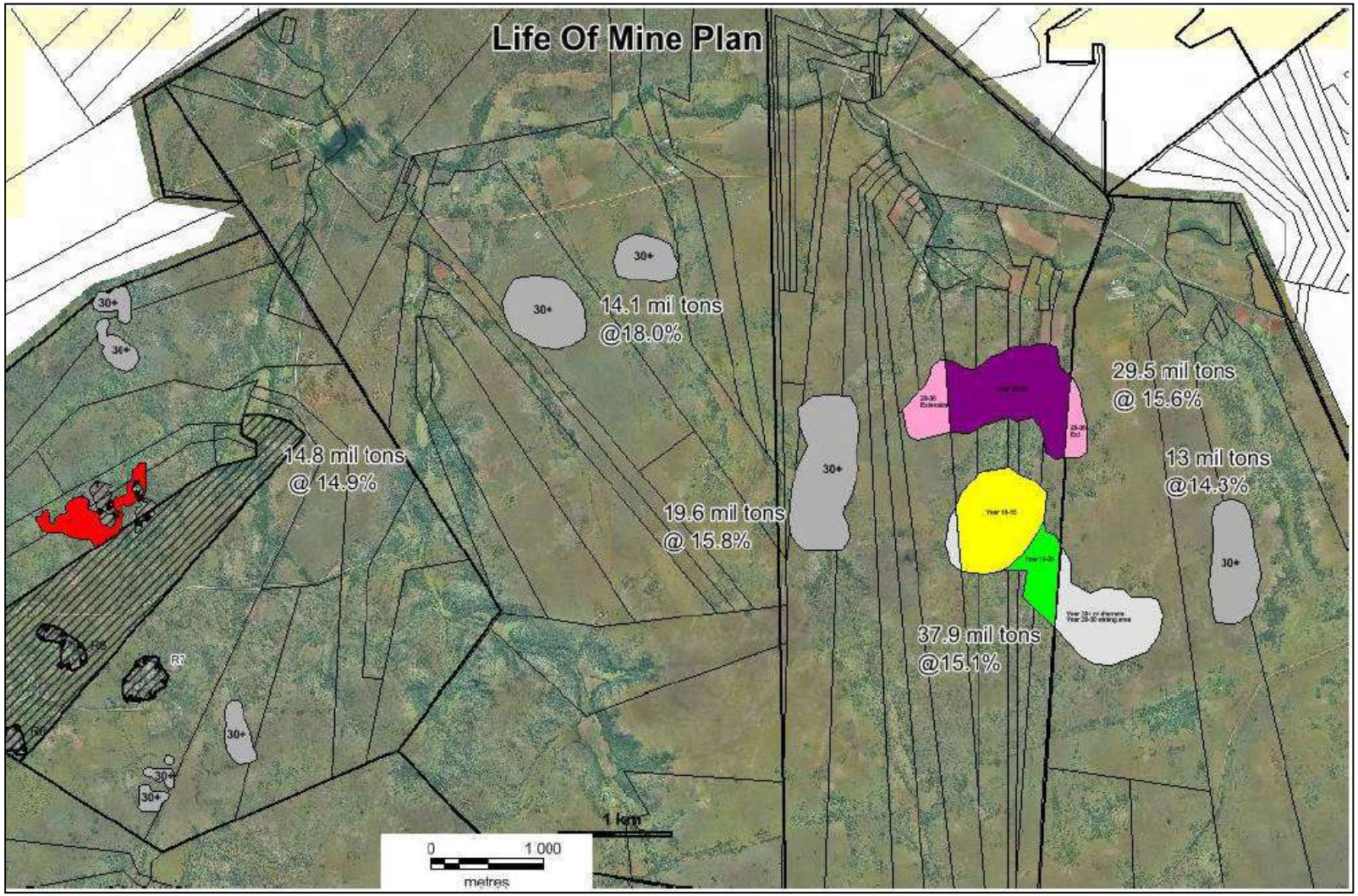

Figure 3. Open Pit Mining Schedule

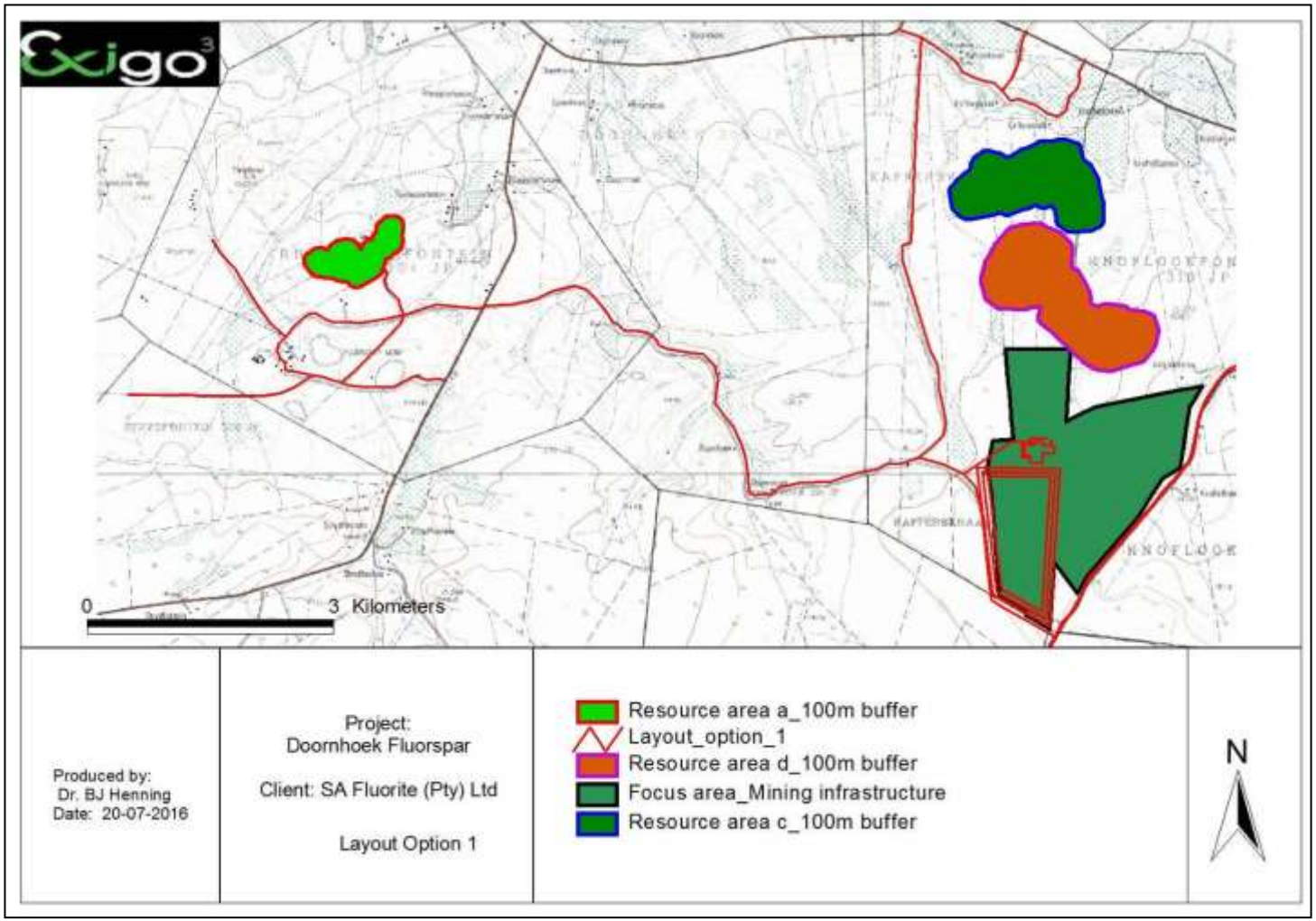

Figure 4.Layout option 1 for the mining infrastructure of the Doornhoek Fluorspar Mine

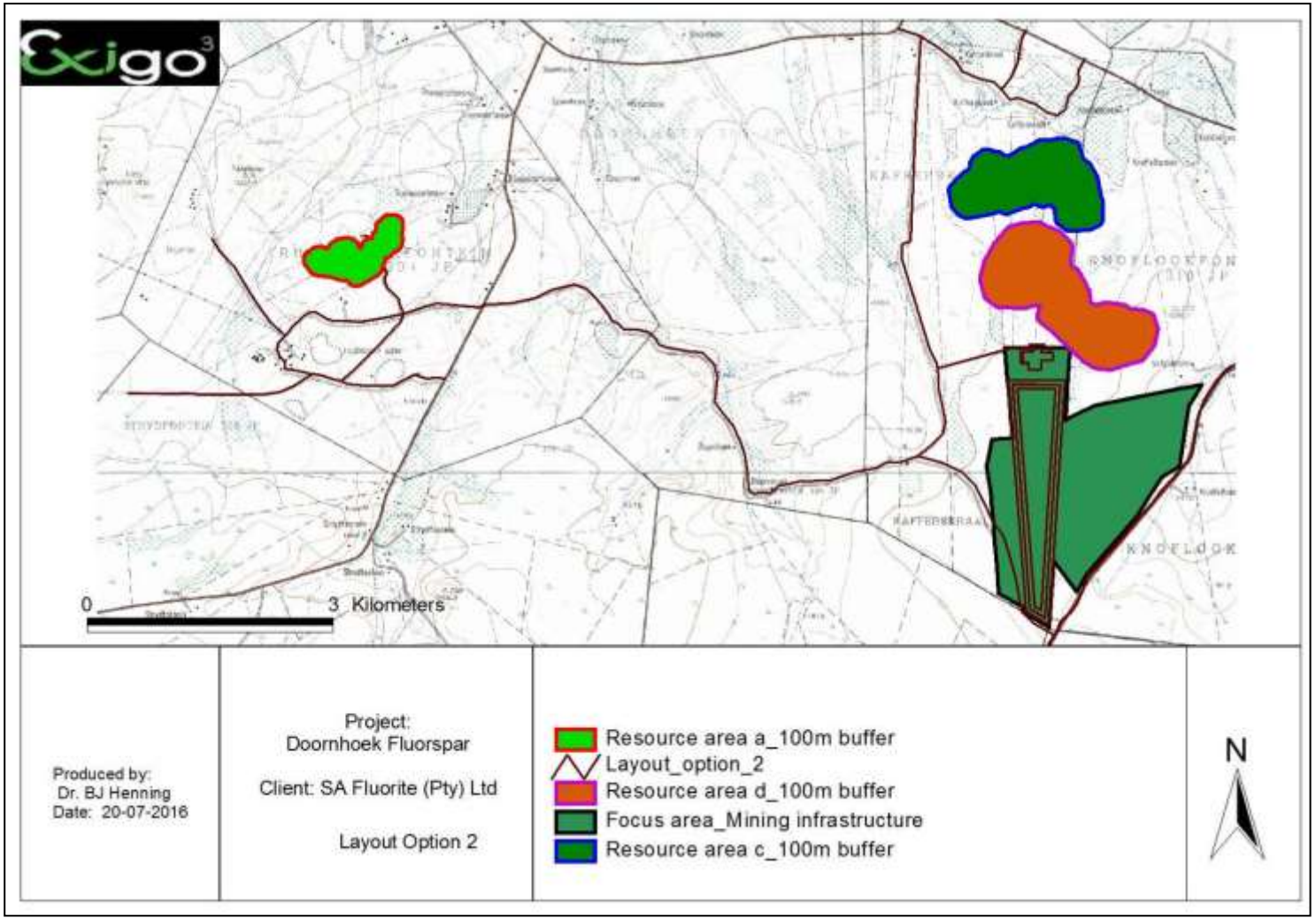

Figure 5. Layout option 2 for the mining infrastructure of the Doornhoek Fluorspar Mine

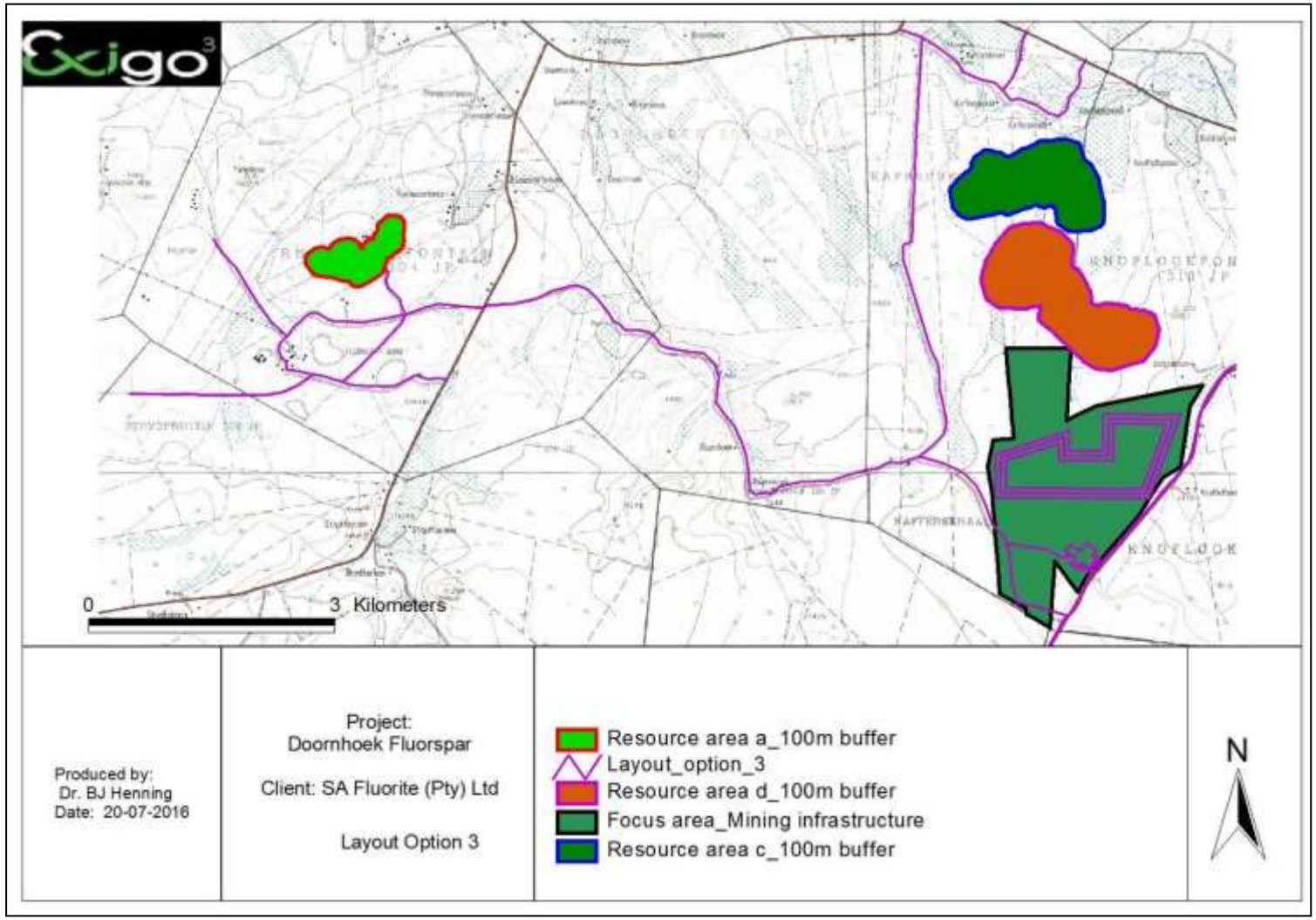

Figure 6. Layout option 3 for the mining infrastructure of the Doornhoek Fluorspar Mine

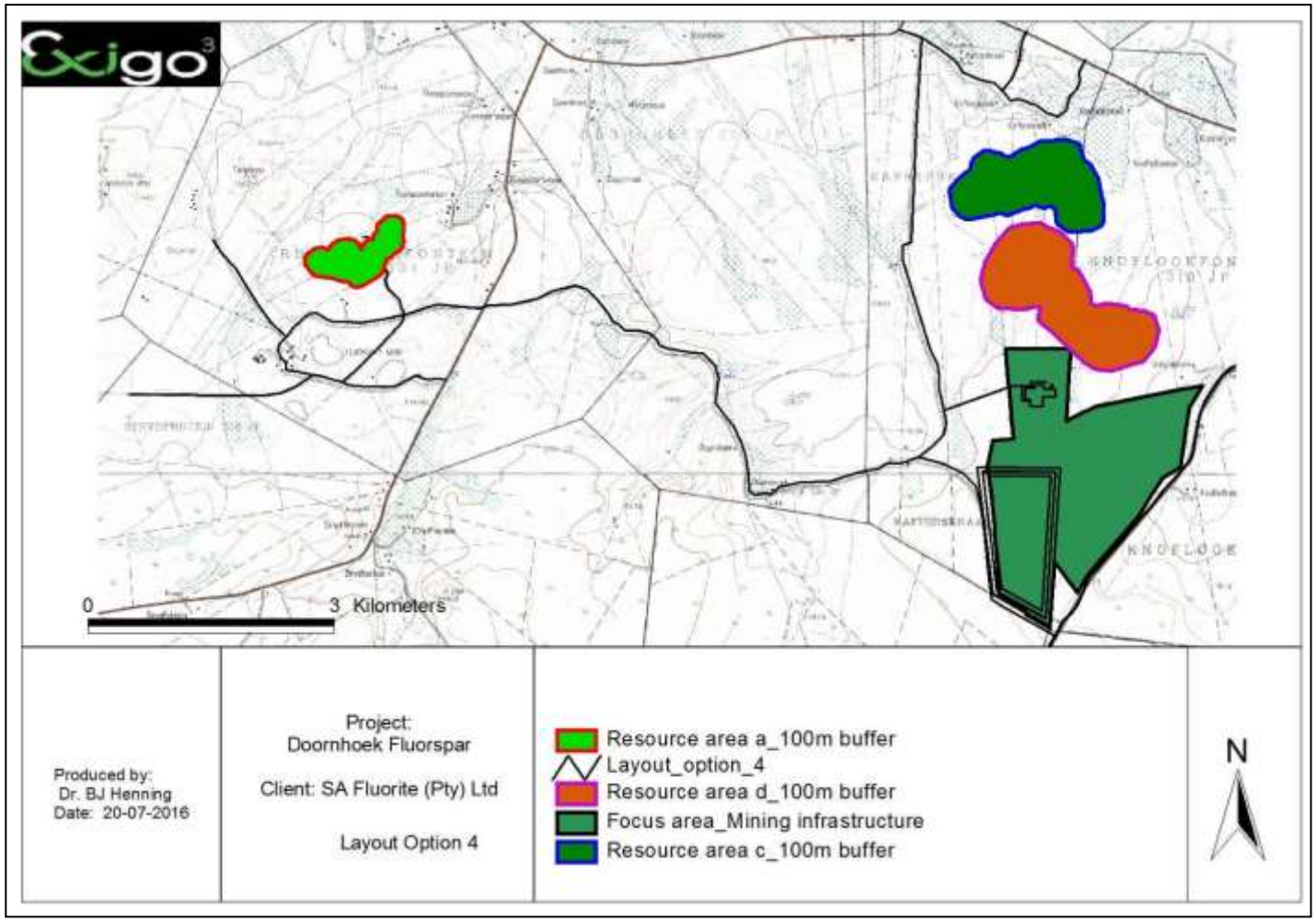

Figure 7. Layout option 4 for the mining infrastructure of the Doornhoek Fluorspar Mine

3.2 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). The climate for the region can be described as warm-temperate.

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).

3.2.1 Rainfall & Temperature

In this report, climate refers to the summation of the daily, weekly and monthly changes of weather over a long period and it is influenced by latitude, altitude, direction and intensity of wind and the presence of large bodies of water such as the ocean, lakes, dams and rivers. The main climatic factors analysed for the site were long-term monthly average rainfall, temperature and relative humidity.

The area known as the Bankeveld, which occur in portions of Zeerust and Marico, can be separated from the Highveld region on the grounds of the differences shown in its climatic statistics. The project site has warm to hot summers and cool and dry to cold winters, with an average annual rainfall of 439mm. According to Groundwater Resource Directed Measures (GRDM) the Mean Annual Precipitation (MAP) is 566mm/a and the Mean Annual Runoff is 8mm/a for the entire catchment. The Mean Annual Evaporation (MAE) is 8mm/a.

The average maximum temperatures for the region have been recorded between November and January, with temperatures reaching a maximum of 31°C. The average minimum temperatures are reached during June and July with a minimum temperature of 1°C.

The rainfall pattern of Marico catchments is highly variable and unevenly distributed within the catchments. The intermittence of the rainfall results in frequent floods and local droughts.

As far as the temperatures are concerned it is noticeable that the daily average maximums are all more than 30.3ºC, while the minimum for Zeerust is below 0˚C. The absolute maximum temperature of Zeerust is in excess of 40.6ºC. The absolute minimums recorded varies between -3,3ºC and -7,8ºC.The days with temperatures below freezing is still in the order of 23 to 32, but days with temperatures of less than -2,5ºC are less than on the Highveld.

As far as precipitation is concerned it is noticeable that the averages are all in excess of 600mm. Zeerust receives on average 57.1 days with thunder and only 1,1 days with hail.

Figure 8 indicates the monthly climatic averages of the project area, while Table 1 indicate the temperature, precipitation and humidity levels for the Zeerust and Mafikeng weather stations :

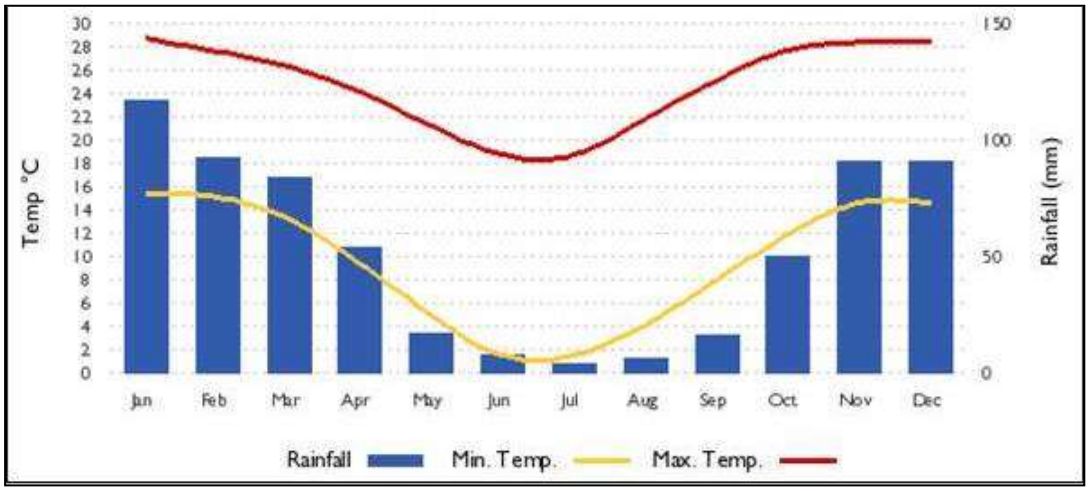

Figure 8. Monthly climatic averages for the project area

Table 1. Temperature, precipitation and humidity levels for the weather stations of the project area (Source: South African Weather Bureau)

STATIONS:	MEAN TEMPERATURES (ºC)		PRECIPITATION (mm)			MEAN RELATIVE HUMIDITY (%)	
	JAN	JUL	MEAN	HIGH	LOW	JAN	JUNE
MAFIKENG	30,4	3,0	553	868	265	65	35
ZEERUST	30,8	-0,8	600	1002	390	69	36

3.2.2 Wind

The long-term weather record indicates that wind speed, experienced in the project area from 0 to more than 10.0 ms-1. The maximum wind speed rarely rises beyond 10 ms-1. Figure 9 indicate the seasonal variations of the wind direction and speed.

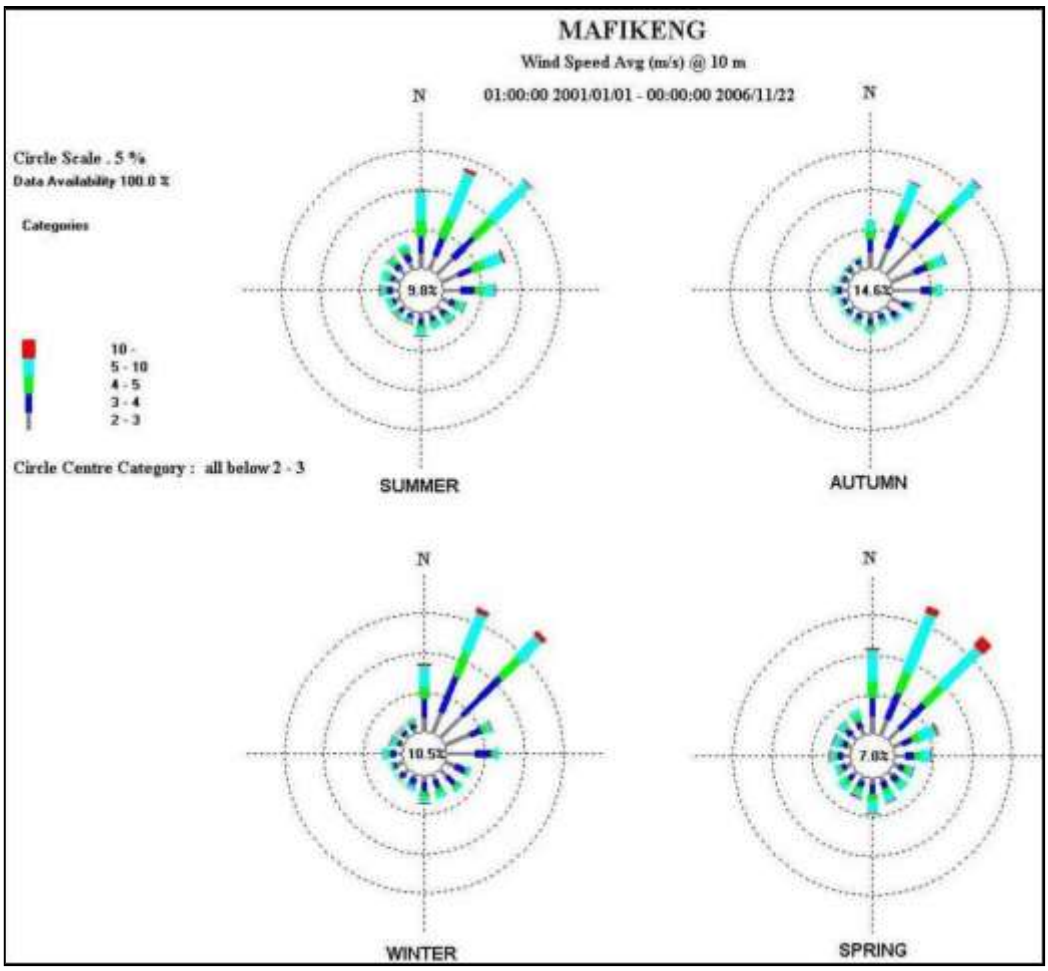

Figure 9. Wind roses for the different seasons of the project area as obtained from the Mafikeng weather station

3.3 GEOLOGY AND SOIL TYPES

Geology is directly related to soil types and plant communities that may occur in a specific area (Van Rooyen & Theron, 1996).

The area is situated close to the western termination of the Bushveld tectonic basin, consisting of the gently dipping sedimentary sequence of the Transvaal Supergroup, intruded by numerous basic sills. The main zone involved is the uppermost subdivision of the Malmani Subgroup or Frisco Formation, a 150 meter thick isolated limestone beds. The Frisco Formation is conformably overlain by banded chert of the Penge Fromation, which was strongly eroded prior to the deposition of the shale, quartzite and iron-formation of the Pretoria Group. The Malmani Subgroup is also known as the Chuniespoort Group. The soils covering the project area can be grouped into different land types. A Landtype 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 landtypes, geology and associated soil types is presented

in Table 2 below as classified by the Environmental Potential Atlas, South Africa (ENPAT, 2000). However, it must be noted that soil types are mostly determined by position on the landscape. A landtype map (figure 11) indicates the location of the landtypes in the area.

Deeper sandy soils are associated with flat topography whilst shallow, rocky soils are associated with the undulating hills and rocky outcrops. Existing agricultural activities are limited to the flat areas of the project area. As a result of the irregular undulating rocky areas, fairly steep rocky slopes, shallow rocky nature of the soils and intensity of rainfall the project area is very susceptible to water erosion, especially on roads and areas denuded of vegetation with a poor herbaceous basal cover.

Table 2. Landtype, soils and geology of the project area

Landtype	Soil	Geology
Ae59	Red-yellow apedal, freely drained soils; red, high base status, > 300 mm deep (no dunes)	Shale, slate, siltstone and hornfels of the Strubenkop, Silverton and Timeball Hill Formations; quartzite of the Timeball Hill and Daspoort Formations; diabase sills present. Rocks possess regional dip of 7 degrees to the north and north-east.
Ac71	Red-yellow apedal, freely drained soils; red and yellow, dystrophic and/or mesotrophic	Shale, slate, siltstone and quartzite of the Rooihoogte and Timeball Hill Formations, with diabase sills in places. Dolomite and chert of the Chuniespoort Group in the south-west.

3.4 TOPOGRAPHY & DRAINAGE

When assessing the ecology of an area, it is important to know in which eco-region it is located. The project area forms part of the Highveld and Western Bankenveld Eco-regions. The project area is located at an altitude of approximately 1 342 metres above mean sea level (m amsl). The topography is relatively flat, dipping at a low angle in a north-westerly direction.

The project area is defined as hills and lowlands in the northern section, while the southern section is classified as escarpment (ENPAT, 2000). The topography of the area is a mixture of terrains, ranging from flat to moderately undulating plains, outcrops, bottomlands (drainage channels) and slightly undulating hills.

The Water Management Areas (WMA) as defined by the Department of Water Affairs within the project area is classified as the Crocodile (West) and Marico water management area. This WMA borders on Botswana to the north-west. Its main rivers, the Crocodile and Marico, give rise to the Limpopo River at their confluence.

The Marico and Crocodile Rivers form the headwaters of the Limpopo at their confluence. The flow in the Marico River is highly variable and intermittent. There are two major storage reservoirs that regulate the

flow in the Marico River, namely the Marico Bosveld Dam in the upper catchment and the Molatedi Dam further down-stream. There are several other dams, such as the Klein Maricopoort and Sehujwane Dams, from which water is mainly used for irrigation along the Marico River, particularly downstream of Marico Bosveld Dam, are present.

A general orientation of the project area in relation to the WMA and subcatchments is given by Figure 10.

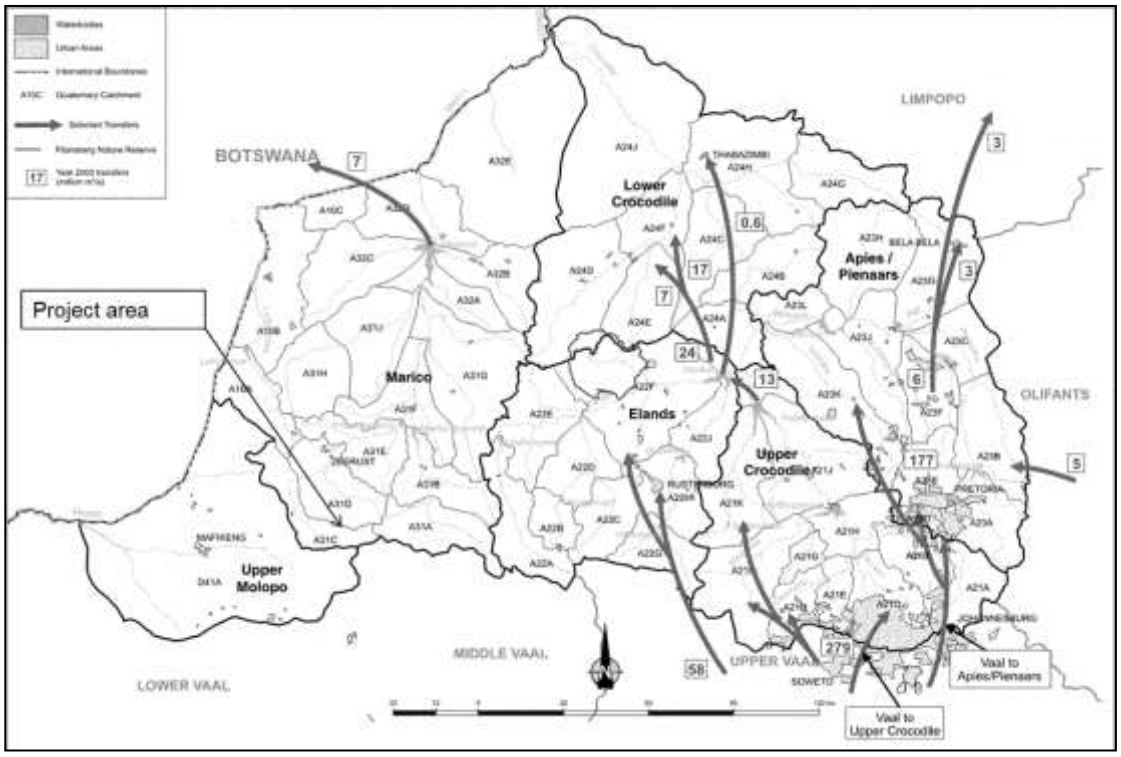

Figure 10. Project area in relation to the Crocodile (West) and Marico WMA

At a basin or sub-basin scale, particularly in semi-arid and arid areas, priority is often placed on monitoring and management of water quantity. Equally important, however, is the monitoring and management of water quality (DWAF 2004). Water quality is often characterised in terms of the concentration of different chemicals in the water (Hatfield 2008). What determines “good” or “bad” water quality depends on the purpose of the assessment - for example, water with naturally elevated concentrations of some metals may be unsafe to drink, but still suitable for industrial uses. Assessment involves comparing measured chemical concentrations with natural, background, or baseline concentrations, and with guidelines established to protect human health or ecological communities.

The Marico sub-management area corresponds to the catchment of the Marico River. Main tributaries of the Marico River include the Klein and Groot Marico rivers. This sub-area forms the western part of the WMA. The town of Zeerust is found in this The Groot Marico River is fed by a number of springs within the

Groot Marico dolomitic aquifer compartment. These dolomitic eyes include the Molemane Eye and the Marico Eye. The upper reaches of this catchment are not densely populated.

The overall EcoStatus for the Klein Marico River study unit is FAIR and comprises the following indices:

- Instream Habitat Integrity is FAIR, this is primarily due to the presence of the Klein-Maricopoort and Kromellenboog dams. Both dams impact on the levels of water in the river and natural sedimentation patterns. Above the Klein-Maricopoort Dam habitat integrity is less impacted. The Riparian Zone Habitat Integrity is GOOD primarily because of the low levels of development in the area. At Oopgenoeg and Nahoek water abstraction has resulted in some wetlands drying up.
- The Riparian Vegetation Integrity is FAIR due to the presence of alien vegetation and the removal of some vegetation for agriculture.
- Fish Assemblage Integrity is POOR, only the most hardy of species are present due to reduced flows and localised poor water quality.
- The Macro-invertebrate Integrity is POOR due to the impact of the dams on water flow but primarily due to the impacts of reduced water quality especially near the town of Zeerust.
- The Water Quality in general is FAIR - flows have intermediate levels of nutrients and there is some evidence of organic pollution.
- Ecological Importance and Sensitivity (EI&S): EI&S is MARGINAL / LOW, overall diversity of habitat types is low. There are however some locally unique areas with noteworthy features such as abundant and often large, Wild Olive trees at Ottoshoop and Molemane Eye Game Reserve. The Molemane dolomitic eye and associated wetland represents a unique, relatively undisturbed wetland ecosystem and is rich in invertebrate species with some unique and isolated fish populations.

The drainage channels provide breeding and foraging habitat for fauna. The state of the major rivers and streams in the quaternary catchments in the project area and surrounding areas is presented in Table 3. Although surface water in the area is not generally used for potable purposes the South African National Standards (SANS) provides a useful benchmark against the more stringent irrigation and the more relaxed livestock watering guidelines.

Table 3. State of major streams / rivers in the project area (DWA)

Name	Class	Quaternary drainage	Ecoregion II	State of river / streams	Category
Klein-Marico	Perennial	A31D	Bushveld basin	Class C: Moderately Modified	Critically endangered
Unknown	Perennial	A31D	Bushveld basin	Class C: Moderately Modified	Critically endangered
Rhenosterfontein	Perennial	A31D	Bushveld basin	Class C: Moderately Modified	Critically endangered
Rhenosterfontein	Perennial	A31D	Highveld	Class C: Moderately Modified	Critically endangered

The project area is located in the Quaternary Catchment Areas A31C and A31D . The storm water collects along roads and footpaths cutting through the area, to drain into the regionally channels indicated above. It must be noted that surface flow along these rivers generally only occurs in the period directly after precipitation events or a wet rainy season, and that these rivers may exhibit a large base-flow component with groundwater flow occurring within the sandy sediments lining its channel.

4 METHODS

4.1 VEGETATION SURVEY

Two basic methods were used during the vegetation survey:

- Line transects were walked on the site surveyed to record the plant species present. Rare and threatened plant species and any botanically sensitive sites or habitats were searched for in the various vegetation units.
- The Braun-Blanquet survey technique to describe plant communities as ecological units was also used for this study. It allows for the mapping of vegetation and the comparison of the data with similar studies in the area.

The vegetation survey was conducted on site during early June 2016. The vegetation was in a moderate to good condition and most species could be identified, although some species might have been missed as a result of the large site. No further surveys were necessary considering that the area received sufficient precipitation during the wet season to allow for the identification of most plants in the study area. Specific differences between the state of vegetation or specific impacts that occurred in the area will be addressed for the different surveying periods.

4.1.1 Data recorded:

Plant names used in this report are in accordance with Arnold & De Wet (1993), with the exception of a few newly revised species. A list of all plant species present, including trees, shrubs, grasses, forbs, geophytes and succulents were compiled. All identifiable plant species were listed. Notes were additionally made of any other features that might have an ecological influence as well as potential fauna habitat that might occur.

4.1.2 Red data species

A species list of the red data species previously recorded in the vicinity of the proposed development was obtained from the South African Biodiversity Institute (SANBI), South Africa as classified by the IUCN red data list categories.

4.1.3 Protected trees

A species list of the protected tree species was obtained from the Department of Forestry. These trees are listed by the NFA (Act 84 of 1998) as protected.

4.1.4 Protected plants

A list of protected and specially protected plants was obtained from the Northwest Nature

Conservation Ordinance and the Threatened or protected species regulations (TOPS) stipulated in NEMBA (ACT NO. 10 OF 2004).

4.1.5 Data processing

A classification of vegetation data was done to identify, describe and map vegetation types. The descriptions of the vegetation units include the tree, shrub and herbaceous layers.

Conservation priority of each vegetation unit was assessed by evaluating the plant species composition in terms of the present knowledge of the vegetation of the Northwest Province, as well as the Dwaalboom Thornveld vegetation type and Savanna Biome of South Africa.

The following four conservation priority categories were used for each vegetation unit:

- High: Ecologically sensitive and valuable land with high species richness that should be conserved and no development allowed.
- Medium: Land that should be conserved but on which low impact development could be considered with the provision of mitigation measures.
- Medium-low: Land that has some conservation value but on which development could be considered with limited impact on the vegetation / ecosystem. It is recommended that certain sections of the vegetation be maintained.
- Low: Land that has little conservation value and that could be considered for developed with little to no impact on the vegetation / ecosystem.

4.2 FAUNA SURVEY

The fauna survey was conducted as follows:

- A site survey was done to identify potential habitats after identifying the vegetation units. Fauna observed on site or any specific indication of species was noted as confirmed in the species lists.
- A scoping survey was then conducted by comparing the habitat types identified with the preferred habitats of species occurring in the area.

The fauna survey was conducted on site during early June 2016.

4.2.1 Data recorded:

A list of all species of fauna and their status as observed on the site or that could potentially occur on the site. Notes were made of any specific sensitive or specialized habitats that occur on the

site.

4.2.2 Red data species lists

A species list of the red data species of the different faunal classes was obtained from the following references:

- Red Data Book of the Mammals of South Africa (Friedman & Daly, 2004)
- The Atlas of the Southern African Birds - digital data on quarter degree grid data (Avian Demography Unit, University of Cape Town)
- Atlas and red data book of the frogs of South Africa, Lesotho and Swaziland (Minter et al. 2004)
- South African Red Data Book – Reptiles and Amphibians. National Scientific Programmes Report no. 151;

4.2.3 Data processing

A comparison of the habitats (vegetation units) occurring on the property was made to the preferred habitats of the faunal species. In addition to species observed on the site, lists of the potential mammal, bird, reptile, amphibian and insect species were compiled and mitigating measures recommended if needed.

4.3 SENSITIVITY ASSESSMENT

The ecological sensitivity of any piece of land is based on its inherent ecosystem service and overall preservation of biodiversity.

4.3.1 Ecological function

The ecological function relates to the degree of ecological connectivity between systems within a landscape matrix. Therefore, systems with a high degree of landscape connectivity amongst one another are perceived to be more sensitive and will be those contributing to ecosystem service (e.g. wetlands) or overall preservation of biodiversity.

4.3.2 Conservation importance

Conservation importance relates to species diversity, endemism (unique species or unique processes) and the high occurrence of threatened and protected species or ecosystems protected by legislation.

4.3.3 Sensitivity scale

- High – sensitive ecosystem with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered being important for the maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems or with high species diversity and usually provide suitable habitat for a number of threatened or rare species. These areas should be protected;
- Medium – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems or ecosystems with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species;
- Low – Degraded and highly disturbed / transformed systems with little ecological function and which are generally very poor in species diversity.

4.4 IMPACT RATING ASSESSMENT

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need.

The significance of the impacts will be determined through a synthesis of the criteria below (Plomp, 2004):

Probability. This describes the likelihood of the impact actually occurring:

- Improbable: The possibility of the impact occurring is very low, due to the circumstances, design or experience.
- Probable: There is a probability that the impact will occur to the extent that provision must be made therefore.
- Highly Probable: It is most likely that the impact will occur at some stage of the development.
- Definite: The impact will take place regardless of any prevention plans, and there can only be relied on mitigation actions or contingency plans to contain the effect.

Duration. The lifetime of the impact

- Short term: The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.

- Medium term: The impact will last up to the end of the phases, where after it will be negated.
- Long term: The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.
- Permanent: Impact that will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

Scale. The physical and spatial size of the impact

- Local: The impacted area extends only as far as the activity, e.g. footprint.
- Site: The impact could affect the whole, or a measurable portion of the above mentioned properties.
- Regional: The impact could affect the area including the neighbouring areas.

Magnitude/ Severity. Does the impact destroy the environment, or alter its function.

- Low: The impact alters the affected environment in such a way that natural processes are not affected.
- Medium: The affected environment is altered, but functions and processes continue in a modified way.
- High: Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

Significance. This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.

- Negligible: The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.
- Low: The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.
- Moderate: The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.

- High: The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

The following weights will be assigned to each attribute (Table 4)

Table 4. Impact assessment matrix weights

Aspect	Description	Weight
Probability	Improbable	1
	Probable	2
	Highly Probable	4
	Definite	5
Duration	Short term	1
	Medium term	3
	Long term	4
	Permanent	5
Scale	Local	1
	Site	2
	Regional	3
Magnitude/Severity	Low	2
	Medium	6
	High	8
Significance	**Sum(Duration, Scale, Magnitude) x Probability**	
	Negligible	<20
	Low	<40
	Moderate	<60
	High	>60

The significance of each activity will be rated without mitigation measures and with mitigation measures for the development.

5 RESULTS: ECOLOGICAL ASSESSMENT

5.1 VEGETATION

5.1.1 Biomes

The project area lies partially within both the Savanna and Grassland Biomes as indicated in Figure 11. 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.

The development site lies within the Grassland Biome which is found chiefly on the high central plateau of South Africa. Grasslands are dominated by a single layer of grasses. The amount of cover depends on rainfall and the degree of grazing. Trees are absent except in a few localised habitats. Geophytes are often abundant. Frost, fire and grazing maintain the grass dominance and prevent the establishment of trees (Low & Rebelo, 1996).

As stated earlier the project area lies partially within the Grassland and Savanna Biome and therefore forms an important ecotone between the two biomes. Ecotones are transitional areas between adjacent but different habitats, ecosystems, landscapes, biomes, or ecoclimatic regions (Risser, 1993). Ecotones that are unique entities in the context of climate change are transition zones between ecoclimatic regions. Ecotones have narrow spatial extent, a steep ecological gradient and hence high species richness (Risser, 1993), a unique species combination, genetically unique populations (Lesica and Allendorf, 1994), and high intra-species genetic diversity (Safriel et al., 1994).

Ecotones further affect distant and larger areas: They regulate interactions between biomes by modifying flows between them (Johnston, 1993; Risser, 1993); they generate evolutionary diversity (Lesica and Allendorf, 1994); and they serve as repositories of genetic diversity to be used for rehabilitation of ecosystems in adjacent ecoclimatic regions if and when these ecosystems lose species because of climate change (Volis et al., 1998; Kark et al., 1999). Conservation of ecotone biodiversity therefore is an adaptation. Finally, although ecological changes in response to climate change will occur everywhere, the signals will be detectable first in ecotones (Neilson, 1993). This sensitivity makes them indicators that provide early warning for other regions (Risser, 1993).

Although ecotones are unique in provision of climate change-related services, they are threatened. Conservation traditionally is aimed at "prime" core areas of biomes rather than ecotones. Even conservation efforts that are directed at ecotones may not suffice, however: 47-77% of the areas of biosphere reserves are predicted to experience change in ecosystem types, compared to only 39-55% of the total global terrestrial area that will undergo such changes (Leemans and Halpin, 1992; Halpin, 1997).

Ecotones are also very important aspects of the woodland-grassland-savanna transition and provide much of the energy in an ecosystem.

5.1.2 Vegetation types

Although the site is classified mainly as Moot Plains Bushveld, representations of the Carletonville Dolomite Grassland was also observed in the area and subsequently this vegetation type is included as part of the focus area. Figure 12 indicates the most recent vegetation map for the project area according to Sanbi (2012).

The vegetation and landscape features of the Carletonville Dolomite Grassland consist of slightly undulating plains dissected by prominent rocky chert ridges. Species-rich grasslands form a complex mosaic pattern dominated by many species. Prominent grasses are *Loudetia simplex, Hyparrhenia hirta, Brachiaria serrata* and *Heteropogon contortus*, as well as scattered shrubs including *Euclea undulata, Searsia magalismontanum, Zanthoxylum capense* and *Diospyros lycoides*. The conservation status is "Vulnerable", with a small extent conserved. Almost a quarter of the Carletonville Dolomite Grassland Vegetation Type is already transformed for cultivation, by urban sprawl or by mining activity as well as the building of dams. Erosion is very low.

The vegetation and landscape features of the Moot Plains Bushveld consist of open to closed low, often thorny savannah dominated by various species of *Acacia* in the bottomlands as well as woodland of varying height and density on the lower hillsides. Herbaceous lyer is dominated by grasses. This vegetation functions as a transitional area between different habitats. This vegetation type has been large modified in the larger project area by agricultural activities. Moot Plains Bushveld has a vulnerable conservation status with 13% statutorily conserved and 28% transformed by means of cultivation and built-up areas.

An important aspect relating to the project area of the Doornhoek Project should be to protect and manage the biodiversity (structure and species composition) of the vegetation types represented on site. Future mining activities should aim to remove minimal vegetation and only vegetation on the footprint areas should be removed during development constructions. The unnecessary removal of tall indigenous tree species (>3m) and indigenous vegetation during construction should be avoided as far as possible.

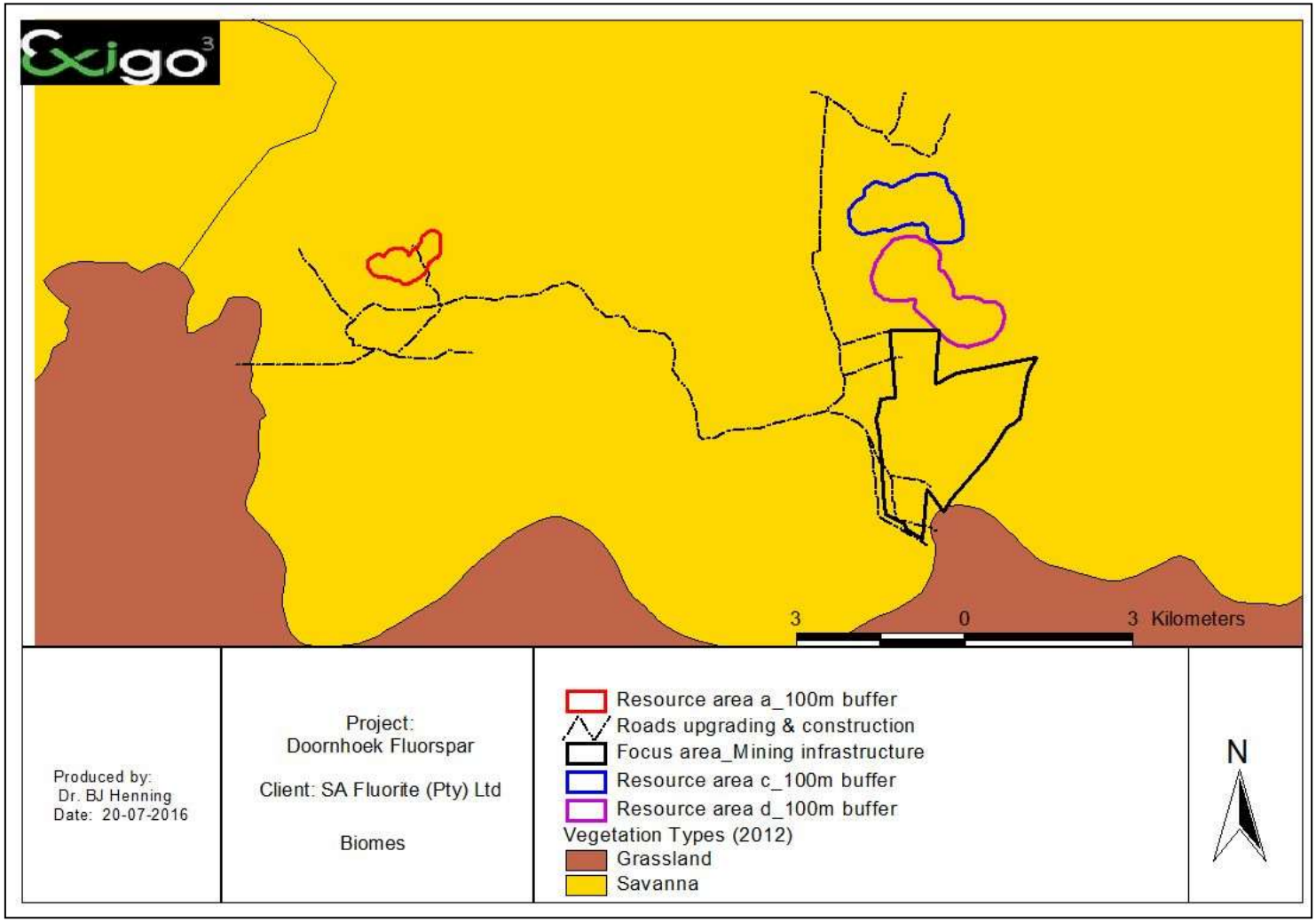

Figure 11. Biome map indicating the location of the planned Doornhoek Fluorspar Mine

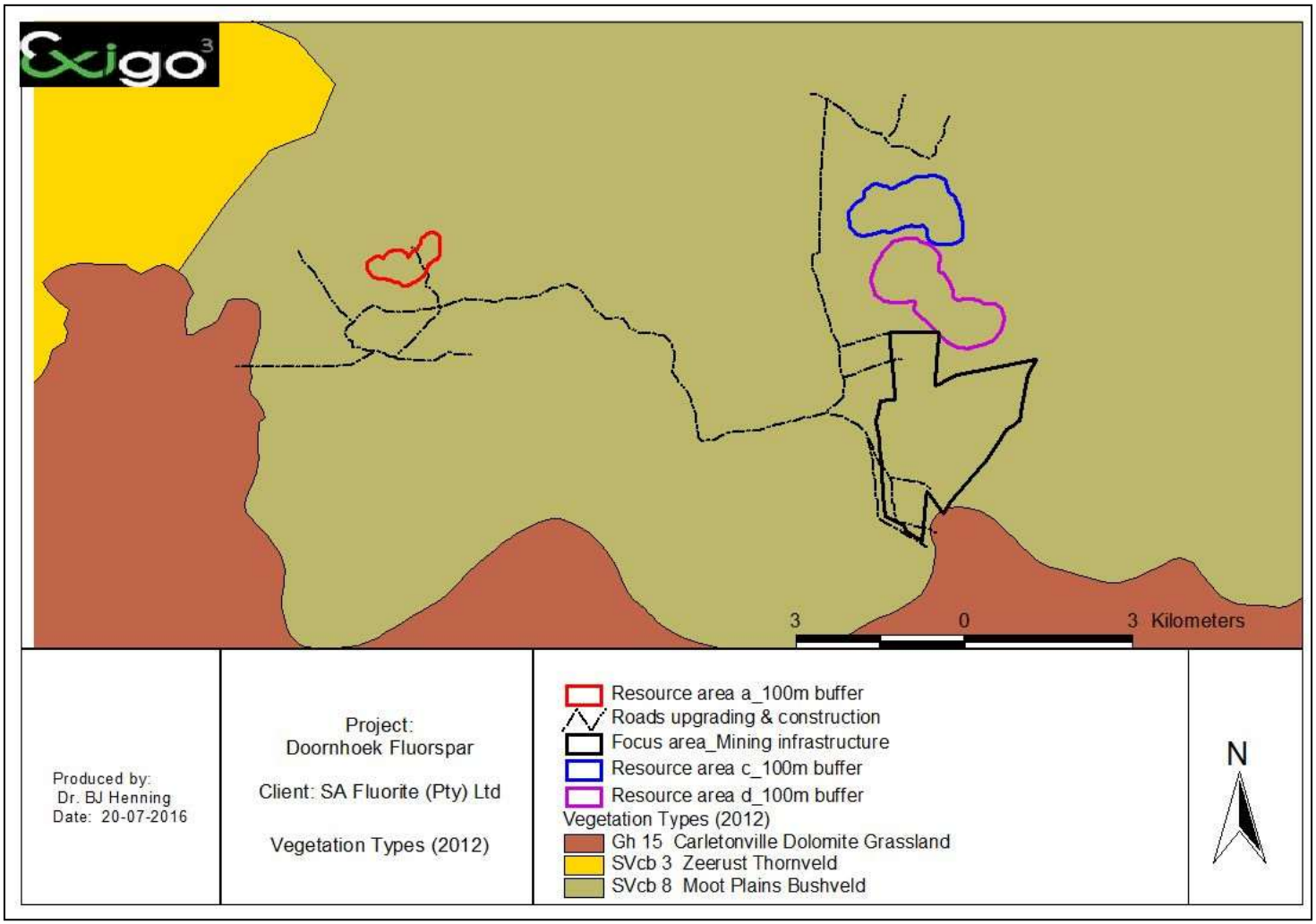

Figure 12. Vegetation Types of the project area according to the 2012 classification by Sanbi (2012)

5.1.3 Vegetation Units

The proposed mining site occurs on a slightly undulating to flat landscape with scattered outcrops. The area is bisected by tributaries of the Klein Marico River, while the Marico River and its floodplain form the northern border of the project area.. The farms surrounding this farm are primarily used for mining, crop cultivation, cattle farming and game farming.

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 site varies from being natural to completely degraded. The farms are currently zoned as agriculture.

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 identified six vegetation units as indicated in figure 13 as follows:

1. *Loudetia simplex – Urelytrum agrypyroides* rocky grassland;
    - Plateaus;
    - Undulating footslopes / plains;
2. Loudetia simplex rocky outcrops;
3. Mountainous woodland:
    - *Open Strychnos - Acacia caffra* woodland
    - *Olea – Strychnos – Combretum* woodland
    - *Strychnos – Combretum* woodland;
    - *Protea caffra* woodland
4. *Acacia karroo – Ziziphus mucronata - Olea europaea* woodland on valleys / plains:
    - Undulating terrain & valleys;
    - Bushclumps (stonewalls);
5. Degraded terrain

- Degraded grassland / old fields
- Degraded woodland
- Old mining quarries / farmsteads

6. Drainage features
    - Mixed *Searsia lancea* - *Acacia karroo* riparian woodland & water courses
    - Floodplains.
    - Hillslope Seep wetlands

The vegetation units as identified during site visits, databases and aerial imagery are indicated in Figure 13.

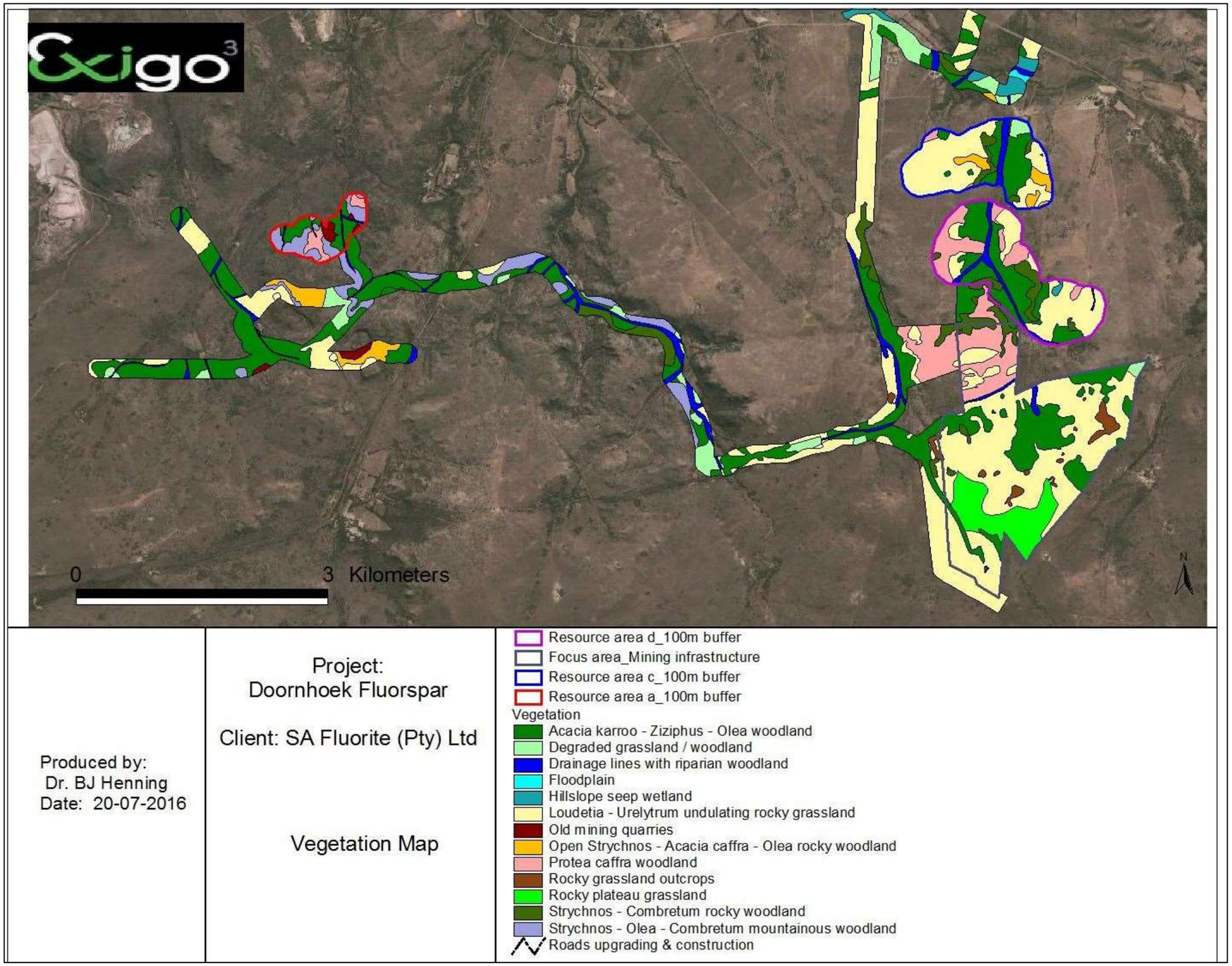

Figure 13. Vegetation Map of the project area

5.1.3.1 *Loudetia simplex – Urelytrum agrypyroides* rocky grassland

The vegetation unit occurs throughout large sections of the southern section of the project area on the cooler plateau and undulating grasslands, although it is mostly absent from the rugged western section. Two variations of this vegetation entity was identified namely the grassland associated with cololer plateaus and the undulating plains that slopes towards the north. The substrate is characterized by very shallow, rocky soils derived from chert or dolomite. The soils of this landscape are mainly lithosols or solid rock with a thin layer of soil (Mispah) in the hollow places. The dominant grass species is *Loudetia simplex, Urelytrum agrypyroides, Themeda triandra* and *Trachypogon spicatus*. The state of the grassland is in a pristine state with a high diversity of forbs and grass species documented during the survey. Isolated areas occur where isolated woody species and termitaria bushclumps were observed, although in terms of percentage cover these areas are negligible small. The herbaceous layer is well developed and dominated mostly by grass species stipulated and geophytes, while the succulent species *Aloe zebrina* is also characteristic species in the herbaceous layer, especially where dolomite bedrock occur. The rocky nature of the area still provide potential habitat for red data flora species such as *Boophane disticha*.

The characteristics of this vegetation unit are presented in Table 5, while the state of the vegetation is presented in photograph 1:

Table 5. Botanical analysis and characteristics of the vegetation associated with the *Loudetia simplex – Urelytrum agrypyroides* rocky grassland in the project area

State of the vegetation:	Pristine rocky grassland
Characteristics	Medium tall grasslandon shallow, rocky soils
Dominant plant species	*Themeda triandra, Trachypogon spicatus, Schizachyrium sanguineum, Loudetia simplex, Urelytrum agrypyroides*
Density of woody layer	Trees: <1% (avg. height: 3-6m) Shrubs: <1% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 80% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)
Conservation priority	Medium-High
Sensitivity	**Undulating terrain**: Medium-High **Flatter plateaus**: Medium
Red data species	Isolated individuals of the declining species *Boophane disticha.*

Photograph 1. *Loudetia simplex – Urelytrum agrypyroides* rocky grassland in the project area

5.1.3.2 *Loudetia simplex* rocky outcrops

This vegetation unit occurs throughout project area, although largely restricted to the southern sections of the farms 306JP and Knoflookfontein. Rocky outcrops and ridges in the Grassland biome of South Africa are often habitats for red data and endemic species of an area, while also supporting a unique floral and faunal species composition. This vegetation unit forms part of the rocky outcrops and ridges in the project area. The rocky outcrops provide suitable habitat to protected plants, small mammals and reptiles. The rocky outcrops function as islands within the landscape and are characterized by unique microclimates in which rare species thrive. They are therefore of High Ecological Function and of High Conservational Value for the biodiversity that they support. The landscape geomorphology of the outcrops represents moderately steep slopes derived from chert or dolomite. The terrain is rocky with the rockiness varying between 50 and 60%, which occur mostly as boulders.

The characteristics this vegetation unit are presented in Table 6, while the state of the vegetation is presented in photograph 2.

Table 6. Botanical analysis and characteristics of the vegetation associated with the *Loudetia simplex* rocky outcrops in the project area

State of the vegetation:	Pristine (natural)
Characteristics	Medium tall grassland in shallow rocky and gravelly soils on outcrops.
Dominant plant species	*Themeda triandra, Trachypogon spicatus, Schizachyrium sanguineum, Loudetia simplex*
Density of woody layer	Trees: <1% (avg. height: 3-6m)

	Shrubs: <1% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 50% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)
Conservation priority	High
Sensitivity	High
Red data species	Isolated individuals of the declining species *Boophane disticha.*

Photograph 2. *Loudetia simplex* rocky grassland on rocky ridge in the southern section of the project area

5.1.3.3 Mountainous woodland

The different woodland variations of the project area are the result of the diverse geological formations, landscapes and microhabitats created by the outcrops and low-lying ravines along the valleys. Four woodland variations were identified on shallow rocky soils on undulating terrain.

5.1.3.3.1 Open *Strychnos - Acacia caffra* woodland

This vegetation unit represent the open plateaus and outcrops in between the grassland and woodland biomes as ecotones. The ecotone of the project area between the Grassland and Savanna Biome are dynamic over-lapping boundary areas where these major terrestrial biomes meet. The structure, size, and scope of the ecotone have changed considerably over the millennia, expanding and shrinking as climate and/or other driving conditions have also changed. Today, however, many of them are changing at a rate not seen for a long time, perhaps largely due to climate change and other humaninduced factors. Grobler

(pers comm.) have indicated that the woodland areas of the western section of the project area were indeed part of the Grassland Biome a mere 50 years back, which confirms the high rate at which these ecotones have shifted. Indeed, ecotones are more sensitive to climate change than the biomes on either side, and therefore play an important role as critical early indicators of future climate change. As ecotones change, they also redefine the limits of the biomes on either side by altering their distributions of species because, in addition to their own endemic species, any ecotone will also have species from both adjoining biomes. Consequently, they may also be places of high levels of species interaction, serving as active evolutionary laboratories, which generate new species that then migrate back into adjacent biomes.

The ecotone of the project area represents rocky grassland with a very open woodland component and in many cases the woody component represents bushclumps. Rocky outcrops also occur on the ecotone and provide microhabitats to many tree and shrub species such as *Protea caffra, Englerophytum magalismontanum* and *Combretum molle.*

The characteristics this vegetation unit are presented in Table 7, while the state of the vegetation is presented in photograph 3.

Table 7. Botanical analysis and characteristics of the vegetation associated with the *Open Strychnos - Acacia caffra* woodland in the project area

State of the vegetation:	Pristine (natural)
Characteristics	Open woodland and bushclumps on shallow rocky soils derived from chert, dolomite or sandstone
Dominant plant species	*Themeda triandra, Loudetia simplex, Strychnos pungens, Protea caffra, Acacia caffra, Combretum molle*
Density of woody layer	Trees: 5-10% (avg. height: 3-6m) Shrubs: 1-2% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 50% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)
Conservation priority	Medium
Sensitivity	Medium
Red data / protected species	Isolated individuals of the declining species *Boophane disticha.* Protected tree species: *Securidaca longipedunculata*

Photograph 3. Typical ecotone with a very open woodland component in the project area

5.1.3.3.2 Dense *Olea – Strychnos – Combretum* woodland woodland on steep / moderately undulating slopes

The western section of the project area is characterised by this dense woodland variation on a moderately undulating hilly landscape. The substrate is shallow, rocky soils (Mispah, Glenrosa soil form) derived from chert or quartzite. The woody component encroached as a result of the lack of fire over the past few decades in combination with overgrazing. Alien invasive species such as *Lantana camara* and *Opuntia ficus-indica* has also invaded this woodland variation to a largfe extent, while the indigenous woody component is dominated by woody species such as *Olea europaea, Strychnos pungens, Searsia leptodictea, Searsia lancea* and *Combretum molle*.

The characteristics this vegetation unit are presented in Table 8, while the state of the vegetation is presented in photograph 4.

Table 8. Botanical analysis and characteristics of the vegetation associated with the dense *Olea – Strychnos – Combretum* woodland woodland on steep / moderately undulating slopes variation in the project area

State of the vegetation:	Slightly degraded as a result of encroachment
Characteristics	Dense woodland on moderately undulating hilly landscape
Dominant plant species	*Strychnos pungens, Olea europaea, Searsia leptodictea, Searsia lancea, Combretum molle*
Density of woody layer	Trees: 25-40% (avg. height: 3-6m) Shrubs: 10-15% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 50% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)

Conservation priority	High
Sensitivity	High
Red data / protected species	Isolated individuals of the declining species *Boophane disticha* occur on rocky areas where the woodland opens up. Protected tree species: *Securidaca longipedunculata*

Photograph 4. View towards a ridge in the western section of the project area supporting dense *Olea – Strychnos – Combretum* woodland woodland on steep / moderately undulating slopes variation variation in the project area

5.1.3.3.3 Strychnos – Combretum woodland

The rugged woodland variation occurs throughout large sections of the eastern section of the project area. The substrate in this area represents rugged terrain with medium to large sized boulders and high percentage rockiness. The vegetation varies from an open woodland structure on the cooler southern and east-facing slopes, to a denser structure on the warm northern and west-facing slopes. Dominant woody speices include *Protea caffra, Cussonia paniculata, Strychnos pungens* and *Acacia caffra* on the cooler slopes, while the warmer slopes support typical woody speices such as *Combretum molle, Tarchonanthus camphoratus, Olea europaea and Searsia leptodictea.* The herbaceous is directly related to the amount of soil present and therefore seldom very dense. The characteristics this vegetation unit are presented in Table 9, while the state of the vegetation is presented in photograph 5.

Table 9. Botanical analysis and characteristics of the vegetation associated with the *Strychnos – Combretum* woodland woodland variation in the project area

State of the vegetation:	Mostly in a natural state, although slightly degraded and overgrazed in some area
Characteristics	Open woodland on cooler slopes to denser woodland on warmer slopes underlied by shallow soils derived from chert and sandstone. Medium to large boulder soccur along slopes.
Dominant plant species	*Protea caffra, Cussonia paniculata, Strychnos pungens, Acacia caffra Combretum molle, Tarchonanthus camphoratus, Olea europaea,* *Searsia leptodictea, Themeda triandra, Loudetia simplex*
Density of woody layer	Trees: 10-30% (avg. height: 3-6m) Shrubs:10% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 40-50% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)
Conservation priority	Medium
Sensitivity	Medium-high
Red data / protected species	None observed

Photograph 5. *Strychnos – Combretum* woodland variation on west facing slopes

5.1.3.3.4 *Protea caffra* woodland

This woodland variation is dominated by a single woody species on the cooler slopes and plateaus namely *Protea caffra,* while *Acacia caffra* dominates the warmer, northern slopes and microhabitats associated with boulders. The woody structure of this variation represents sparse woodland and occurs at slightly

higher (cooler climate) altitudes. The habitat is on shallow soils in moderately exposed lower altitude habitats, with moderately deep soils of the Mispah, Glenrosa, Avalon and Clovelly soil forms. The characteristics this vegetation unit are presented in Table 10, while the state of the vegetation is presented in photograph 6.

Table 10. Botanical analysis and characteristics of the vegetation associated with the *Protea caffra* woodland variation in the project area

State of the vegetation:	Slightly degraded as a result of encroachment
Characteristics	Very open woodland on higher altitudes and exposed, cool plateaus in southern section of project area
Dominant plant species	*Protea caffra, Acacia caffra, Loudetia simplex*
Density of woody layer	Trees: 10-15% (avg. height: 3-6m) Shrubs: 2-5% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 50-60% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)
Conservation priority	Medium
Sensitivity	Medium-High
Red data / protected species	Isolated individuals of the declining species *Boophane disticha* occur on rocky areas where the woodland opens up. Management as indicated in Section 5.7.3. Protected tree species: *Securidaca longipedunculata*

Photograph 6. Open *Protea caffra* woodland in the project area

5.1.3.4 *Acacia karroo – Ziziphus mucronata - Olea europaea* woodland on valleys / plains

Two woodland variations occur on the plains and footslopes of the project area, although the bushclumps / archaeological sites rather represent a vegetation entity that forms part of a larger vegetation unit.

5.1.3.4.1 *Acacia karroo – Ziziphus mucronata - Olea europaea* woodland

This vegetation unit represents the woodland in the low lying valleys and plains of the project area and represent areas of secondary successional processes where the woodland has successfully invaded grassland areas from the surrounding Savanna biome to the north and west of the project area. The soils vary from medium depth red apedal soils on the plains and plateaus, to shallow, gravelly soils on the terraces and footslopes. The vegetation structure forms an open woodland variation dominated by *Searsia* lancea, Acacia karroo, Olea europaea and Ziziphus mucronata and a dense herbaceous layer dominated by Themeda triandra and Hyparrhenia hirta. The characteristics this vegetation unit are presented in Table 11, while the state of the vegetation is presented in photograph 8.

Table 11. Botanical analysis and characteristics of the vegetation associated with the *Acacia karroo – Ziziphus mucronata - Olea europaea* woodland variation in the project area

State of the vegetation:	Mostly in a natural state, although slightly degraded and overgrazed in some area
Characteristics	Mostly open to very woodland on plains, footslopes and plateaus
Dominant plant species	*Searsia lancea, Searsia leptodictea, Olea europaea, Themeda triandra, Hyparrhenia hirta*
Density of woody layer	Trees: 10% (avg. height: 3-6m) Shrubs:2-5% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 70-80% (avg. height: 0.8m) Forbs: <1 (avg. height: 0.5m)
Conservation priority	Medium
Sensitivity	Medium
Red data / protected species	None observed

Photograph 7. *Acacia karroo – Ziziphus mucronata - Olea europaea* woodland variation in the project area

5.1.3.4.2 Bushclumps / archaeological sites (stonewall terrains)

The bushclumps occur as pockets of woody species on low mounds built by termites (Van der Meulen, 1979, Photograph 8). The size of termitaria determines the structure of vegetation. Tall trees like *Pappea capensis, Acacia robusta* and *Ziziphus mucronata* are common, with *Grewia flava* also being part of the lower structure of the termitaria vegetation. The sweetveld associated vegetation occur on termitaria due to the depth and aeration, better drainage, as well as the finer texture and higher nutrient status of the soil (Lee & Wood, 1971). Termitaria mostly occur on plateaus, terraces and lowlands on sandy to loamy soils without rocks, as termites need a certain depth of soil for their activities (Van der Meulen, 1979).

The vegetation associated with the larger stonewall archaeological sites of the study area have a similar plant species composition compared to the termitaria bushclumps as a result of the soils being enriched from old cattle kraals and ash. The stonewalls provide an artificial microhabitat and therefore most woody species in the stonewall sites occur on and directly adjacent to the stonewalls (Photograph 8).

Photograph 8. Vegetation associated with an archaeological stonewall site in the project area

5.1.3.5 Drainage features

The drainage features can be divided into 3 specific vegetation units as described below and have a HIGH sensitivity. Any impact on these features would need an IWUL licence application prior to any construction.

5.1.3.5.1 Mixed *Searsia lancea - Acacia karroo* riparian woodland & water courses

All rivers and streams with their associated riparian vegetation (Photograph 9) in the project area are considered to be ecologically sensitive, forming important, limited and specialised habitats for several flora and fauna species. The species composition is unique and relatively limited in distribution and coverage. These habitats also form linear corridors linking different open spaces. The riparian zone varies from being completely removed in some areas, to approximately 30-40m wide as identified from the aerial photograph. A more open riparian zone of thornveld is locally associated with some of the smaller non-perennial river systems. Here the vegetation is dominated by tall *Acacia karroo* and *Searsia lancea* trees with some scattered grasses and weeds. Eradication and control of woody alien plants will be necessary (Conservation of Agricultural Resources Act (Act No. 43 of 1983) amended in 2001) and needs to be addressed in the ecological report. The riparian zone delineation should form part of the ecological study, and the functional status of the riparian zone of the major drainage channels in the project area should be assessed.

The riparian woodland still plays many essential roles in the functioning of the ecosystem, including:

- Flow regulation: the riparian vegetation slows the flow of water, both by physically blocking the

passage of water, and by absorbing the water into its root systems. This moderates the impacts of flooding on surrounding areas.

- Water quality regulation: the riparian vegetation acts as a buffer or filter between nutrients, sediments, contaminants, and bacteria from the surrounding land and air, and the river channel itself. The riparian vegetation therefore prevents soil, pesticides, fertilizers and oil from entering the river and impacting on in-stream communities.
- Habitat provision: The riparian zone is an important habitat for many plants and animals, because it is an area of transition between the land and the river. These relatively steep environmental gradients (moisture, temperature, topography, and soil) generally support higher levels of biodiversity than more homogeneous areas.
- Corridor functions: because it follows the river, the riparian zone serves as a corridor, connecting two or more habitats that may otherwise be isolated by land transformation of areas in between. Many species of animals use corridors to disperse, and find food and mates.

The riverine forest would be important dry season refuge areas for many fauna species in their natural state. It is also a centre of floral diversity. Riparian areas have been identified as important dry season refuge areas for a variety of large mammal species. The perennial Klein Marico River also provides a source of water, particularly in below average rainfall years, while the deeper alluvial soils may provide better forage than areas inland of the riparian zone. The impacts on the sensitive riparian ecosystems, regardless of the source, need to be restricted. Impacts on this system include erosion, habitat loss and degradation and the associated impacts on faunal and floral diversity, dewatering of marshes and wetlands, water abstraction as well as increased sedimentation. Continued impacts on the riverine ecosystems may also ultimately reduce the capacity of this system to absorb dramatic flooding events.

The ephemeral rivers in the area may also provide refuge for a number of fish species and could therefore be critical to their survival. Here groundwater extraction may be problematic as it may lower the water table to the extent that even species adapted to survival in small mud pools, such as sharptooth catfish, may no longer survive (SANParks, 2003).

Photograph 9. Riparian vegetation associated with the project area

5.1.3.5.2 Floodplains

The wetland classification system of the National Water Act classifies the HGM unit associated with the Klein Marico River as a floodplain wetland (Photograph 10). A floodplain, is a flat or nearly flat land adjacent a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge (figure 14). It includes the floodway, which consists of the stream channel (in this case the Klein Marico River) and adjacent areas (riparian woodland, hygrophilic grassland) that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current. In other words, a floodplain is an area near a river or a stream which floods easily.

Floodplains are made by a meander eroding sideways as it travels downstream. When a river breaks its banks and floods, it leaves behind layers of rock and mud. These gradually build up to create the floor of the flood plain. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream. These are accumulations of sand, gravel, loam, silt, and/or clay, and are often important aquifers, the water drawn from them being pre-filtered compared to the water in the river.

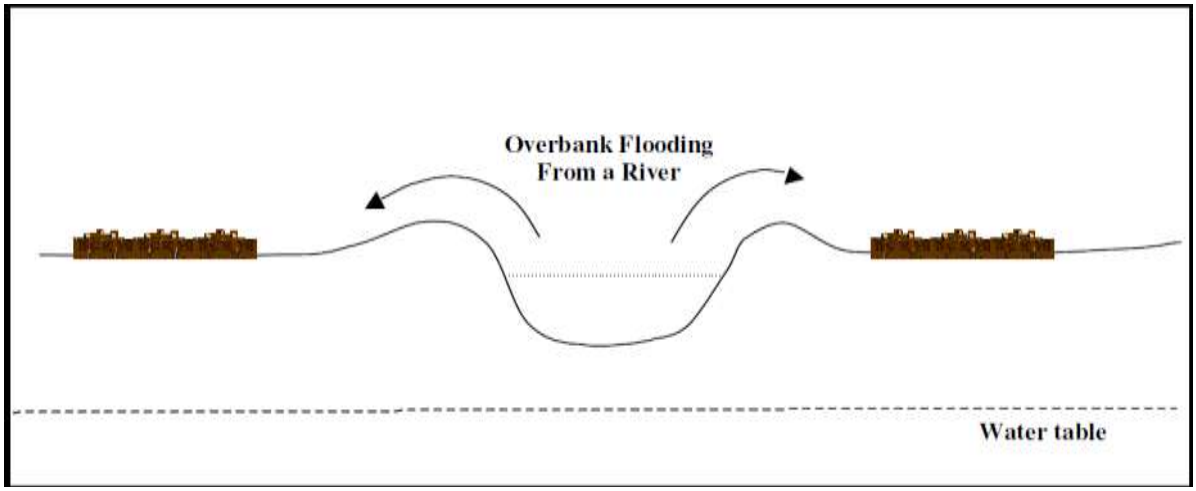

Figure 14. Cross section through a floodplain

Photograph 10. Floodplains and riparian woodland adjacent to the Klein Marico River in the project area

5.1.3.5.3 Hillslope seep wetland

This vegetation unit represent the grassland areas classified as 'Hill slope Seep Wetlands' mostly adjacent to the valley-bottom wetlands. The seep areas either feed the floodplains or valley-bottom wetland or occur isolated along a slope. A Hill slope seep is classified as a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Water inputs are primarily from precipitation that that enters the wetland from an up-slope direction in the form of subsurface flow. Water movement through the wetland is mainly in the form of interflow, with diffuse overland flow ('sheetwash') often being significant during and after rainfall events. In this hill slope seep the water leaves the 'Hill slope seep without channelled outflow', although it is

directly connected to a water course (SANBI, 2009).

This wetland type has a unique nature due to its direct connectivity to the drainage valley-bottom as a result of the geological formation directly adjacent to the drainage channel that forms an impermeable layer of hard plinthite rock and very shallow soils. Hard plinthite is also called ferricrete and is a mineral conglomerate consisting of surficial sand and gravel cemented into a hard mass by iron oxide derived from the oxidation of percolating solutions of iron salts (Wikipedia, undated). The presence of ferricrete is indicative of a fluctuating water table. The fluctuations may have only occurred in the past but may be active at present. Ferricrete can be present as discrete nodules within the residual granitic soil or may be in the form of hardpan. Where hardpan has developed (as is the case of the study area) a perched water table is often present. These characteristics encourage poor infiltration of surface flow and high surface run off. Hill Slope wetlands have several functions including supporting biological diversity, water storage, water exchange between surface water and underground water, surface water filtration.

The vegetation associated with the seep wetland varies according to various factors such as land-use and soils. The most common grass species associated with hillslope seep wetland is *Eragrostis gummiflua*. Where degradation such as overgrazing has occurred the dwarf shrub *Stoebe vulgaris* completely dominate the lower herbaceous stratum as observed on the seeps (Photograph 8). The overgrazing further caused sheet erosion along hillslope seeps of this area.

Photograph 11. A hillslope seep in the southern section of the project area dominated by *Eragrostis gummiflua*

5.1.3.6 Degraded terrain

The degraded areas on site represent low sensitivity land that can be divided in terms of land use or successional processes as follows:

- Old mining infrastructure / quarries (represent degraded grassland / woodland);
- Primary old fields (degraded grassland);
- Secondary old fields (degraded woodland);
- Farmsteads

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 most common old fields in the are the young old fields of 1-5 years old (Smits et al. 1999) dominated by the pioneer grass species of disturbed areas, *Cynodon dactylon* (Van Oudtshoorn, 1999). Secondary grassland communities may develop from this old field variation, dominated by the secondary grassland species directly related to man-made disturbances, *Hyparhenia hirta*. These fields are still in an early successional state, although somewhat older (older than 5 years) with several grass species like *Aristida junciformis, Aristida congesta s. congesta* and *Eragrostis rigidior*. The outer successional stage of old fields 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*, Acacia karroo*, Acacia tortilis* and *Ziziphus mucronata*. Where overgrazing occurs the encroacher *Dichrostachys cinerea* becomes dominant as is evident on site. The secondary old fields is a more open structured old field. Both primary (Photograph 12) and secondary old fields (Photograph 13) occur in the project area.

Photograph 12. Primary old fields in the project area

Photograph 13. Secondary old fields representing degraded woodland in the project area

5.2 FLORA: SPECIES LEVEL ASSESSMENT

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.

5.2.1 Species of concervation 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 8 indicates the classification system used by Sanbi for SCC:

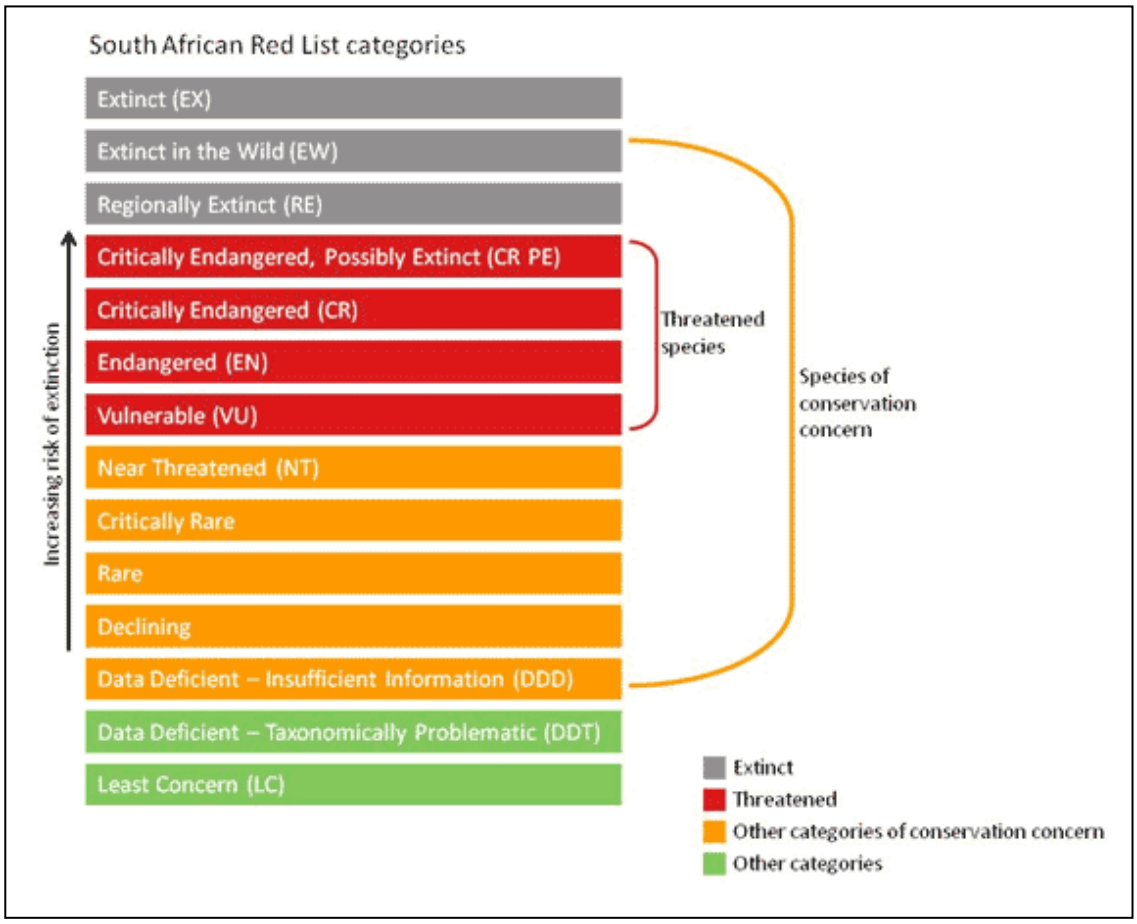

Figure 15. South African red list categories indicating the categories to be used for Species of Conservation Concern

Mucina and Rutherford (2006) identified the following plant species as endemic to the main vegetation types (Carletonville dolomite Grassland and Moot Plains Bushveld) in the region:

Succulent shrub: *Delosperma davyi*

Habitat degradation is one of the main reasons for plant species becoming extinct in a particular area. Threatened species are also seen as indicators of the overall health of an ecosystem (Hilton-Taylor, 1996). Although no threatened species and Species of Conservation Concern were listed for the Grids 2526CC and 2526CA (SANBI, POSA website October 2011), the following red data species was found during the site surveys (Table 12):

Table 12. Red data species found during the vegetation survey

Plant species	Status	Habitat on site
Boophane disticha	Declining	Rocky grassland, woodland on rocky slopes

5.2.2 Protected tree species

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 as a result 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 DAFF (or a delegated authority). Two tree species listed as protected under the national list of declared protected tree species as promulgated by the National Forest Act (NFA), 1998 (No. 84 of 1998) was observed in the project area. The trees species listed in LEMA and the DAFF protected tree species list (Table 13) have a wide distribution in Southern Africa, although these trees have an importance in terms of medicinal, cultural and heritage value to local communities. The application form and procedure to be followed for the eradication, pruning, removal etc. of protected tree species according to DAFF. The following protected tree species of concern occur in the area:

Table 13. Protected tree species of concern in the project area

Species	National Conservation status	Status in project area	Habitat of species
Acacia erioloba	Protected (NFA)	Isolated	Occur along old wagon-tracks as part of the historical areas of site
Securidaca longipedunculata (Photograph 1)	Protected (NFA)	Widespread	Shallow rocky soils with a sandy layer above on terraces and plateaus

The listed protected tree species in terms of the National Forest Act of 1998, 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 Department of Agriculture, Forestry and Fisheries (DAFF) or a delegated authority. Obtaining relevant permits are therefore required prior to any impact on these individuals.

Photograph 14. Protected tree species *Securidaca longipedunculata* on farm 306JP Protected species according to National Forest Act

5.2.3 Protected Plants according to the TOPS regulations in NEMBA

No plant species was found in the project area as protected under the TOPS regulations in the NEMBA (Act 10 of 2004).

5.2.4 Medicinal plants of the site

Medicinal plants are an important aspect of the daily lives of many people and an important part of the Southern African cultural heritage. The impact of the proposed development on populations of medicinal plants will be very little, although certain plants play an important role in the culture. The following medicinal plant species occur in the project area (Van Wyk & Gericke, 1997) as indicated in Table 14:

Table 14. Medicinal plant species and their habitats in the project area

Species	Indigenous / exotic	Status	Habitat of species
Acacia karroo	Indigenous	Widespread	Riparian woodland / floodplains / old fields on fertile soils

Species	Indigenous / exotic	Status	Habitat of species
Acacia tortilis	Indigenous	Widespread	Woodlands on loamy to clayey soils including floodplains / old fields on fertile soils
Datura stramonium	Exotic	Widespread	Old fields / disturbed land
Dichrostachys cinerea	Indigenous	Widespread	Degraded woodland / natural woodland areas on sandy soils
Dombeya rotundifolia	Indigenous	Widespread	Riparian woodland / mountainous areas
Ehretia rigida	Indigenous	Localized	Termitaria / riparian woodland
Elephanthorhiza elephanthina	Indigenous	Widespread	Sandy plains
Euclea undulata	Indigenous	Widespread	Floodplains along rivers, riparian woodland and on termitaria
Grewia bicolor	Indigenous	Widespread	All habitats of area
Gomphocarpus fruticosa	Indigenous	Localized	Along floodplains of rivers / in seasonal zones of rivers
Lippia javanica	Indigenous	Widespread	Old fields / disturbed land
Pavonia burchellii	Indigenous	Localized	Shady areas under trees / among rocks
Ricinus communis	Exotic	Widespread	Varied habitats / disturbed land along river courses
Terminalia sericea	Indigenous	Widespread	Deep sandy soils on plains
Typha capensis	Indigenous	Localized	In standing water of pans / rivers
Vernonia oligocephala	Indigenous	Widespread	Throughout many vegetation units of Savanna Biome
Ximenia caffra	Indigenous	Widespread	Bushveld / rocky terrain, termite mounds
Ziziphus mucronata	Indigenous	Widespread	Riparian woodland / floodplains / old fields on fertile soils

The following recommendations for the site can be made regarding medicinal plants of importance:

- The project area should be assessed with regards to the most popular medicinal plants that may potentially become Red Data plants in the future. A management strategy in association with the users as well as nurseries should be established to maintain sustainable utilization patterns.
- Develop a comprehensive medicinal plant monitoring and evaluation system that uses indicators describing driving forces, states and impacts of key variables. This needs to be implemented at various levels along the supply and demand chain, and will facilitate the early identification of non-sustainable harvesting levels, improved policy, and regulations and law enforcement.
- Promote the substitution of rare and endangered plants with more common alternatives.
- Provide background research for the establishment of an alternative health farm. Specific

emphasis should be placed on the traditional use of medicinal plants by various cultural groups.

- Persons collecting plants and animals should have the necessary permits from the relevant provincial department as well as have the permission for such activities from the Management Authority. This should also apply to traditional healers and scientists and general information sessions should be held to educate people of such requirements

5.2.5 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 fight against invasive alien plants is spearheaded by the Working for Water (WfW) programme, launched in 1995 and administered through the DWA. This programme works in partnership with local communities, to whom it provides jobs, and also with Government departments including the Departments of Environmental Affairs and Tourism, Agriculture, and Trade and Industry, provincial departments of agriculture, conservation and environment, research foundations and private companies.

WfW currently runs over 300 projects in all nine of South Africa's provinces. 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.
- Chemical methods - using environmentally safe herbicides.
- 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.
- Integrated control - combinations of the above three approaches. Often an integrated approach is required in order to prevent enormous impacts.

Vehicles often transport many seeds and some may be of invader species, which may become established along the roads through the area, especially where the area is disturbed. The construction phase of the development 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 invasive alien 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 site, 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. The following alien invasives and exotic plant species were recorded on site during the surveys as stipulated in the Alien and Invasive Species Regulations (GNR 599 of 2014) (Table 15):

Table 15. Declared weeds and invader plants of the study area

Species		***Category***
Agave sessilana	Sisal	2
Arundo donax	Spanish reed	1b
Cereus jamacaru	Queen of the night	1b
Datura innoxia	Downy thorn apple	1b
Datura stramonium	Large thorn apple	1b
Eucalyptus spp.	River red gum	1b (if within riparian zones)
Harrisia martinii	Moon cactus	1b
Jacaranda mimosifolia	Jacaranda	1b

Species		*Category*
Lantana camara	Tickberry, lantana	1b
Melia azedarach	Seringa	1b
Morus alba	Common mulberry	3
Opuntia ficus-indica	Prickly pear	1b
Opuntia stricta	Pest pear of Australia	1b
Populus alba	White poplar	2
Solanum mauritianum	Bugweed	1b
Tecoma stans	Yellow bells	1b
Thevetia peruviana	Yellow oleander	1b
Xanthium strumarium	Large cocklebur	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.

5.2.6 Encroacher species

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 Acacia 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 have to 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 have to 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. Typical bush encroacher species that occur in the area of the proposed development listed under

CARA (Act No 43 of 1983) is included in Table 16 below:

Table 16. Listed encroacher species for the Doornhoek project area

Species	Status	Habitat of species
Acacia karroo	Widespread	Riparian woodland / floodplains / old fields on fertile soils
Acacia tortilis	Widespread	Woodlands on loamy to clayey soils including floodplains / old fields on fertile soils
Dichrostachys cinerea	Widespread	Degraded woodland / natural woodland areas on sandy soils
Grewia bicolor	Widespread	All habitats of area
Grewia flava	Localized	Bushveld on floodplains / sandy soils
Terminalia sericea	Widespread	Deep sandy soils on plains

5.2.7 General

An important aspect relating to the proposed development should be to protect and manage the biodiversity (structure and species composition) of the Moot Plains Thornveld vegetation type which are represented on the proposed development site. Vegetation removal should be kept to a minimum during the construction phase of the mining development and only vegetation on the footprint areas should be removed. Mitigation measures and monitoring should however be implemented should the development be approved.

5.3 FAUNAL ASSESSMENT

5.3.1 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.

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 have 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). Several authors have shown this preference of mammals to certain habitats through analysis (Beardall et al. 1984; Ben-Shahar, 1991; Dekker et al. 1996).

A survey was conducted 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 mixed vegetation component with a diverse vegetation structure and height class. A detailed species list for the area is included in Appendix B (Birds), C (Mammals) and D (Herpetofauna). Appendix E indicates the different conservation status descriptions of the fauna and flora.

Five main fauna habitats potentially occur in the area namely:

- Cliffs, rock-strewn hillsides and rocky hillslopes;
- Riparian woodland and open water habitat;
- Mixed broadleaf woodland habitat;
- Grassland habitats
- Old cultivated fields / degraded areas.

5.3.2 Fauna Habitats

5.3.2.1 Habitat A: Ridges / outcrops

The rocky habitat on site is an important habitat for various fauna species of conservation concern of which the most important would be reptiles (South African python), bats and smaller mammal species. The rocky ridges occupy isolated pockets of the project area. The ridges and outcrops create important microhabitats for fauna on site.

Although larger mammal species may not be as common in this habitat type, smaller species such as the dassie and Jameson's red rock rabbit are important prey species to predators in this habitat type. Dassies are the main prey of leopard in the rocky areas (Walker, 1986). The scavenger, the brown hyaena, also seems to prefer these rocky areas to hide during the daytime. Other typical nocturnal animals which may occur in this habitat type include large spotted genet, small spotted genet, and species with a wide habitat tolerance such as, African wild cat, porcupine, pangolin, honey badger and striped polecat.

5.3.2.2 Habitat B: Open water habitat type and riparian woodland

The open water habitat type is associated with the perennial rivers and dams in the project area (Photograph 15). These areas provide habitat and feeding grounds for various amphibians, fish species and avifauna. Mammal species that will specifically utilize this habitat are the Cape clawless otter. Otters are dependant on their food source such as crabs, frogs, fish or other aquatic life in the river ecosystems.

The shallow water habitat that occurs along the dam shores and rivers throughout the year is more suitable for waterbirds that forage along its banks. Threatened birds prefer these dense habitat types associated with riparian woodland in the area.

The riparian woodland along the banks of the riverine systems is important habitat for various birds, mammals and Herpetofauna (reptiles and amphibians).

Unique biota associated with the dolomitic eyes / springs in the area includes the following:

- Fish: The cichlid fish (Tilapia sparmanii) is genetically distinct from other known conspecific populations;
- Insecta:
    - Four new mayfly (Ephemeroptera) species;
    - Eight new caddisfly (Tricoptera) species, most of these only occurring at the site;
- Crustacea:
    - Four new seed shrimp (Ostracods) distribution records and one new species

Photograph 15. Open water habitat of the Klein Marico River

5.3.2.3 Habitat C: Mixed woodland associated with plains and valleys

The woodland area of the lower-lying plains and open valleys play an important role as habitat for various generalized fauna species. Birds and arboreal reptiles would utilize the larger trees species for breeding, roosting and foraging.

5.3.2.4 Habitat D: Pristine grasslands

The grassland habitat occurs in the southern and eastern sections of the project area. It would appear as though the changes in climate and lack of fire has changed most of the grasslands that used to occur in the larger area into woodlands (Grobler, pers. Comm). Grasslands in all their variations are currently one of South Africa's most threatened biomes, with only 2.5% formally conserved and more than 60% already irreversibly transformed. The primary threats to grassland habitat for fauna include degradation and conversion mainly as a result of large scale agriculture development, urbanisation, prospecting and mining. Although the giant bullfrog and oribi used to occur in the grasslands of the area, it would appear as though it disappeared although more studies are needed to show whether this is in fact the case. Species typical of

the grasslands in the region include species such as Jameson's red rock rabbit, secretary bird, steenbok and redwing francolin.

5.3.2.5 Habitat E: Old fields and cultivated land

The region has a long history of agricultural and urban settlement and these areas support a relatively low faunal diversity, with few threatened or sensitive species. However, Savanna and grassland habitats are usually interconnected, allowing easy movement for fauna. The degraded habitat types associated with cultivation and urban areas still provide important feeding grounds to some fauna in the area. The abandoned croplands present in this landscape increase the connectivity by 25%.

5.3.3 Common fauna documented and potentially occurring in the project area

As a result of anthropogenic disturbance in the larger area and the limitations created by game fences, only the most tolerant generalists of the larger vertebrates still occur in the project area outside the nature reserves. Examples are grey duiker, bushbuck, steenbok and baboon. The more sensitive habitat-specialist species like honey badger, leopard, brown hyena and caracal have retreated into areas of lower disturbance such as the surrounding ridges and riparian woodland.

5.3.3.1 Mammals

Large mammals such as elephant, lion, buffalo and rhinoceros species that occurred historically at the site are mainly restricted to game reserves and national parks (Madikwe Game Reserve) 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.

The majority of the habitat types are still intact. Therefore, the expected mammalian richness on these areas are considered high although slightly lower richness values are expected from the more degraded areas on the farm Oporto. Predators that still roam freely in the area include larger predators such as leopard and brown hyena, while smaller predators such as caracal, serval, honey badger and cape clawless otter are common throughout the area. Antelope species such as klipspringer, kudu, bushbuck and duiker will roam freely through the area and are not restricted by game fences. Although the red data oribi used to occur in the area, it would appear as though they have disappeared from the area completely (Grobler, pers. Comm). Smaller mammal 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 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. Any individuals that utilize the 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 most important corridors that need to be preserved for free-roaming mammal species in the area include the perennial Klein Marico River (optimal habitat for the red data species cape clawless otter), rocky ridges, rocky grasslands and riparian woodland.

5.3.3.2 Birds (avifauna)

Six major bird habitat systems were identified within the borders of the study site, including the open water habitats associated with wetlands and streams, rocky outcrops, mixed woodlands, riparian woodland, old fields (degraded grassland) and grassland.

The woodland biome covers the greater part of Southern Africa, although it is largely restricted to the north and east of the region. Woodland is defined as vegetation with tree cover from sparse to almost closed canopy cover, and generally with a grassy understory. The woodland biome in Southern Africa supports the highest diversity of bird species of all the vegetation types in the sub region. This includes such characteristic and colourful woodland birds as rollers, bee eaters and waxbills, as well as large birds of prey such as vultures and eagles.

Broad-leaved, winter-deciduous woodlands typically occur on nutrient poor (leached) soils in the wetter (>600 mm/annum) eastern regions compared with acacia woodlands but the two woodland types are often mixed, with acacia woodlands on the alluvial plains and broad-leaved woodlands on the higher slopes. Examples of typical broad-leaved woodland trees are Colophospermum mopane and Combretum apiculatum. Broad-leaved woodlands typically show lower bird numbers, but higher bird diversity, than acacia woodlands. The Longtailed Widow is an example of a species restricted (in Southern Africa) to, and found throughout, the grassland biome, and its distribution neatly delineates the boundaries of this vegetation type. Many grassland birds, several of which are endemic to southern Africa, show a clear preference for sour over sweet and mixed grassland, and some of these are essentially absent from the last two grassland types, e.g. Bald Ibis, Redwing Francolin, Blackwinged Plover, Rudd's Lark, Botha's Lark, Blue Swallow, Buffstreaked Chat, Palecrowned Cisticola and Yellowbreasted Pipit. Examples of grassland species preferring sweet and mixed grasslands appear fewer but include Melodious Lark and South African Cliff Swallow. The extensive human pressures on the grassland biome have severe conservation implications for its avifauna: many of the globally threatened species present on the mainland of South Africa, Lesotho and Swaziland have major strongholds in the grassland biome and five of these (Bald Ibis, Whitewinged Flufftail, Rudd’s and Botha’s larks, and Yellowbreasted Pipit) are entirely restricted to this biome in the region.

The riparian habitats of the Klein Marico River is fringed by dense bush thickets and tall riverine vegetation and is a good place for exercising one's warbler identification skills. Icterine Warbler, Olivetree Warbler, Garden Warbler and Whitethroat are among the species that occur. This is also a good place to look for African Finfoot.

The old fields occur on small isolated sections of the project area. Bird species such as crowned plovers, crested guineafowls, francolin species as well as the birds of prey the smaller bird species attract utilize these areas. Although this microhabitat is in a degraded state, the area is a popular habitat for bird species, especially as foraging area, while species such as crowned plover and other smaller non-passerine birds also breed on the ground in this area.

The project area is characterised by isolated rocky outcrops and ridges in some areas. These habitats are characterised by large boulders and steep slopes. The rocky areas provide distinct foraging, nesting and perching habitats for various species, as well as prominent points for display's singing and courtship. This habitat will most likely be frequented by smaller species such as Chats, Pipits and Larks.

Some bird species such as the redbilled oxpeckers and vulture species that occur in the area are primarily dependant on the presence of their food source.

There is a long list of red data bird species that have a geographical distribution that includes the site. The presence of the habitat of these species is mostly confined to the open water habitat, riparian woodland and rocky habitats observed on site. These habitat types will be avoided during the proposed development and it is therefore highly unlikely that species utilizing these habitat types will be impacted on.

5.3.3.3 Herpetofauna (Reptiles and Amphibians)

The only amphibian species of conservation concern that have a distribution that includes the project area and which could occur on site is the giant bullfrog, although Grobler (pers. Comm.) have indicated that the giant bullfrog seems to have disappeared from the project area due to harvesting from local communities. Breeding habitat of frogs and toads can be found mostly in the perennial rivers and dams in the project area. These areas won't be affected by the development, although peripheral impacts should be avoided. The amphibians appear to be poorly represented on site.

Reptile species such as the southern rock python, black mamba, puff adder, boomslang, vine snake, spotted bush snake and several members of the green snakes (Philothamnus spp.) is expected to occur in the project area, although the presence of these snakes is dependant on the presence of their prey species (rodents, frogs etc.). 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. The rocky habitat in the area is optimal habitat for snakes, skinks and lizards.

The only reptile species listed in the IUCN red data categories that could potentially be impacted on is the South African python. The proposed mining activities should allow the species to still have optimal living conditions on the remainder of the area (specifically the rocky outcrop areas and tall grassland floodplains that represent optimal habitat for the species). Although highly charismatic, individuals could be killed by workers when encountered on the construction site, since P. natalensis is highly valued in the "muthi" trade (Branch, 1988).

5.3.3.4 Insects and invertebrates

Insects and spiders are very good indicators of the plant diversity and ecological sensitivity of an area. Butterflies can be used in the field as indicators of biodiversity. An insect and spider desktop survey was done in addition to the field observations.

All of the potential invertebrate habitats are well represented by a high family richness of insects and spiders. Spiders occur throughout all the habitats, and both web builders and active hunters find their ways in trapping and actively hunt around for potential food.

5.3.4 Red data fauna

Table 17 indicate the potential and confirmed red data species occurring in the project area for each of the major groups. Detailed species lists are included in the Appendices section of the document:

Table 17. Red data and threatened fauna of the project area

English Name	Conservation status
BIRDS	
African Marsh Harrier	Vulnerable
Black Harrier	Near threatened
Black Stork	Near threatened
Blackwinged Pratincole	Near threatened
Blue Crane	Vulnerable
Cape Vulture	Vulnerable
Caspian Tern	Near threatened
Chestnutbanded Plover	Near threatened
Greater Flamingo	Near threatened
Halfcollared Kingfisher	Near threatened
Kori Bustard	Vulnerable
Lanner Falcon	Near threatened

English Name	Conservation status
BIRDS	
Lappetfaced Vulture	Vulnerable
Lesser Flamingo	Near threatened
Lesser Kestrel	Vulnerable
Marabou Stork	Near threatened
Martial Eagle	Vulnerable
Melodious Lark	Near threatened
Pallid Harrier	Near threatened
Peregrine Falcon	Near threatened
Pinkbacked Pelican	Vulnerable
Redbilled Oxpecker	Near threatened
Secretarybird	Near threatened
Shortclawed Lark	Near threatened
Tawny Eagle	Vulnerable
White Pelican	Near threatened
Whitebacked Vulture	Vulnerable
Whitebellied Korhaan	Vulnerable
Yellowbilled Stork	Near threatened
MAMMALS	
Cheetah	Vulnerable
South African Hedgehog	Near threatened
Reddish grey musk shrew	Data deficient
Tiny musk shrew	Data deficient
Lesser red musk shrew	Data deficient
Swamp musk shrew	Data deficient
Lesser grey-brown musk shrew	Data deficient
Roan antelope	Vulnerable
Sundevall's leaf-nosed bat	Data deficient
Brown hyena	Near threatened
Single striped mouse	Data deficient
Serval	Near threatened
Pangolin	Vulnerable

English Name	Conservation status
BIRDS	
Honey badger	Near threatened
Schreiber's long-fingered bat	Near threatened
White tailed rat	Endangered
Rusty bat	Near threatened
African weasel	Data deficient
Darling's horseshoe bat	Near threatened
Bushveld gerbil	Data deficient
HERPETOFAUNA	
South African Python	Vulnerable
Giant bullfrog	Near threatened

5.3.5 Management and recommendations for red data, protected and endemic fauna of the project area

Recommendations and mitigating measures need to be implemented to ensure the survival of the threatened and protected fauna habitats and feeding grounds:

- If one considers the habitat descriptions of the red data species, some of them are limited in range or threatened as a direct result of habitat loss in the southern African sub-region, although other species with large home ranges (e.g martial eagle) are not directly threatened by habitat loss. The impact of any development on the red data species would therefore be less than predicted;
- Future development would not have a significant impact on the above mentioned red data fauna provided that adequate natural habitat/vegetation would preserved on the peripheral woodland habitats in the project area;
- The removal of vegetation should be confined to the footprints of developments. Development should not influence the natural feeding and movement patterns of the existing fauna in the area. Peripheral impacts on the larger area should be avoided;
- The protection of different habitat types in the area will be important to ensure the survival of the different animals due to each species' individual needs and requirements. Sufficient natural corridor sections should be protected around the proposed development footprints to allow fauna to move freely between the different vegetation units on the property. In this regard the Klein Marico River and surrounding riparian woodland, surrounding mountainous area and natural

grassland that occur in the area of the proposed development area will be more than sufficient as corridors;

- The riparian woodland and floodplains associated with the drainage channels in the area represent highly sensitive areas and mitigation measures should be implemented to ensure that these habitats are protected;
- The few taller than 3m indigenous trees within this area also provide resting/perching sites for larger birds like vultures, birds of prey, arboreal reptiles and mammals that might occur/pass through the area and should preferably be preserved. These larger trees should be protected as far as possible and be incorporated as part of the landscaping of future development in the area. A monitoring programme needs to be implemented by a specialist.

The cumulative negative impact of development in the project area on the fauna has the potential to be moderate to high should development disregard the environment. However, considering the following general mitigation and management actions taken on site, the impact on faunal populations should be low.

- 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 process;
- No animals may be poached during any constructional processes of any kind. Many animals are protected by law and poaching or other interference could result in a fine or jail term;
- Do not feed any wild animals on development site;
- The occurrence of the vulture species will be influenced by the availability of carcasses and adequate roosting and nesting sites on the property. Poisons for the control of problem animals should rather be avoided since the wrong use thereof can have disastrous consequences for the vulture species as well as other birds of prey occurring in the area. The use of poisons for the control of rats, mice or other vermin should only be used after approval from an ecologist;
- Waste bins and foodstuffs should be made scavenger proof;
- Roads in the area should be designed without pavements to allow for the movement of small mammals;
- The habitat and feeding grounds of the water birds would be in and around the riverine areas and natural springs of the area. The development should aim to promote these areas as potential bird watching areas, and could potentially benefit the survival of the species;
- Power line structures in the area can present electrocution hazards to birds when less than adequate separation exist between energized conductors or between energized conductors and grounded conductors. Avian-safe facilities can be provided by one or more of the following mitigation measures:

a) Increasing separation between conductors to achieve adequate separation for the species involved (larger birds, raptors);
b) Covering energized parts and / or covering grounded parts with materials appropriate for providing incidental contact protection to birds;
c) Applying perch managing techniques such as conspicuous objects and support roosting sites along the power line that would allow large raptors and bustards to safely roost.

Monitoring of the environmental aspects should be done over the longer term to ensure that impacts are limited to a minimum during the constructional and operational phases. Monitoring of specific species such as the ground hornbill is necessary to ensure that these species would be unaffected over the longer term by the development. Information on red data species should be provided to construction workers to make them more aware of these fauna and their behaviour.

6 DISCUSSION OF IMPACTS ON FLORA AND FAUNA FOR DIFFERENT MINING PHASES

The objective of this section was to identify impacts and provide a list of actions and potential impacts associated with the various mining phases namely the planning and design phase, construction phase, operational phase, decommission phase and closure phase for the various mining components:

- Opencast Mining;
- Processing Plant and TSF;
- Support infrastructure including roads, workshops (but excluding portal areas and surface area).

6.1 PLANNING AND DESIGN PHASE

Planning and design is necessary to ensure that mitigation and impact management can be effectively implemented and minimise impacts in future. The planning and design phase of the mine will involve the following actions:

- Obtaining of flora species permits (if relevant);
- Avoidance of sensitive habitats through identification of alternatives;

No specific direct impacts will occur on the fauna and flora of the area.

6.2 CONSTRUCTIONAL PHASE

The development and start-up of the mining operation covers the period of time when considerable changes take place as the mine infrastructure, plant and facilities are constructed, and when the ore body is first exposed. The most immediate impacts are seen as disruptions and disturbances to flora communities due to site clearance for construction of the plant, tailings facility, access and haul roads and other mining related infrastructure. 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 Doornhoek Fluorspar Mine:

- 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 (plant site), pit footprints, access and haul roads, and laydown areas for the stockpiles and overburden dumps. 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 construction of buildings, fences and roads 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 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 opencast 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 for the on the flora and fauna apply to both the Doornhoek Fluorspar Mine for the various components during the construction phase:

6.2.1 Opencast Mining

- **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

6.2.2 Processing Plant and tailings storage facility (TSF)

- **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

6.2.3 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
- **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, access road and bridges**
  - Spillages of harmful substances to the ecosystem;
  - Habitat degradation due to dust;
  - Road mortalities of fauna

6.2.4 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 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 exposure of ore bodies, followed by 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:

- Opencast mining of ore body;
- Processing of ore in the processing plant;
- Storage of tailings (revised TSF height is approx. 40 m.)
- Disposal of overburden on overburden dumps;
- 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 overburden 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 as a result 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 open pit, as well as the roads and additional surface areas created on the slopes of the stockpiles and overburden 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 as a result of specific mining activities. Furthermore, opencast developments can threaten migration routes or flight paths as a result 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 for the on the flora and fauna apply to both the Doornhoek Fluorspar Mine for the various components during the operational phase:

6.3.1 Opencast Mining

- **Activity 1: Laydown areas of stockpiles and overburden dumps**
- **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, storage and transportation**
    - Habitat degradation due to dust;
    - Road mortalities of fauna

- **Activity 3: Crushing and stockpiling**
    - Habitat degradation due to dust;
    - Increased Soil erosion and sedimentation (increased runoff from hardened surfaces and slopes of stockpiles);

6.3.2 Processing Plant and tailings storage facility (TSF)

- **Activity 1: Stockpiling of ore**
- **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:**
    - Spillages of harmful substances to the ecosystem;

6.3.3 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

6.3.4 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.

6.4 DECOMMISION 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;
- Removal of mine infrastructure
- Backfilling of the mined out areas

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.

6.4.1 Opencast Mining

- **Activity 1: Cessation of mining**
- **Related impacts**
  - Potential establishment and spread of declared weeds and alien invader plants;

6.4.2 Processing Plant 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

6.4.3 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

6.4.4 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.

6.5 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:

- Ripping and rehabilitation of all haul roads;
- Rehabilitation of the opencast areas and TSF;
- 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 though.

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

- Soil compaction is likely to occur over much of the rehabilitated area as a consequence of the storage and placement of soil and the change in structure following replacement. The poor soil cover associated with the cleared areas, stockpiles and overburden dumps 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 as a result 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 as a result 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;
- The impact on fauna mortality will continue during the closure phase as a result of rehabilitation activities on site.

6.5.1 Opencast Mining

- **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

6.5.2 Processing Plant and tailings storage facility (TSF)

- **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

6.5.3 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;
  - Road mortalities of fauna

6.5.4 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 represent degraded land.

7 QUANTITATIVE IMPACT ASSESSMENT

Table 18 indicate the impacts described above and specific ratings of significance the impact will potentially have on the ecosystem during the proposed mining activities according to the layout plan of the mining development:

Table 18. Quantitative impact assessment for the various mining components and mining phases

Nr	Impact	Activity	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigtion Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
Planning Phase																
1	Delay of plant construction	Eradication of protected trees / flora through permit application	**WOM**	**Negative**	Definite	5	Short term	1	Local	1	Low	2	20	Negligible	Apply and obtain permits from DAFF after liaison with relevant officials and follow-up site visit to the area	Can be avoided, managed or mitigated
			WM	**Negative**	Highly Probable	4	Short term	1	Local	1	Low	2	16	Negligible		Can be reversed
Construction Phase																
2	Habitat destruction / fragmentation of fauna habitats	Clearing of vegetation for openpit, construction of infrastructure, access roads etc. causing direct habitat destruction / fragmentation	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Local	1	High	8	65	High		Can be avoided, managed or mitigated
3	Soil erosion and sedimentation	Topsoil & subsoil stripping, exposure of soils, ore and rock to wind and rain during construction causing erosion and sedimentation	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Local	1	Medium	6	44	Moderate		Can be avoided, managed or mitigated
4	Spreading and establishment of alien invasive species	Vegetation clearing / vehicle movement	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low		Can be reversed
5	Habitat degradation due to dust	Vegetation clearing / vehicle movement	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	Medium	6	60	Moderate		Can be reversed
6	Spillages of harmfull substances	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible		Can be reversed
7	Road mortalities of fauna / impact of human activities on site	Heavy machinery and vehicle movement on site; Construction of infrastructure, roads etc. on site	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible		Can be avoided, managed or mitigated
Operational Phase																
8	Habitat destruction / fragmentation of fauna habitats	Storage of tailings, laydown areas of overburden dumps and stockpiles	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	High	8	70	High	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
9	Soil erosion and sedimentation	Increased hardened surfaces around infrastructure and exposed areas around openpits, laydown areas of overburden dumps and stockpiles as well as TSF	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
10	Spreading and establishment of alien invasive species	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low	Refer to section 8 (Table 19)	Can be reversed
11	Habitat degradation due to dust	Heavy machinery and vehicle movement on site	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources

Nr	Impact	Activity	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigtion Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
			WM	Negative	Definite	5	Medium term	3	Site	2	Medium	6	55	Moderate	Refer to section 8 (Table 19)	Can be reversed
12	Spillages of harmfull substances	Heavy machinery and vehicle movement on site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to section 8 (Table 19)	Can be reversed
13	Road mortalities of fauna / impact of human activities on site	Heavy machinery and vehicle movement on site; workers accommodated on site causing poaching, wood collection, fires etc.	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
Closure and Decommissioning Phase																
13	Improvement of habitat through revegetation / succession over time	Rehabilitation of mining site	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate	Refer to section 8 (Table 19)	Can be reversed
	Soil erosion and sedimentation	Demolition of mining infrastructure / cessation of mining / rehabilitation of mining site	WOM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Local	1	Low	2	12	Negligible	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
14	Spreading and establishment of alien invasive species	Demolition of mining infrastructure / cessation of mining / rehabilitation of mining site	WOM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to section 8 (Table 19)	Can be reversed
	Habitat degradation due to dust	Demolition of mining infrastructure / cessation of mining / rehabilitation of mining site / vehicle movement on site	WOM	Negative	Highly Probable	4	Long term	4	Site	2	High	8	56	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
15			WM	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Refer to section 8 (Table 19)	Can be reversed
	Spillages of harmfull substances	Heavy machinery and vehicle movement on site	WOM	Negative	Highly Probable	4	Medium term	3	Regional	3	Medium	6	48	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
16			WM	Negative	Probable	2	Short term	1	Site	2	Low	2	10	Negligible	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
	Road mortalities of fauna / impact of human activities on site	Heavy machinery and vehicle movement on site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
17			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
Post-Closure Phase																
	Improvement of habitat through revegetation / succession over time	Natural Successional processes	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
18			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate	Refer to section 8 (Table 19)	Can be reversed
	Soil erosion and sedimentation	Exposed surfaces / unrehabilitated areas on site post closure / poor monitoring during LoM	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
19			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated
	Spreading and establishment of alien invasive species	Exposed surfaces / poor monitoring of revegetation on site	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	Refer to section 8 (Table 19)	May cause irreplaceable loss of resources
20			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Refer to section 8 (Table 19)	Can be avoided, managed or mitigated

8 ECOLOGICAL MANAGEMENT PLAN AND MITIGATION MEASURES FOR THE PROPOSED DOORNHOEK FLUORSPAR MINE

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 below.

Table 19. Ecological Management Plan to be implemented as part of the Environmental Management Programme Report for the Doornhoek Fluorspar Mine

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
Flora and Fauna Planning and Design phase									
Pre-mining	Eradication of protected trees through permit application	Flora	Eradication of protected trees	Section 15(1) of the National Forests Act, 1998	Obtain permits for the eradication of protected trees	Application forms completed as obtained from DAFF regarding specific species, numbers of trees and ecological conditions of the site	Apply and obtain permits from DAFF after liaison with relevant officials and follow-up site visit to the area	2 months	Ecologist / Environmental Assessment Practitioner (EAP)
Construction Phase									
OC Mining, Support infrastructure, TSF and Plant	Clearing of vegetation	Fauna & Flora	Habitat destruction	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) Northwest Environmental Management Act Schedules 2, 3, 11 and 12	• 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 in order to reduce negative impacts on species of concern; • Remove and relocate any plants of botanical or ecological significance as indicated by the ecologist or Environmental Control Officer (ECO); • Vegetation to be removed as it becomes necessary; • Construction should preferably take place in winter to reduce disturbance to breeding fauna and flowering flora; • Remove and relocate any plants of botanical or ecological significance as indicated by the ecologist or Environmental Control Officer (ECO); • 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 ECO should advise the construction team in all relevant matters to ensure minimum destruction and damage to the environment. The 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
OC Mining, Support infrastructure, TSF and Plant	Clearing of vegetation	Fauna	Habitat fragmentation	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) Northwest Environmental Management Act Schedules 2, 3, 11 and 12	• 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, in order to	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							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		
OC Mining, Support infrastructure, TSF and Plant	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 overburden dumps • To prevent the loss of topsoil capability during stockpiling • To prevent the contamination of soils due to spillages of reagents • To prevent soil erosion	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; • 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 in order to limit soil erosion;	Continuous	Contractor / ECO
OC Mining, Support infrastructure, TSF and Plant	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. In order 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. • The hydrochloric acid tanks are contained within an epoxy-coated, concrete lined and bermed facility that has been designed to contain 110% of the volume of the tanks in the event of a spill. This eliminates the potential impacts to soils from spills of hydrochloric acid. • Spills from the tailings thickener will flow by gravity to the mine reclaim water ponds at the southern toe of the existing fines residue deposit. From there they will be pumped back to the processing plant. . The area that would be affected by such a spill has already been impacted by the mining operation. • 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
OC Mining, Support infrastructure, TSF and Plant			Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Prevent fauna mortalities as a result of vehicle movement	Control of vehicle speed Control of vehicle movement	• More fauna are normally killed the faster vehicles travel. A speed limit should be enforced (speed on site max 40 km/hour; Outside of the site 80 km/h. In Rain max 40 km/h). 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
OC Mining, Support infrastructure, TSF and Plant	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:	To implement an alien invasive eradication programme to manage and control alien species	Prevent and control of spreading and establishment of alien invasive species on the mining area and larger	• 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	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
				Biodiversity Act (10/2004)	on the mine	region	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 as a result of new surface disturbance activities at the site. The plan should address monitoring, weed identification, the manner in which weeds spread, and methods for treating infestations.		
OC Mining, Support infrastructure, TSF and Plant	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
OPERATIONAL PHASE									
OC Mining, Support infrastructure, TSF and Plant	Laydown areas of stockpiles and overburden dumps	Flora	Habitat destruction	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 Northwest Environmental Management Act Schedules 2, 3, 11 and 12	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 overburden dumps. 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 construction phase that are similar to the mitigation measures needed for this phase	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
	Laydown areas of stockpiles and overburden dumps	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 Northwest Environmental Management Act Schedules 2, 3, 11 and 12	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase that are similar to the mitigation measures needed for this phase	Continuous	Contractor / ECO
	Laydown areas of overburden dumps 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 in order 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 time 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 construction phase that are similar to the mitigation measures needed for this phase	Continuous	Contractor / ECO
	Laydown areas of overburden dumps 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 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 similar to the mitigation measures for impacts during the construction phase	Continuous	Contractor / ECO
	Laydown areas of overburden dumps 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 construction phase that are similar to the mitigation measures needed for this phase	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
	Laydown areas of overburden dumps 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 construction phase that are similar to the mitigation measures needed for this phase	Continuous	Contractor / ECO
	Laydown areas of stockpiles and overburden dumps	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 construction phase that are similar to the mitigation measures needed for this phase		Ecologist / ECO
DECOMMISSIONING PHASE									
OC Mining, Support infrastructure, TSF and Plant	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 needed during the construction phase that are similar to the mitigation measures needed for this phase	Continuous	Ecologist / ECO
	Demolition of mining infrastructure	Fauna & Flora	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	Refer to mitigation measures needed during the construction phase that are similar to the mitigation measures needed for this phase	Continuous	Contractor / ECO
	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 needed during the construction phase that are similar to the mitigation measures needed for this phase	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 needed during the construction phase that are similar to the mitigation measures needed for this phase	Continuous	Contractor / ECO
CLOSURE PHASE & POST CLOSURE PHASES									
OC Mining, 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	Rehabilitate within development footprint to ensure revegetation and	• Plant vegetation species for rehabilitation that will effectively bind the loose material and which can absorb run-off from the mining areas.	Continuous	Ecologist / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
TSF and Plant					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	rehabilitation impacts are kept within the mining footprint 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.		
	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
		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 closure phase that are relevant	Continuous	Contractor / ECO

9 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.

9.1 CRITICAL BIODIVERSITY & ECOLOGICAL SUPPORT AREAS OF THE PROJECT AREA

The North West Biodiversity Conservation Assessment (NWBCA) identifies specific Critical Biodiversity Areas (CBAs) in the North West Province. Critical Biodiversity Areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (North West Department of Agriculture, Conservation, Environment and Rural Development, 2009).

The majority of the terrestrial areas on site, especially with regards to the locality of the plant and TSF as well as Resource Area C and D are classified as ESA 1 with small occurrences of ESA 2 (refer to Figure 16). The terrestrial areas for the location of Resource Area A are classified as CBA 2.

ESA 1 areas are semi-natural ecologically functional landscapes that retain basic natural attributes:

- Ecosystems are still in a natural, near-natural or semi-natural state, and have not been previously developed;
- Ecosystems are moderately to significantly disturbed but are still able to maintain basic functionality;
- Individual species or other biodiversity indicators may be severely disturbed or reduced;
- These are areas with low irreplaceability with respect to biodiversity pattern targets only.

ESA 2 areas which have been substantially modified and where ecological functionality must be maintained as much as possible with the following attributes:

- Maintain current land use or restore area to a natural state;

- Ecosystems are NOT in a natural or near-natural state, and has been previously developed (e.g. ploughed);
- Ecosystems are significantly disturbed but are still able to maintain some ecological functionality;
- Individual species or other biodiversity indicators are severely disturbed or reduced and these are areas that have low irreplaceability with respect to biodiversity pattern targets only;
- These are areas with low irreplaceability with respect to biodiversity pattern

CBA 2 areas are near natural landscape with the following attributes:

- Ecosystems and species largely intact and undisturbed;
- Areas with intermediate irreplaceability or some flexibility in terms of area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets, although loss of these sites would require alternative sites to be added to the portfolio of CBAs.
- These are landscapes that are approaching but have not passed their limits of acceptable change (READ, 2015).

The CBA Map categories, in particular Protected Areas, CBAs and ESAs, should inform the development of municipal land use schemes in terms of the Spatial Planning and Land Use Management Act (Act. 6 of 2013) (SPLUMA) schedule 2 land use purposes (or other land use zones developed in terms of municipal bylaws), as well as land use change applications (e.g. rezoning). The guidelines also give the evaluators of EIAs an indication of appropriate land uses within each category. Importantly, the North West Biodiversity Sector Plan provides guidance on appropriate land uses but does not grant or remove existing land use rights or take the place of development application authorisation processes.

The following land management objectives apply to ESA 1 and CBA 2 areas and should guide land use planning and decision-making:

- ESA 1: Maintain in at least a semi-natural state as ecologically functional landscapes that retain basic natural attributes.
- CBA 2: Maintain in a natural or near-natural state that maximises the retention of biodiversity pattern and ecological process.

The following land use zones and associated activities are recommended for ESA 1 and CBA 2 areas (READ, 2015): (Y = Yes, N = No, R = Restricted)

Table 20. Land use zones and associated activities are recommended for ESA 1 and CBA 2 areas

Land Use Zone	Associated Land Use Activities	Allowance/Status
Environmental Conservation	Conservation management, low intensity eco-tourism activities and sustainable consumptive activities	Y
Environmental Management Overlay Zone	These are areas that are designated as priority areas for protection, namely CBA's and ESA's, and can include ONA's	Y
Tourism and Accommodation	Low Impact Tourism / Recreational and Accommodation	R
	High Impact Tourism / Recreational and Accommodation (e.g. golf estates)	N
Rural Residential	Low density rural housing or eco-estates	R
	Tradition Areas (existing) and Rural Communal Settlement (New)	N
Agriculture	Extensive Game Farming	Y
	Extensive Livestock Production	Y
	Game Breeding	N
	Arable Land – Dryland and Irrigated Crop Cultivation	N
	Agricultural infrastructure – Intensive Animal farming (e.g.) feedlot, dairy, piggery, chicken battery)	N
Municipal Commonage	Local Agri-economic Development	R
Open Space	Public or Private Open Space, including recreational areas, parks, etc.	R
Residential	Low, low-medium and medium-high, and high density urban residential development (Urban & Business Development)	N
Urban Influence	An amalgamation of land use zones, including institutional, urban influence, general mixed use, low impact mixed use, suburban mixed use and general business (Urban & Business Development)	N
Low or High Impact and General Industry	Low impact, general industry and high impact industry (Urban & Business Development)	N
Transport Services	Transportation service land uses e.g. airports, railway stations, petro-ports and truck stops, bus and taxi ranks and other transport depots (In NW – Linear Engineering Structures)	R
Roads and Railway	Excising and planned linear infrastructure such as hardened roads and railways, including activities and buildings associated with road construction and maintenance, e.g. toll booths, construction camps and road depots sites (Linear Engineering Structures)	R
Utilities	Linear engineering structures, such as pipelines, canals and power lines (Linear Engineering Structures)	R
	Small scale infrastructural	R

Land Use Zone	Associated Land Use Activities	Allowance/Status
	installations, including wastewater treatment works and energy sub-stations	
	Large scale infrastructure installations, including bulk water transfer schemes, impoundments (Water Projects & Transfers), and energy generation facilities (power stations)	N
	Renewable Energy (PV farms and solar arrays)	N
	Renewable Energy (wind farms)	R
Quarrying and Mining	Prospecting and Underground Mining	R
	Quarrying and open cast mining (includes surface mining, dumping & dredging)	N
	Hydraulic Fracturing (fracking)	N

It is important to note that land development applications may require environmental authorisations and town planning permission irrespective of the CBA Map category; and that these processes must be followed. Where development applications other than the preferred biodiversity-compatible land uses are submitted in terms of the NEMA EIA Regulations, integrated environmental management tools or land use legislation (SPLUMA regulations/municipal bylaws), the following is recommended:

- A screening exercise should be undertaken by a biodiversity or ecological specialist appointed by the Environment Assessment Practitioner (EAP), to verify the CBA Map category on site
- If the site is verified as a CBA 1, CBA 2, ESA 1 and/or ESA 2, land development applications other than the preferred biodiversity-compatible land uses should be investigated in detail and the mitigation hierarchy applied in full.
- If the application is pursued, the application should be informed by the specialist biodiversity or ecological assessment as undertaken during the screening phase (READ, 2015).

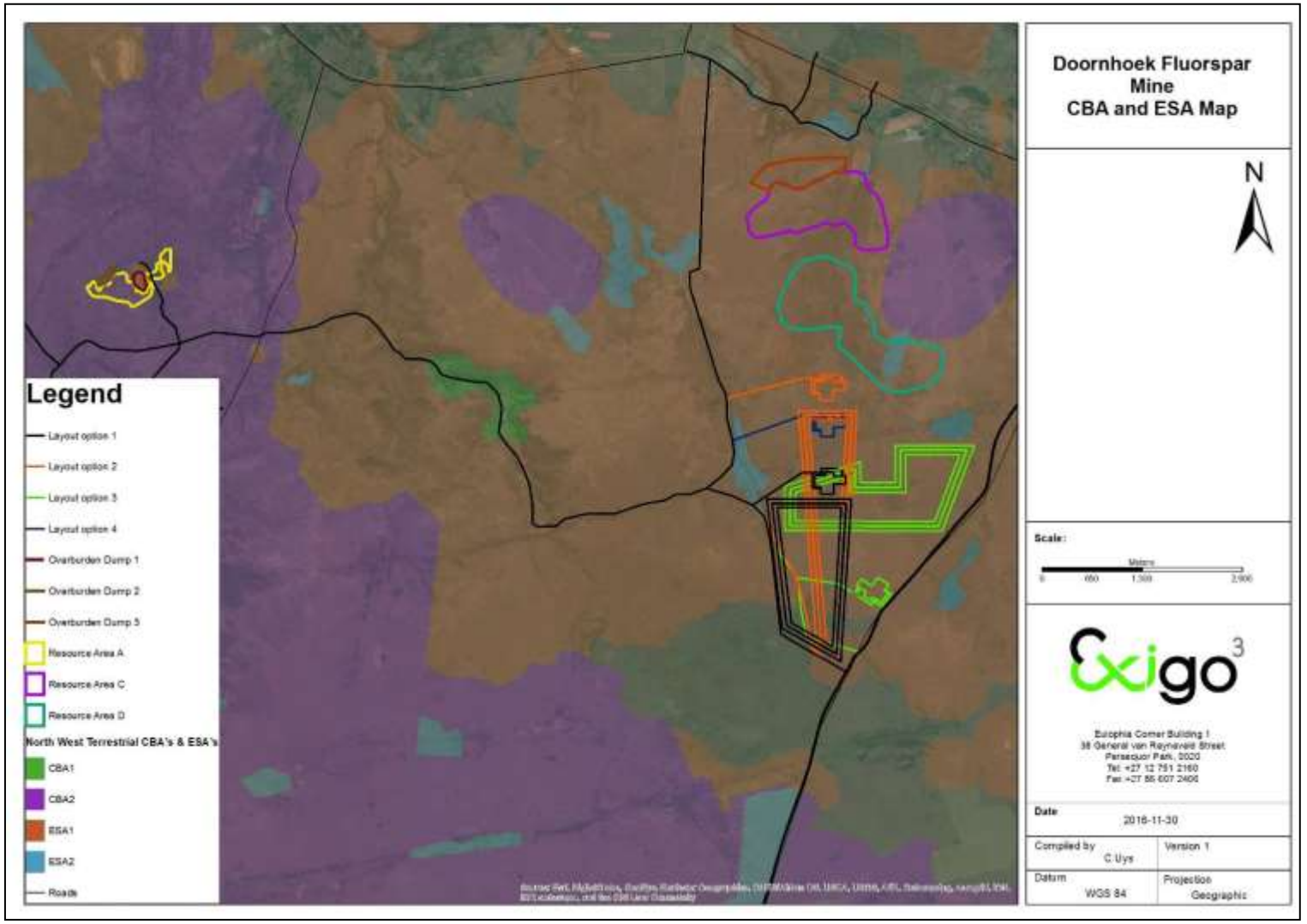

Figure 16. Terrestrial CBA areas of the study area (2015)

9.2 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 Doornhoek Mining site and associated infrastructure however, the Molemane Nature Reserve is located southwest in proximity to the study area, although the closest point of the reserve to the site is 7km to the southwest (Figure 9).

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 NPAES is linked to the Molemane Nature Reserve to the North, although it does not overlap with the project area.

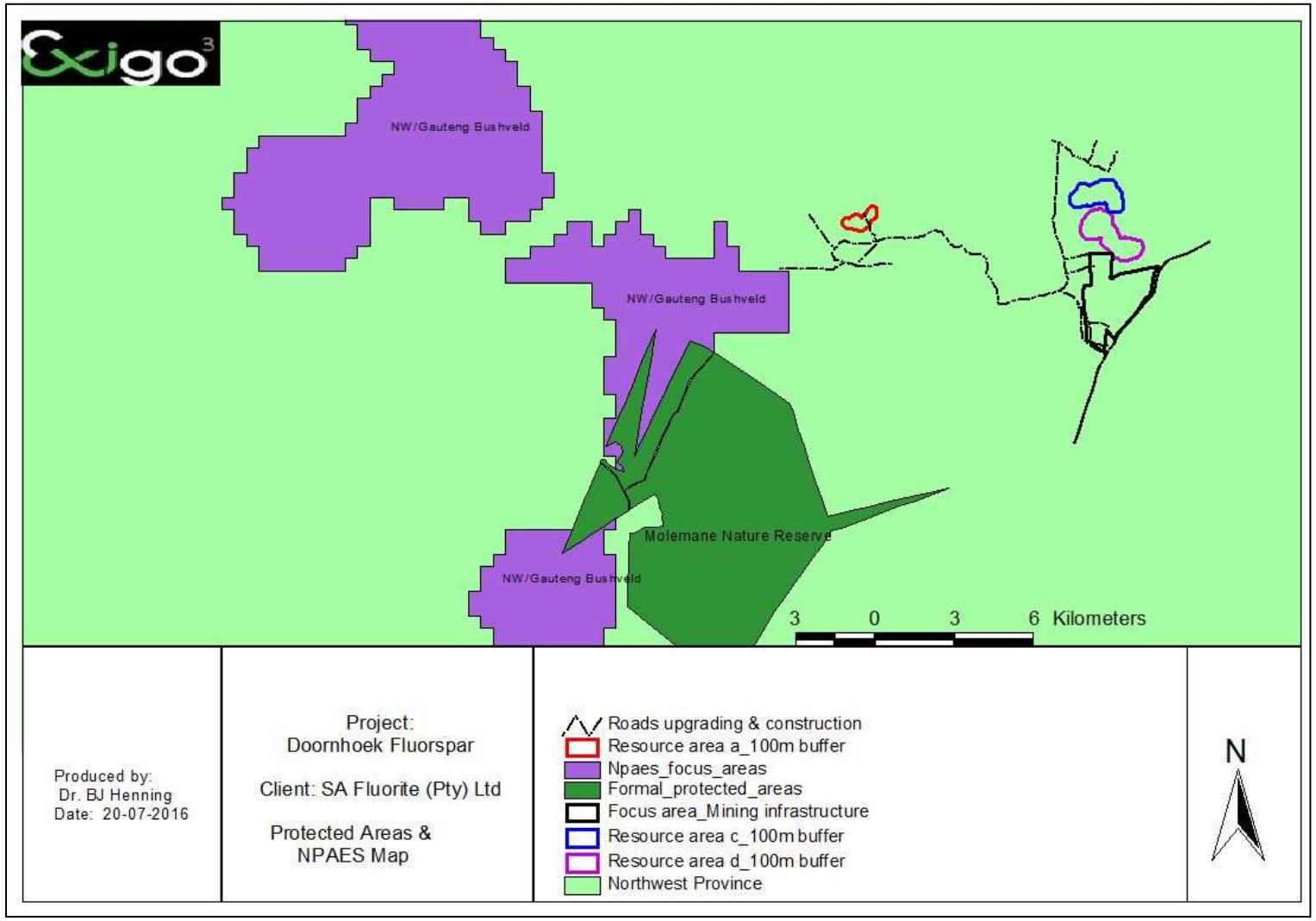

Figure 17. Protected areas in close proximity to the project area

9.3 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).

No IBA is located within close proximity to the project area, with the closest IBA located roughly 40 kilometers northwest of the site.

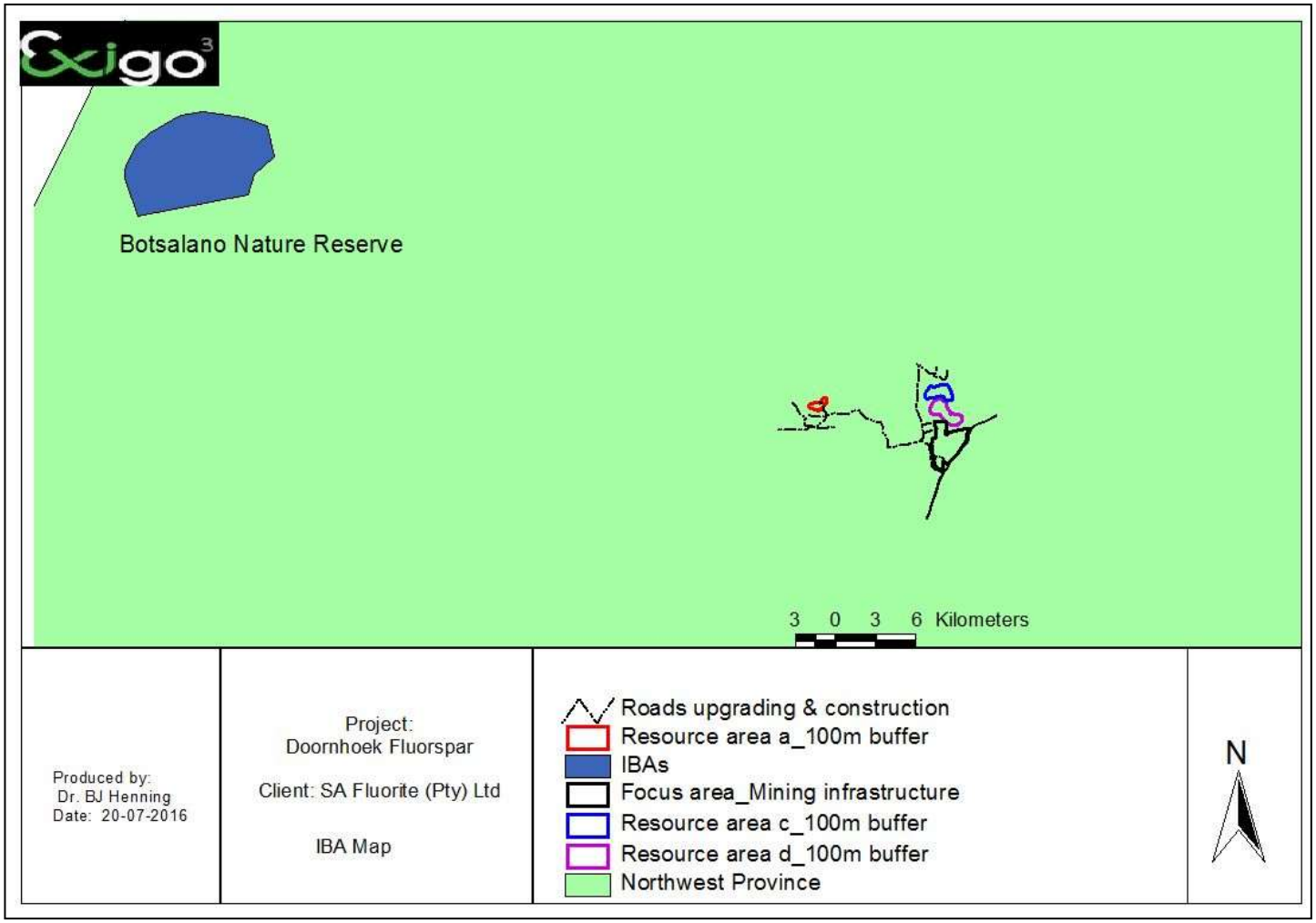

Figure 18. Location of the project area in relation to IBAs

9.4 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 a number of 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. No listed ecosystem occurs in close proximity of the project area as indicated in Figure 12. Both the Mafikeng Bushveld and Rand Highveld Grassland vegetation types is located more than 25km from the site.

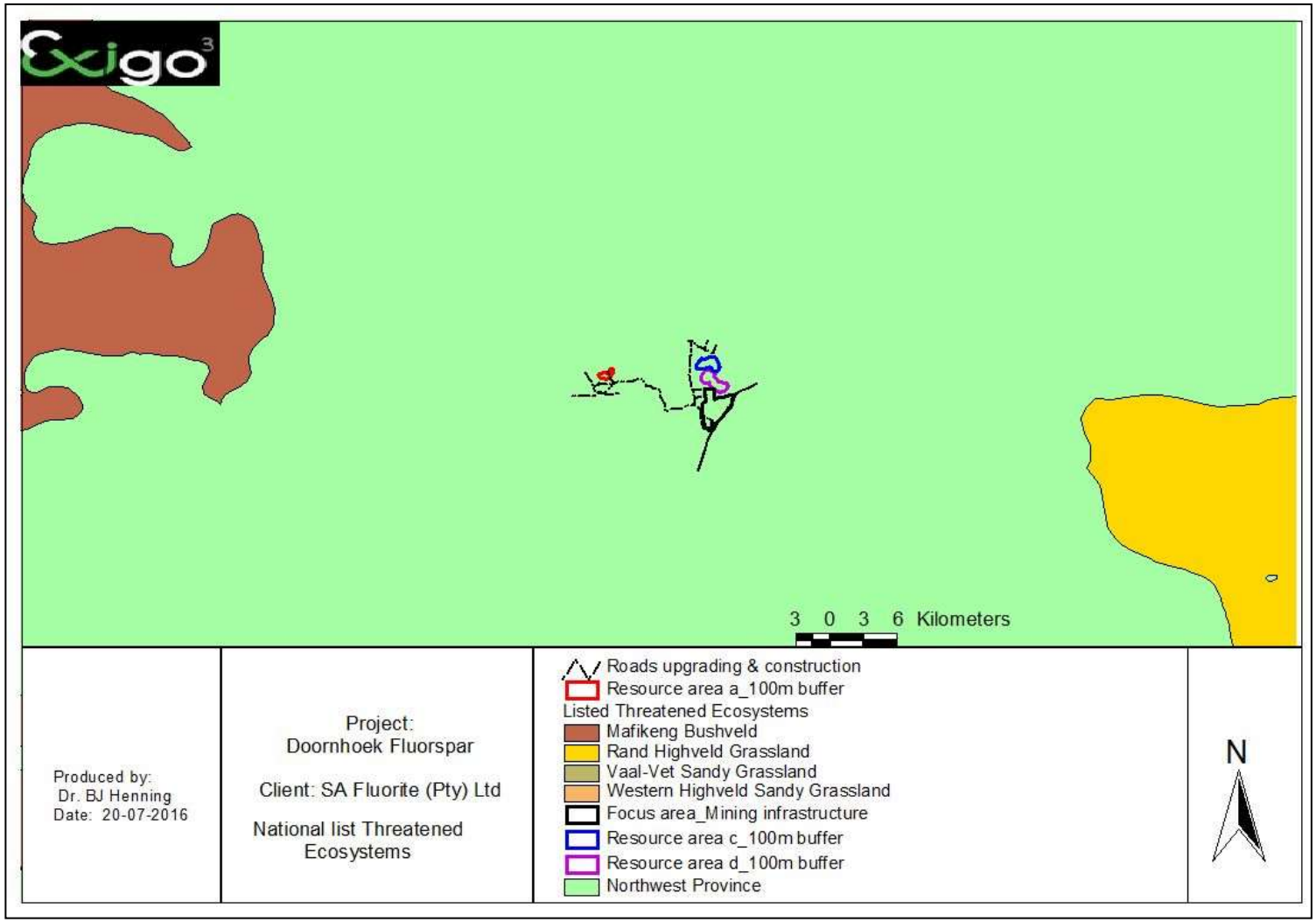

Figure 19. Location of the project area in relation to National List of Terrestrial Threatened Ecosystems (2011)

9.5 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 total area (Figure), as well as separate sensitivity maps for the layout alternatives. Only criteria applicable to the specific vegetation units were used to determine the sensitivity of the specific unit.

Table 21 compared the different mining infrastructure options from an ecological point of View, while figures 21 to 24 indicate the overlay of the mining infrastructure on the sensitivity map.

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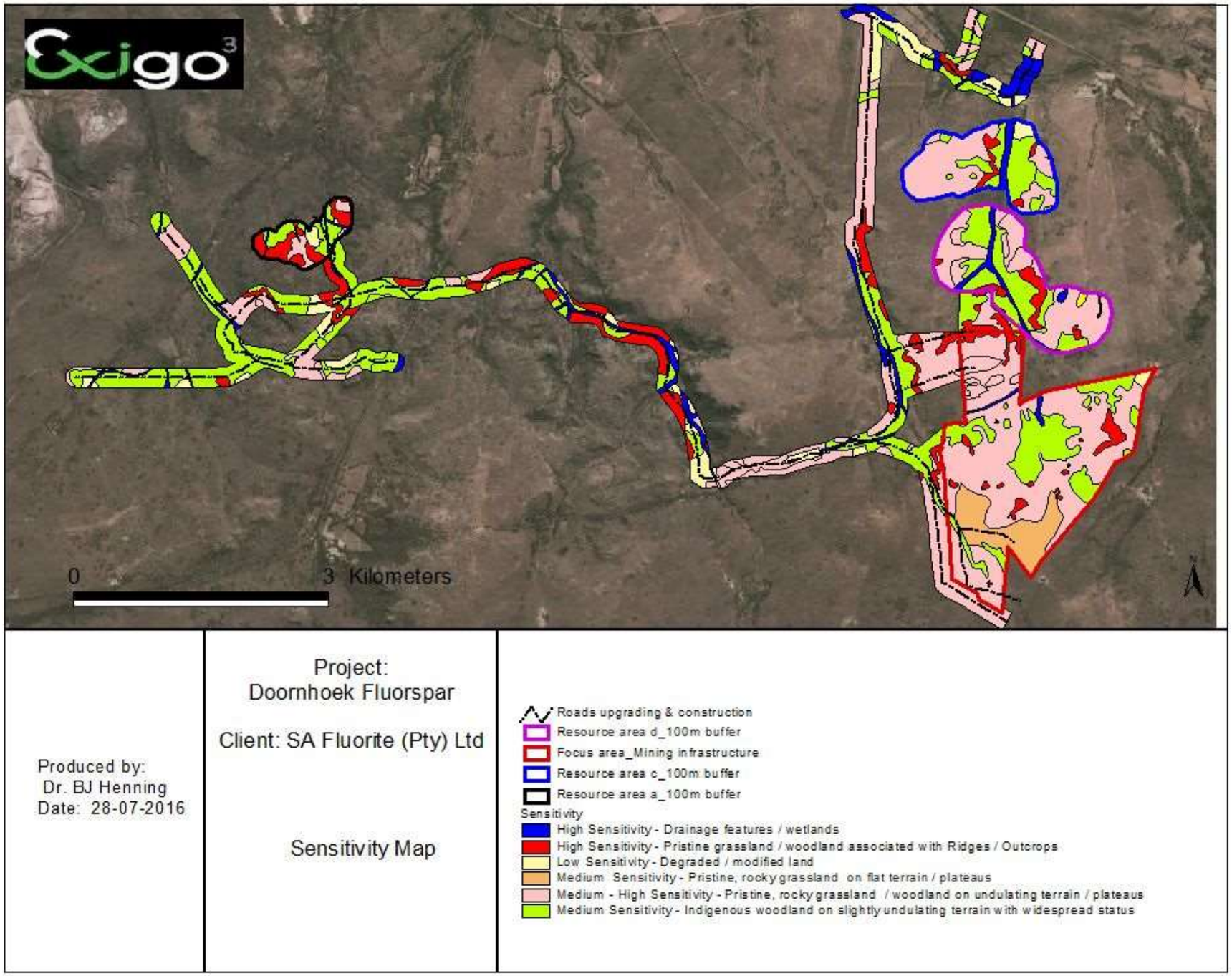

Figure 20. Sensitivity Map of the proposed Doornhoek Fluorspar Mine site

Table 21. Preferred and alternative layout options for the proposed Doornhoek Fluorspar Mine

Options	Positives	Negatives	Recommendation
Layout Option 1	• Plant location close to resource • Plant location on less sensitive woodland compared to other options • Infrastructure on less sloping terrain	• TSF and sections of plant impacting on pristine grassland and outcrop area	**2nd most suitable option from an ecological point of view**
Layout Option 2	• Plant location close to resource • TSF restricted to long narrow section without sensitive outcrops and flatter terrain being impacted on	• Plant located on sensitive woodland and outcrop areas as well as rocky and sloping terrain • TSF impacting on pristine grasslands	**4th most suitable option from ecological point of view**
Layout Option 3	• Plant located close to access road for construction • Plant and TSF on less sensitive terrain (footprint surface area) compared to other options	• Plant located further away from resource area • TSF impacting on rocky ridge	**1st – Most suitable option from an ecological point of view**
Layout Option 4	• Plant location close to resource • Infrastructure on less sloping terrain	• TSF and sections of plant impacting on pristine grassland and outcrop area	**3rd most suitable option from ecological point of view**

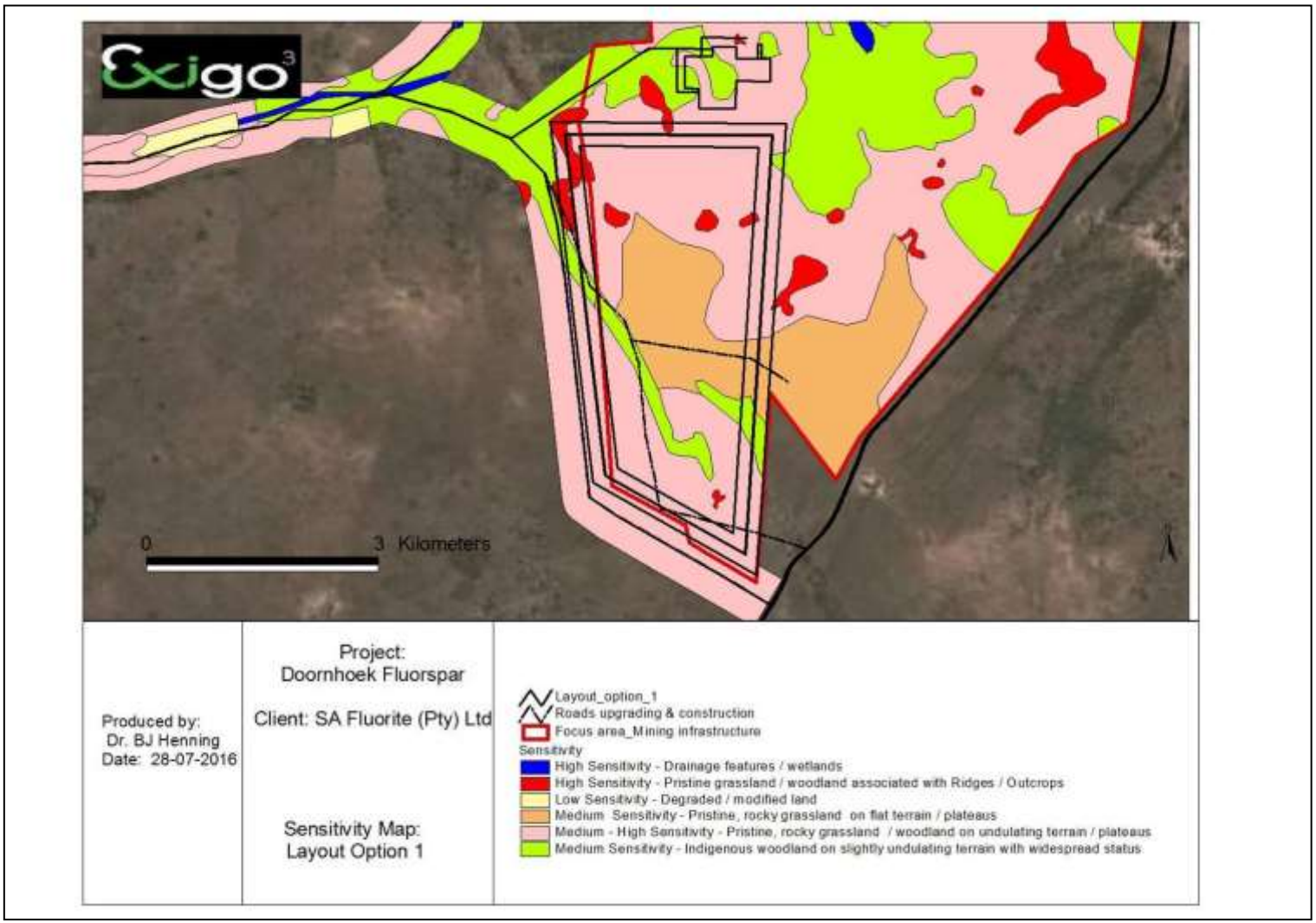

Figure 21. Layout option 1 Sensitivity Overlay

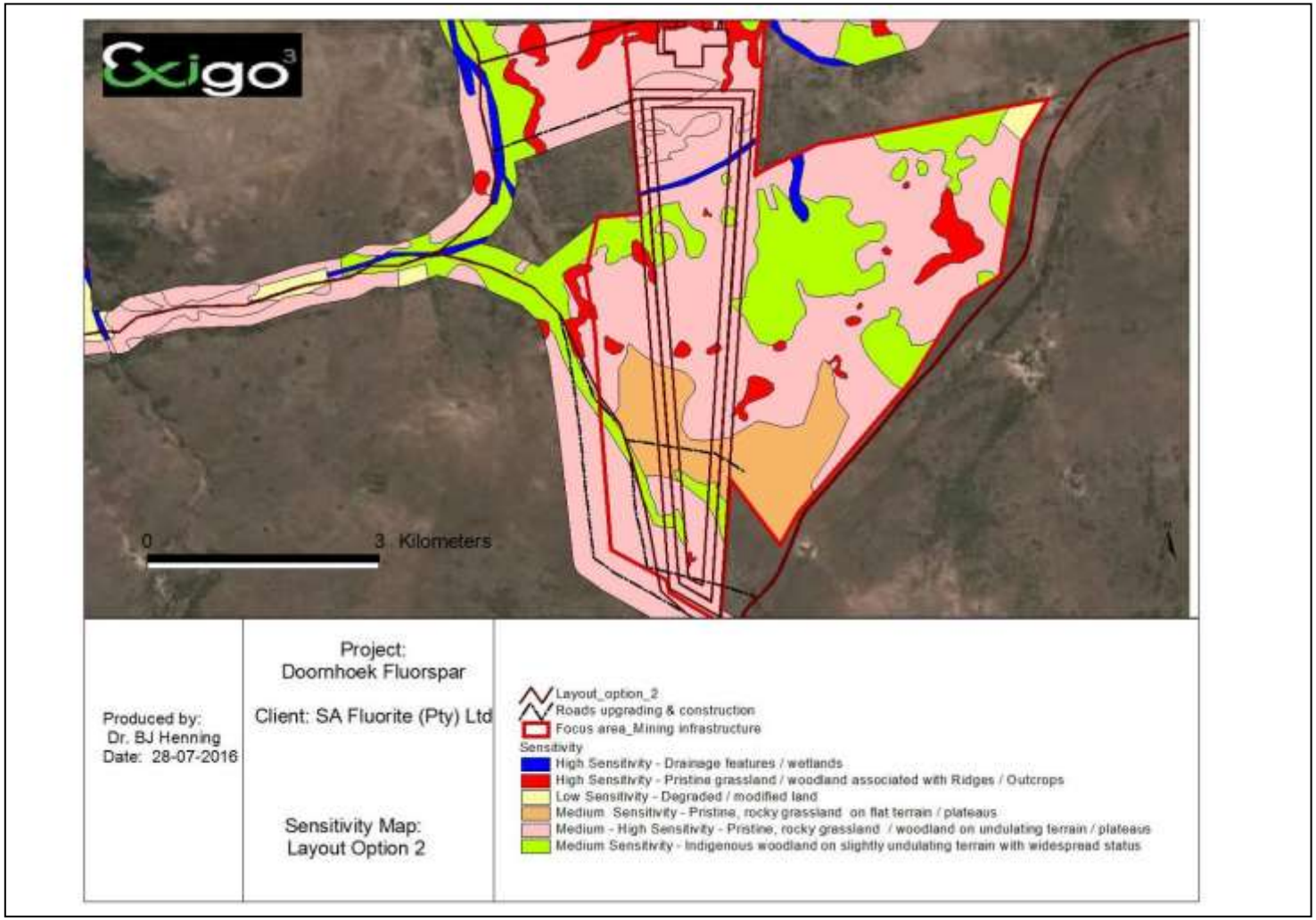

Figure 22. Layout option 2 Sensitivity Overlay

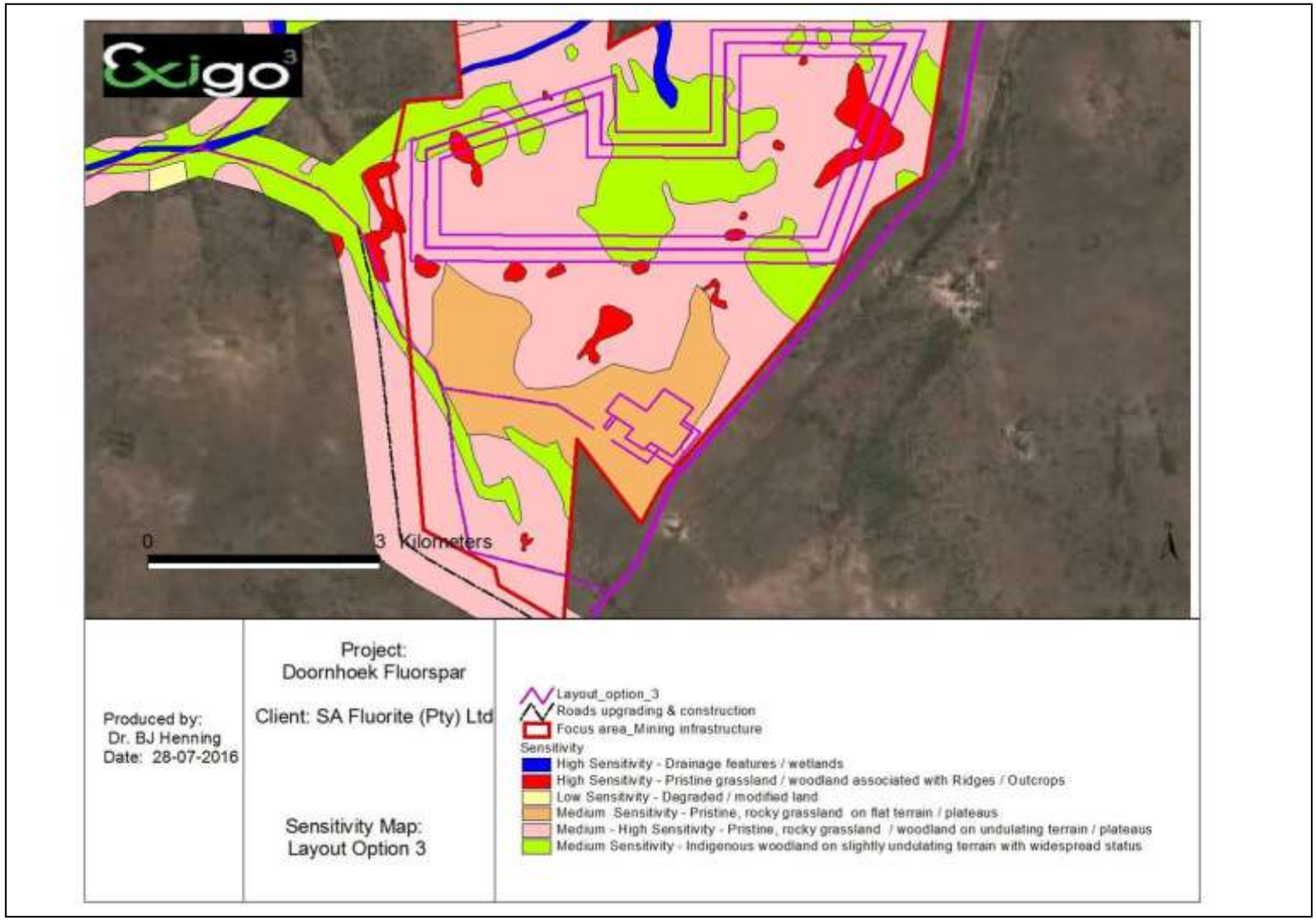

Figure 23. Layout option 3 Sensitivity Overlay

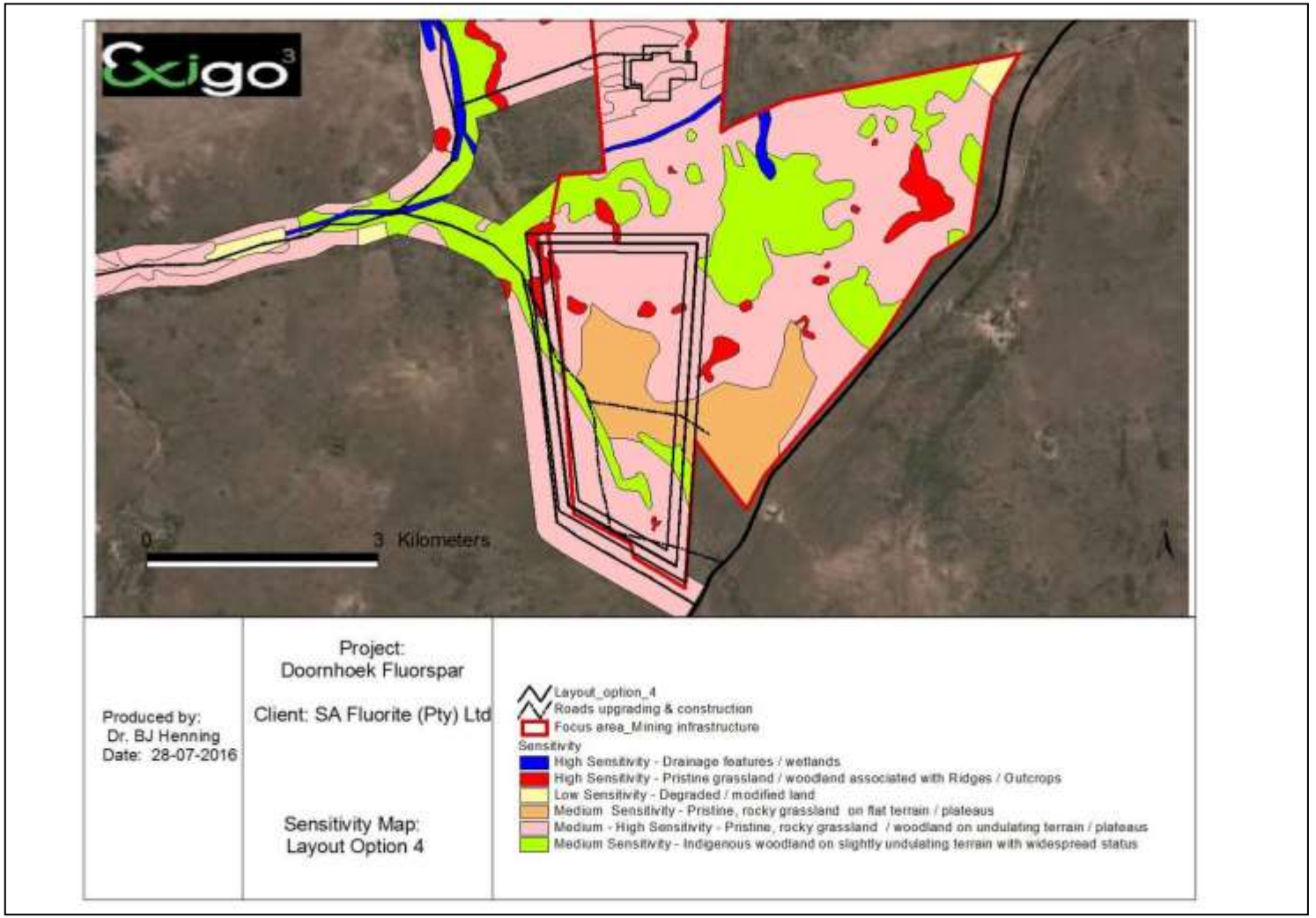

Figure 24. Layout option 4 Sensitivity Overlay

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 permanent plots 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 actually 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 Thaba Cronimet Mining 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
- 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 particular 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.
- 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;
- 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
    - 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 also 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 particular 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 Polokwane there is an opportunity to develop a comprehensive monitoring program providing management directions and educational benefit. Many guides and programs on wetland monitoring exist. Bio-monitoring form 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 past 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 in order 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.
- 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, if mining in the area has been approved. Monitoring actions in different seasons of the year often provides diverse but complementary insights much needed for an informative baseline of data. In future some seasons may be excluded from the monitoring where deemed more cost-effective. If open cast mining takes place on site the monitoring will allow for detecting changes and possibly guide rehabilitation actions.

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 December and January which is 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 particular conservation priority.

Table 22 indicate the monitoring requirements for the fauna and flora components within the project area.

Table 22. Fauna and Flora Monitoring requirements for the Doornhoek Fluorspar 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								
OC Mining, 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								
OC Mining, Support infrastructure, TSF and Plant	Laydown areas of overburden dumps and stockpiles, materials handling and transportation, crushing and stockpiling,	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		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
	Stockpiling of ore, disposal of tailings, vehicle movement during construction of infrastructure, access roads and bridges	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								
	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								
OC Mining, 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 • Ratio of bare soil patches and ground cover • Presence, absence and trends in the occurrence of identified	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
			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 ALTERNATIVES

Table 23 provide a description of alternatives for specific ativties in close proximity to sensitive environmental areas:

Table 23. Alternatives for specific mining activities

Alternative	Definition of Alternatives	
Activity	Process Plant & TSF area	Opencast mining
Location	Farms Knoflookfontein and 306JP	Project area
Process	Construction of TSF and plant in sensitive vegetation units	Construction of openpits in water courses and vegetation associated with outcrops
Demand	Limited space available for the layout and placement of these mining infrastructure options	Openpit mining dependant on location of resource
Scheduling	No scheduling alternatives that are more favourable to the environment could be identified	
Input	Ecological suitability determined location	N/a
Routing	The TSF and Plant areas on level terrain impacting less sensitivie vegetation units were preferred	N/a
Site Layout and Design	Refer to routing description	Not possible considering that the mining is dependant on the resource
Scale	Site specific	Site specific
No-go alternative:	Construction of TSF and Plant across wetlands or highly sensitive outcrops or in areas with sensitive vegetation and / or protected species (permits needed)	Opencast mining in natural wetlands and vegetation types without IWUL application or permits for the eradication of protected plants

12 IMPACT STATEMENT AND VIABILITY OF MINING PROJECT

The proposed mining activities that form part of the Doornhoek Fluorspar Mine will definitely impact on the flora and fauna of the area. The following can be concluded with regards to the impacts:

- Vegetation clearing and topsoil stripping will have the most definite and permanent direct negative impact on the flora and fauna of the area during the construction phase of the mine. The clearance will eradicate all vegetation and displace fauna that will migrate to neighbouring areas;
- The laydown areas of overburden dumps and stockpiles during the operational phase of the mine will have a direct, significant negative impact on the vegetation and fauna habitats, considering that most of the vegetation in the larger area can be considered as pristine;
- The indirect impacts such as soil erosion, fauna mortalities, spillages and establishment of alien invasive species are relevant for all mining phases, although with strict implemented of the mitigation measures and action plans for the various components, the impacts can be minimized;
- Considering the cumulative impacts of the mining phases on the fauna and flora of the area, it can be concluded that the current degraded state of the vegetation and fauna habitats caused by the surrounding and on site mining activities, will cause some negative impacts, although the implementation of a rehabilitation and revegetation plan will allow the vegetation to recover over time and the fauna to return to the area;
- The mining development can be considered as viable, although strict mitigation and monitoring will need to be implemented throughout all of the mining phases to ensure the impacts are kept to a minimum.

13 CONCLUSION

All aspects of the environment, especially living organisms, are vulnerable to disturbance of their habitat. The mining activities will completely modify the natural vegetation and faunal habitats. The importance of monitoring, rehabilitation and implementation of mitigation processes to prevent negative impacts on the environment during and after the closure phases of the mines should be considered a VERY HIGH priority. Any negative impacts created by such actions and processes will ultimately scar the environment and negatively impact on the ecosystem both on a local and global scale. The proposed site for the mining operation occurs largely in a pristine environment. The project area consists of sensitive drainage features, indigenous woodland and rocky outcrops providing a unique habitat for a variety of plant species to establish as well as perching and breeding areas for larger birds of prey. The riverine woodland, floodplains and smaller drainage channels also provide valuable corridors and feeding and breeding areas for red data and other birds, reptiles and amphibians. Many features of the study area contribute to its ecological sensitivity and it is recommended to be considered during the environmental impact process. Provided that the mitigation measures and recommendations are adhered to as stated in the report, the development of the Doornhoek Fluorpsar Mine and associated infrastructure can be supported, although under strict conditions with regards to monitoring, rehabilitation and management measures.

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APPENDIX A – PLANT SPECIES LISTS FOR SITE

Plant species of the Grasslands (including old fields / degraded areas)

Woody species	Grass species	Forbs, geophytes & succulents
Acacia caffra	*Aristida congesta*	*Aloe zebrina*
Acacia karroo	*Aristida junciformes*	*Ancylobotrys capensis*
Acacia nilotica	*Aristida scabrivalis*	*Asparagus suaveolens*
Acacia tortilis	*Aristida stipitata*	*Athrixia elata*
Brachylaena discolor	*Brachiaria nigropedata*	*Boophane disticha*
Combretum molle	*Brachiaria serrata*	*Bulbostylis burchelli*
Cussonia paniculata	*Cynodon dactylon*	*Ceratotheca triloba*
Diospyros lycioides	*Digitaria eriantha*	*Crabbea hirsuta*
Dombeya rotundifolia	*Digitaria ternata*	*Dicoma zeyheri*
Englerophytum magalismontanum	*Elionorus muticus*	*Helichrysum areonitens*
Ficus glumosa	*Eragrostis lehmanniana*	*Helichrysum setosum*
Ozoroa sphaerocarpa	*Eragrostis racemosa*	*Indigofera nebrowniana*
Protea caffra	*Eragrostis viscosa*	*Jamesbrittenea burkeana*
Rhoicissus revolli	*Heteropogon contortus*	*Kalanchoe thyrsiflora*
Rothmannia capensis	*Loudetia simplex*	*Leonotis leonorus*
Searsia lancea	*Melinis repens*	*Lippia javanica*
Searsia leptodictea	*Pogonarthria squarrosa*	*Nidorella anomala*
Securidaca longipedunculata	*Schizavhyrium jeffreysii*	*Parinari capensis*
Strychnos pungens	*Setaria lindenbergiana*	*Pellaea calomelanos*
Tapiphyllum parvifolium	*Setaria sphacelata*	*Pseudognaphalium luteo-album*
Ximebnia caffra	*Sporobolus iocladus*	*Raphionacme hirsita*
Zanthoxylum capense	*Themeda triandra*	*Searsia magalismontanum*

Woody species	Grass species	Forbs, geophytes & succulents
	Trachypogon spicatus	*Senecio inornatus*
	Trichoneura grandiglumis	*Senecio inornatus*
	Triraphis andropogonoides	*Stoebe vulgaris*
	Tristachya biseriata	*Triumfetta sonderi*
	Urelytrum agrypyroides	*Vernonia oligocephala*
		Viscum rotundifolium
		Xerophyta retinervis

Plant species of the woodlands (including wetlands & riparian woodland)

Woody species	Grass species	Forbs, geophytes & succulents
Acacia caffra	*Aristida spp.*	*Acretome hispida*
Acacia erioloba	*Brachiaria nigropedata*	*Agave sessilana*
Acacia karroo	*Brachiaria serrata*	*Aloe cryptopoda*
Acacia robusta	*Chloris virgata*	*Aloe davyana*
Acacia tortilis	*Cynodon dactylon*	*Aloe marlothii*
Anonna senegalensis	*Digitaria eriantha*	*Altenanthera pungens*
Apodytes dimidiata	*Enneapogon scoparius*	*Argemone ochroleuca*
Bridelia mollis	*Enteropogon macrostachys*	*Asparagus africanus*
Buddleja salvifolia	*Eragrostis gummiflua*	*Asparagus laricinus*
Burkea africana	*Eragrostis lehmanniana*	*Asparagus suaveolens*
Celtis africana	*Fingerhutia africana*	*Berkheya setifera*
Cereus jamacaru	*Heteropogon contortus*	*Bidens pilosa*
Combretum erythrophyllum	*Hyparrhenia hirta*	*Boophane disticha*
Combretum molle	*Pogonarthria squarrosa*	*Ceratotheca triloba*
Combreum zeyheri	*Schizachyrium sanguineum*	*Commelina erecta*
Cussonia paniculata	*Setaria lindenbergiana*	*Cyperus sexangularis*
Dichrostachys conerea	*Setaria megaphylla*	*Datura oligotricha*
Diospyros whyteana	*Setaria sphacelata*	*Datura stramonium*
Dombeya rotundifolia	*Setaria verticillata*	*Flaveria bidentis*
Ehretia rigida	*Sporobolus fimbriatus*	*Harissia martinii*
Eucalyptus spp.	*Themeda triandra*	*Helichrysum krausii*
Euclea undulata	*Triraphis andropogonoides*	*Kalanchoe thrysiflora*

Woody species	Grass species	Forbs, geophytes & succulents
Faurea saligna		*Lippia javanica*
Grewia flava		*Opuntia ficus-indica*
Gymnosporia buxifolia		*Opuntia imbricata*
Jacaranda mimosifolia		*Opuntia stricta*
Kiggelaria africana		*Pellaea calomelanos*
Lannea discolor		*Schkuria pinnata*
Lantana camara		*Solanum panduriforme*
Maytenus tenuispina		*Stoebe vulgaris*
Myrsine africana		*Tagetes minuta*
Ochna pulchra		*Triumfetta sonderi*
Olea europaea		*Typha capensis*
Osyris lanceolata		*Verbena bonariensis*
Ozoroa sphaerocarpa		*Viscum rotundifolium*
Pappea capensis		*Xanthium strumarium*
Populus alba		
Protea caffra		
Salix babylonica		
Searsia chirindensis		
Searsia lancea		
Searsia leptodictea		
Searsia pyroides		
Securidaca longipedunculata		
Solanum mauritianum		
Strychnos madagascariensis		

Woody species	Grass species	Forbs, geophytes & succulents
Strychnos pungens		
Tarchonanthus camphoratus		
Tecoma stans		
Vitex poara		
Zanthoxylum capense		
Ziziphus mucronata		

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APPENDIX B –PLANT SPECIES LIST FOR QDS

Family name	Species Name
MALVACEAE	*Abutilon piloso-cinereum*
FABACEAE	*Acacia caffra*
FABACEAE	*Acacia erubescens*
FABACEAE	*Acacia hebeclada subsp. hebeclada*
FABACEAE	*Acacia hereroensis*
FABACEAE	*Acacia karroo*
FABACEAE	*Acacia robusta subsp. robusta*
EUPHORBIACEAE	*Acalypha angustata*
EUPHORBIACEAE	*Acalypha villicaulis*
CUCURBITACEAE	*Acanthosicyos naudinianus*
ASTERACEAE	*Acanthospermum glabratum*
ASTERACEAE	*Acanthospermum hispidum*
AMARANTHACEAE	*Achyranthes aspera var. aspera*
LAMIACEAE	*Acrotome inflata*
ASTERACEAE	*Adenostemma caffrum*
PTERIDACEAE	*Adiantum capillus-veneris*
CRASSULACEAE	*Adromischus sp.*
AMARANTHACEAE	*Aerva leucura*
LORANTHACEAE	*Agelanthus natalitius subsp. zeyheri*
ROSACEAE	*Agrimonia procera*
POACEAE	*Agrostis lachnantha var. lachnantha*
OROBANCHACEAE	*Alectra sessiliflora var. sessiliflora*
ASPHODELACEAE	*Aloe greatheadii var. davyana*
ASPHODELACEAE	*Aloe zebrina*
AMARANTHACEAE	*Alternanthera pungens*
FABACEAE	*Alysicarpus zeyheri*
AMARANTHACEAE	*Amaranthus hybridus subsp. hybridus var. hybridus*
AMARANTHACEAE	*Amaranthus spinosus*
AMARANTHACEAE	*Amaranthus thunbergii*
PORTULACACEAE	*Anacampseros filamentosa subsp. filamentosa*
RUBIACEAE	*Anthospermum rigidum subsp. rigidum*
MENISPERMACEAE	*Antizoma angustifolia*
ICACINACEAE	*Apodytes dimidiata subsp. dimidiata*
SCROPHULARIACEAE	*Aptosimum elongatum*
ASTERACEAE	*Arctotis arctotoides*
ASTERACEAE	*Arctotis microcephala*
PAPAVERACEAE	*Argemone ochroleuca subsp. ochroleuca*
POACEAE	*Aristida canescens subsp. canescens*
POACEAE	*Aristida congesta subsp. congesta*
ASTERACEAE	*Artemisia afra var. afra*

Family name	Species Name
APOCYNACEAE	*Asclepias aurea*
APOCYNACEAE	*Asclepias brevipes*
APOCYNACEAE	*Asclepias fallax*
APOCYNACEAE	*Asclepias sp.*
ASPARAGACEAE	*Asparagus flavicaulis subsp. flavicaulis*
ASPARAGACEAE	*Asparagus laricinus*
ASPARAGACEAE	*Asparagus suaveolens*
ASPARAGACEAE	*Asparagus virgatus*
APOCYNACEAE	*Aspidoglossum restioides*
ASPLENIACEAE	*Asplenium aethiopicum*
ASPLENIACEAE	*Asplenium phillipsianum*
POACEAE	*Avena byzantina*
IRIDACEAE	*Babiana bainesii*
ACANTHACEAE	*Barleria macrostegia*
ACANTHACEAE	*Barleria pretoriensis*
BEHNIACEAE	*Behnia reticulata*
RHAMNACEAE	*Berchemia zeyheri*
ELATINACEAE	*Bergia decumbens*
ASTERACEAE	*Berkheya onopordifolia var. onopordifolia*
ASTERACEAE	*Berkheya radula*
ASTERACEAE	*Bidens pilosa*
ACANTHACEAE	*Blepharis integrifolia var. integrifolia*
ACANTHACEAE	*Blepharis natalensis*
ACANTHACEAE	*Blepharis serrulata*
ORCHIDACEAE	*Bonatea antennifera*
ORCHIDACEAE	*Bonatea polypodantha*
POACEAE	*Bothriochloa bladhii*
POACEAE	*Brachiaria brizantha*
POACEAE	*Brachiaria deflexa*
POACEAE	*Brachiaria serrata*
APOCYNACEAE	*Brachystelma circinatum*
APOCYNACEAE	*Brachystelma incanum*
POACEAE	*Bromus sp.*
BUDDLEJACEAE	*Buddleja saligna*
BUDDLEJACEAE	*Buddleja salviifolia*
ASPHODELACEAE	*Bulbine abyssinica*
ASPHODELACEAE	*Bulbine frutescens*
ASPHODELACEAE	*Bulbine narcissifolia*
APIACEAE	*Bupleurum mundii*
FABACEAE	*Burkea africana*
CANNABACEAE	*Cannabis sativa var. sativa*

Family name	Species Name
CELTIDACEAE	*Celtis africana*
ASTERACEAE	*Centaurea melitensis*
PEDALIACEAE	*Ceratotheca triloba*
SCROPHULARIACEAE	*Chaenostoma floribundum*
SCROPHULARIACEAE	*Chaenostoma patrioticum*
ACANTHACEAE	*Chaetacanthus burchellii*
ACANTHACEAE	*Chaetacanthus costatus*
FABACEAE	*Chamaecrista biensis*
FABACEAE	*Chamaecrista comosa var. capricornia*
VERBENACEAE	*Chascanum adenostachyum*
VERBENACEAE	*Chascanum hederaceum var. hederaceum*
VERBENACEAE	*Chascanum pinnatifidum var. pinnatifidum*
PTERIDACEAE	*Cheilanthes hirta var. brevipilosa*
PTERIDACEAE	*Cheilanthes viridis var. glauca*
PTERIDACEAE	*Cheilanthes viridis var. viridis*
CHENOPODIACEAE	*Chenopodium ambrosioides*
CHENOPODIACEAE	*Chenopodium carinatum*
CHENOPODIACEAE	*Chenopodium multifidum*
CHENOPODIACEAE	*Chenopodium phillipsianum*
GENTIANACEAE	*Chironia palustris subsp. palustris*
ASPHODELACEAE	*Chortolirion angolense*
ASTERACEAE	*Chrysocoma ciliata*
ASTERACEAE	*Cineraria alchemilloides subsp. alchemilloides*
ASTERACEAE	*Cirsium vulgare*
RANUNCULACEAE	*Clematis sp.*
RANUNCULACEAE	*Clematis villosa subsp. villosa*
RANUNCULACEAE	*Clematopsis scabiosifolia subsp. stanleyi*
CAPPARACEAE	*Cleome conrathii*
CAPPARACEAE	*Cleome gynandra*
CAPPARACEAE	*Cleome macrophylla*
CAPPARACEAE	*Cleome maculata*
CAPPARACEAE	*Cleome monophylla*
CAPPARACEAE	*Cleome rubella*
CUCURBITACEAE	*Coccinia rehmannii*
CUCURBITACEAE	*Coccinia sessilifolia*
COMBRETACEAE	*Combretum erythrophyllum*
COMBRETACEAE	*Combretum hereroense*
COMBRETACEAE	*Combretum molle*
COMBRETACEAE	*Combretum sp.*
COMBRETACEAE	*Combretum zeyheri*
COMMELINACEAE	*Commelina africana var. barberae*

Family name	Species Name
COMMELINACEAE	*Commelina africana var. krebsiana*
COMMELINACEAE	*Commelina africana var. lancispatha*
NYCTAGINACEAE	*Commicarpus pentandrus*
CONVOLVULACEAE	*Convolvulus ocellatus var. ocellatus*
CONVOLVULACEAE	*Convolvulus sagittatus*
CONVOLVULACEAE	*Convolvulus thunbergii*
ASTERACEAE	*Conyza bonariensis*
ASTERACEAE	*Conyza canadensis*
ASTERACEAE	*Conyza scabrida*
ASTERACEAE	*Conyza ulmifolia*
LOPHIOCARPACEAE	*Corbichonia decumbens*
MALVACEAE	*Corchorus asplenifolius*
ASTERACEAE	*Cotula nigellifolia var. nigellifolia*
ACANTHACEAE	*Crabbea acaulis*
ACANTHACEAE	*Crabbea angustifolia*
CRASSULACEAE	*Crassula dejecta*
CRASSULACEAE	*Crassula lanceolata subsp. transvaalensis*
CRASSULACEAE	*Crassula nodulosa var. nodulosa forma nodulosa*
CRASSULACEAE	*Crassula setulosa var. setulosa forma setulosa*
CRASSULACEAE	*Crassula subulata var. subulata*
AMARYLLIDACEAE	*Crinum bulbispermum*
AMARYLLIDACEAE	*Crinum graminicola*
FABACEAE	*Crotalaria burkeana*
FABACEAE	*Crotalaria distans subsp. distans*
FABACEAE	*Crotalaria lotoides*
FABACEAE	*Crotalaria orientalis subsp. allenii*
FABACEAE	*Crotalaria orientalis subsp. orientalis*
FABACEAE	*Crotalaria pisicarpa*
FABACEAE	*Crotalaria podocarpa*
FABACEAE	*Crotalaria sphaerocarpa subsp. sphaerocarpa*
EUPHORBIACEAE	*Croton gratissimus var. gratissimus*
APOCYNACEAE	*Cryptolepis oblongifolia*
CUCURBITACEAE	*Cucumis hirsutus*
CUCURBITACEAE	*Cucumis myriocarpus subsp. myriocarpus*
FABACEAE	*Cullen tomentosum*
CONVOLVULACEAE	*Cuscuta campestris*
COMMELINACEAE	*Cyanotis speciosa*
OROBANCHACEAE	*Cycnium adonense*
POACEAE	*Cymbopogon pospischilii*
POACEAE	*Cynodon dactylon*
BORAGINACEAE	*Cynoglossum lanceolatum*

Family name	Species Name
CYPERACEAE	*Cyperus albostriatus*
CYPERACEAE	*Cyperus congestus*
CYPERACEAE	*Cyperus esculentus var. esculentus*
CYPERACEAE	*Cyperus longus var. tenuiflorus*
CYPERACEAE	*Cyperus obtusiflorus var. obtusiflorus*
CYPERACEAE	*Cyperus rupestris var. rupestris*
CYPERACEAE	*Cyperus sp.*
LOBELIACEAE	*Cyphia stenopetala*
VITACEAE	*Cyphostemma schlechteri*
VITACEAE	*Cyphostemma segmentatum*
VITACEAE	*Cyphostemma spinosopilosum*
SOLANACEAE	*Datura inoxia*
SOLANACEAE	*Datura stramonium*
PEDALIACEAE	*Dicerocaryum senecioides*
DICHAPETALACEAE	*Dichapetalum cymosum*
CONVOLVULACEAE	*Dichondra repens*
ACANTHACEAE	*Dicliptera minor subsp. minor*
ASTERACEAE	*Dicoma anomala subsp. gerrardii*
ASTERACEAE	*Dicoma macrocephala*
POACEAE	*Digitaria eriantha*
POACEAE	*Digitaria sp.*
POACEAE	*Digitaria ternata*
ASTERACEAE	*Dimorphotheca spectabilis*
EBENACEAE	*Diospyros lycioides subsp. lycioides*
HYACINTHACEAE	*Dipcadi viride*
FABACEAE	*Dolichos angustifolius*
ACANTHACEAE	*Dyschoriste transvaalensis*
FABACEAE	*Elephantorrhiza elephantina*
POACEAE	*Eleusine coracana subsp. africana*
POACEAE	*Enneapogon cenchroides*
POACEAE	*Enneapogon scoparius*
ONAGRACEAE	*Epilobium hirsutum*
POACEAE	*Eragrostis biflora*
POACEAE	*Eragrostis capensis*
POACEAE	*Eragrostis chloromelas*
POACEAE	*Eragrostis curvula*
POACEAE	*Eragrostis lehmanniana var. lehmanniana*
POACEAE	*Eragrostis plana*
POACEAE	*Eragrostis racemosa*
POACEAE	*Eragrostis rigidior*
POACEAE	*Eragrostis sp.*

Family name	Species Name
POACEAE	*Eragrostis superba*
POACEAE	*Eragrostis tef*
POACEAE	*Eragrostis trichophora*
FABACEAE	*Eriosema burkei var. burkei*
FABACEAE	*Eriosema salignum*
ERIOSPERMACEAE	*Eriospermum flagelliforme*
ERIOSPERMACEAE	*Eriospermum porphyrium*
ERPODIACEAE	*Erpodium coronatum subsp. transvaaliense*
BRASSICACEAE	*Erucastrum strigosum*
FABACEAE	*Erythrina lysistemon*
EBENACEAE	*Euclea crispa subsp. crispa*
EBENACEAE	*Euclea crispa subsp. ovata*
EBENACEAE	*Euclea natalensis subsp. angustifolia*
EBENACEAE	*Euclea undulata*
HYACINTHACEAE	*Eucomis autumnalis subsp. clavata*
HYACINTHACEAE	*Eucomis pallidiflora subsp. pallidiflora*
ORCHIDACEAE	*Eulophia hereroensis*
ORCHIDACEAE	*Eulophia hians var. hians*
EUPHORBIACEAE	*Euphorbia clavarioides var. truncata*
EUPHORBIACEAE	*Euphorbia davyi*
EUPHORBIACEAE	*Euphorbia inaequilatera var. inaequilatera*
EUPHORBIACEAE	*Euphorbia perangusta*
EUPHORBIACEAE	*Euphorbia schinzii*
EUPHORBIACEAE	*Euphorbia striata var. striata*
CONVOLVULACEAE	*Evolvulus alsinoides*
CONVOLVULACEAE	*Falkia oblonga*
PROTEACEAE	*Faurea saligna*
ASTERACEAE	*Felicia fascicularis*
ASTERACEAE	*Felicia muricata subsp. muricata*
POACEAE	*Fingerhuthia africana*
ASTERACEAE	*Flaveria bidentis*
SCROPHULARIACEAE	*Freylinia lanceolata*
RUBIACEAE	*Galium capense subsp. capense*
RUBIACEAE	*Galopina circaeoides*
ASTERACEAE	*Gazania krebsiana subsp. serrulata*
ASTERACEAE	*Geigeria brevifolia*
ASTERACEAE	*Geigeria burkei subsp. burkei var. burkei*
ASTERACEAE	*Geigeria burkei subsp. burkei var. zeyheri*
ASTERACEAE	*Gerbera ambigua*
ASTERACEAE	*Gerbera piloselloides*
GISEKIACEAE	*Gisekia pharnacioides var. pharnacioides*

Family name	Species Name
IRIDACEAE	*Gladiolus elliotii*
IRIDACEAE	*Gladiolus permeabilis subsp. edulis*
IRIDACEAE	*Gladiolus pretoriensis*
ASTERACEAE	*Gnaphalium filagopsis*
THYMELAEACEAE	*Gnidia capitata*
THYMELAEACEAE	*Gnidia kraussiana var. kraussiana*
THYMELAEACEAE	*Gnidia sericocephala*
APOCYNACEAE	*Gomphocarpus fruticosus subsp. fruticosus*
BUDDLEJACEAE	*Gomphostigma virgatum*
AMARANTHACEAE	*Gomphrena celosioides*
FUNARIACEAE	*Goniomitrium africanum*
MALVACEAE	*Grewia flava*
MALVACEAE	*Grewia monticola*
MALVACEAE	*Grewia occidentalis var. occidentalis*
CELASTRACEAE	*Gymnosporia buxifolia*
CELASTRACEAE	*Gymnosporia polyacanthus subsp. vaccinifolia*
CELASTRACEAE	*Gymnosporia tenuispina*
ASTERACEAE	*Haplocarpha scaposa*
SCROPHULARIACEAE	*Hebenstretia comosa*
ASTERACEAE	*Helichrysum acutatum*
ASTERACEAE	*Helichrysum aureum var. monocephalum*
ASTERACEAE	*Helichrysum caespititium*
ASTERACEAE	*Helichrysum callicomum*
ASTERACEAE	*Helichrysum cerastioides var. cerastioides*
ASTERACEAE	*Helichrysum miconiifolium*
ASTERACEAE	*Helichrysum nudifolium var. nudifolium*
ASTERACEAE	*Helichrysum rugulosum*
ASTERACEAE	*Helichrysum setosum*
ASTERACEAE	*Helichrysum zeyheri*
BORAGINACEAE	*Heliotropium nelsonii*
MALVACEAE	*Hermannia depressa*
MALVACEAE	*Hermannia lancifolia*
MALVACEAE	*Hermannia parvula*
MALVACEAE	*Hermannia sp.*
MALVACEAE	*Hermannia stellulata*
MALVACEAE	*Hermannia tomentosa*
AMARANTHACEAE	*Hermbstaedtia odorata var. odorata*
APIACEAE	*Heteromorpha arborescens var. abyssinica*
MALVACEAE	*Hibiscus calyphyllus*
MALVACEAE	*Hibiscus cannabinus*
MALVACEAE	*Hibiscus engleri*

Family name	Species Name
MALVACEAE	*Hibiscus pusillus*
MALVACEAE	*Hibiscus sidiformis*
MALVACEAE	*Hibiscus trionum*
ASTERACEAE	*Hilliardiella oligocephala*
ASTERACEAE	*Hirpicium bechuanense*
POACEAE	*Hyparrhenia anamesa*
POACEAE	*Hyparrhenia hirta*
POACEAE	*Hyparrhenia tamba*
ACANTHACEAE	*Hypoestes forskaolii*
HYPOXIDACEAE	*Hypoxis angustifolia var. angustifolia*
HYPOXIDACEAE	*Hypoxis rigidula var. rigidula*
FABACEAE	*Indigofera comosa*
FABACEAE	*Indigofera cryptantha var. cryptantha*
FABACEAE	*Indigofera disticha*
FABACEAE	*Indigofera filipes*
FABACEAE	*Indigofera glaucescens*
FABACEAE	*Indigofera heterotricha*
FABACEAE	*Indigofera holubii*
FABACEAE	*Indigofera oxytropis*
FABACEAE	*Indigofera vicioides var. vicioides*
FABACEAE	*Indigofera zeyheri*
CONVOLVULACEAE	*Ipomoea bathycolpos*
CONVOLVULACEAE	*Ipomoea bolusiana*
CONVOLVULACEAE	*Ipomoea crassipes var. crassipes*
CONVOLVULACEAE	*Ipomoea gracilisepala*
CONVOLVULACEAE	*Ipomoea obscura var. obscura*
CONVOLVULACEAE	*Ipomoea oenotherae var. oenotherae*
CONVOLVULACEAE	*Ipomoea ommanneyi*
CONVOLVULACEAE	*Ipomoea papilio*
SCROPHULARIACEAE	*Jamesbrittenia atropurpurea subsp. atropurpurea*
SCROPHULARIACEAE	*Jamesbrittenia aurantiaca*
SCROPHULARIACEAE	*Jamesbrittenia burkeana*
SCROPHULARIACEAE	*Jamesbrittenia sp.*
JUNCACEAE	*Juncus exsertus*
ACANTHACEAE	*Justicia anagalloides*
ACANTHACEAE	*Justicia betonica*
CRASSULACEAE	*Kalanchoe luciae subsp. luciae*
CRASSULACEAE	*Kalanchoe paniculata*
CRASSULACEAE	*Kalanchoe thyrsiflora*
ASPHODELACEAE	*Kniphofia ensifolia subsp. ensifolia*
RUBIACEAE	*Kohautia amatymbica*

Family name	Species Name
RUBIACEAE	*Kohautia caespitosa subsp. brachyloba*
RUBIACEAE	*Kohautia virgata*
CYPERACEAE	*Kyllinga alba*
AMARANTHACEAE	*Kyphocarpa angustifolia*
FABACEAE	*Lablab purpureus subsp. uncinatus*
ASTERACEAE	*Lactuca inermis*
VERBENACEAE	*Lantana rugosa*
IRIDACEAE	*Lapeirousia sandersonii*
HYACINTHACEAE	*Ledebouria marginata*
HYACINTHACEAE	*Ledebouria ovatifolia*
FABACEAE	*Leobordea divaricata*
LAMIACEAE	*Leonotis ocymifolia var. schinzii*
BRASSICACEAE	*Lepidium africanum subsp. africanum*
LAMIACEAE	*Leucas capensis*
LAMIACEAE	*Leucas martinicensis*
MOLLUGINACEAE	*Limeum fenestratum var. fenestratum*
MOLLUGINACEAE	*Limeum viscosum subsp. viscosum var. kraussii*
MOLLUGINACEAE	*Limeum viscosum subsp. viscosum var. viscosum*
VERBENACEAE	*Lippia javanica*
FABACEAE	*Listia heterophylla*
BORAGINACEAE	*Lithospermum cinereum*
LOBELIACEAE	*Lobelia thermalis*
FABACEAE	*Lotononis bainesii*
FABACEAE	*Lotononis calycina*
FABACEAE	*Lotononis sp.*
FABACEAE	*Lotononis wilmsii*
SOLANACEAE	*Lycium cinereum*
CAPPARACEAE	*Maerua angolensis subsp. angolensis*
MALVACEAE	*Malva verticillata var. verticillata*
FABACEAE	*Medicago sativa*
MALVACEAE	*Melhania prostrata*
FABACEAE	*Melilotus indicus*
POACEAE	*Melinis repens subsp. repens*
OLEACEAE	*Menodora heterophylla var. australis*
LAMIACEAE	*Mentha aquatica*
LAMIACEAE	*Mentha longifolia subsp. capensis*
CONVOLVULACEAE	*Merremia palmata*
MESEMBRYANTHEMACEAE	*Mesembryanthemum sp.*
SCROPHULARIACEAE	*Mimulus gracilis*
SAPOTACEAE	*Mimusops zeyheri*
CUCURBITACEAE	*Momordica balsamina*

Family name	Species Name
GERANIACEAE	*Monsonia angustifolia*
GERANIACEAE	*Monsonia burkeana*
IRIDACEAE	*Moraea pallida*
FABACEAE	*Mundulea sericea subsp. sericea*
MYRSINACEAE	*Myrsine africana*
SCROPHULARIACEAE	*Nemesia fruticans*
SCROPHULARIACEAE	*Nemesia sp.*
AMARYLLIDACEAE	*Nerine frithii*
ASTERACEAE	*Nidorella hottentotica*
ASTERACEAE	*Nidorella resedifolia subsp. resedifolia*
ASTERACEAE	*Nolletia ciliaris*
BUDDLEJACEAE	*Nuxia glomerulata*
OCHNACEAE	*Ochna pulchra*
LAMIACEAE	*Ocimum americanum var. americanum*
LAMIACEAE	*Ocimum angustifolium*
LAMIACEAE	*Ocimum obovatum subsp. obovatum var. obovatum*
ONAGRACEAE	*Oenothera rosea*
ONAGRACEAE	*Oenothera tetraptera*
RUBIACEAE	*Oldenlandia corymbosa var. caespitosa*
RUBIACEAE	*Oldenlandia herbacea var. herbacea*
OLEACEAE	*Olea europaea subsp. africana*
FABACEAE	*Ophrestia oblongifolia var. oblongifolia*
FABACEAE	*Ophrestia oblongifolia var. velutinosa*
APOCYNACEAE	*Orbea lutea subsp. lutea*
HYACINTHACEAE	*Ornithogalum tenuifolium subsp. tenuifolium*
LAMIACEAE	*Orthosiphon suffrutescens*
ASTERACEAE	*Osteospermum microcarpum subsp. microcarpum*
ASTERACEAE	*Osteospermum muricatum subsp. muricatum*
ASTERACEAE	*Othonna sp.*
FABACEAE	*Otoptera burchellii*
OXALIDACEAE	*Oxalis corniculata*
OXALIDACEAE	*Oxalis obliquifolia*
POLYGONACEAE	*Oxygonum dregeanum subsp. canescens var. canescens*
ANACARDIACEAE	*Ozoroa paniculosa var. paniculosa*
APOCYNACEAE	*Pachycarpus schinzianus*
POACEAE	*Panicum coloratum var. coloratum*
POACEAE	*Panicum sp.*
CHRYSOBALANACEAE	*Parinari capensis subsp. capensis*
POACEAE	*Paspalum dilatatum*
APIACEAE	*Pastinaca sativa*
RUBIACEAE	*Pavetta gardeniifolia var. subtomentosa*

Family name	Species Name
MALVACEAE	*Pavonia burchellii*
MALVACEAE	*Pavonia transvaalensis*
FABACEAE	*Pearsonia cajanifolia subsp. cajanifolia*
FABACEAE	*Pearsonia sessilifolia subsp. sessilifolia*
GERANIACEAE	*Pelargonium alchemilloides*
GERANIACEAE	*Pelargonium dolomiticum*
PTERIDACEAE	*Pellaea calomelanos var. calomelanos*
APOCYNACEAE	*Pentarrhinum insipidum*
POLYGONACEAE	*Persicaria decipiens*
POACEAE	*Phalaris canariensis*
POACEAE	*Phragmites australis*
PHYLLANTHACEAE	*Phyllanthus maderaspatensis*
PHYLLANTHACEAE	*Phyllanthus parvulus var. parvulus*
SOLANACEAE	*Physalis angulata*
SOLANACEAE	*Physalis peruviana*
PLANTAGINACEAE	*Plantago lanceolata*
PLANTAGINACEAE	*Plantago major*
LAMIACEAE	*Plectranthus neochilus*
POACEAE	*Pogonarthria squarrosa*
CARYOPHYLLACEAE	*Pollichia campestris*
POLYGALACEAE	*Polygala amatymbica*
POLYGALACEAE	*Polygala hottentotta*
POLYGALACEAE	*Polygala krumanina*
POLYGALACEAE	*Polygala transvaalensis subsp. transvaalensis*
POLYGONACEAE	*Polygonum aviculare*
PORTULACACEAE	*Portulaca oleracea*
PORTULACACEAE	*Portulaca quadrifida*
POTAMOGETONACEAE	*Potamogeton pusillus*
PROTEACEAE	*Protea caffra subsp. caffra*
PROTEACEAE	*Protea welwitschii*
ASTERACEAE	*Pseudognaphalium luteo-album*
ASTERACEAE	*Pseudognaphalium oligandrum*
ASTERACEAE	*Psiadia punctulata*
PTERIDACEAE	*Pteris cretica*
PTERIDACEAE	*Pteris dentate*
PTERIDACEAE	*Pteris vittata*
FABACEAE	*Pterocarpus rotundifolius subsp. rotundifolius*
ASTERACEAE	*Pulicaria scabra*
AMARANTHACEAE	*Pupalia lappacea var. lappacea*
RUBIACEAE	*Pygmaeothamnus zeyheri var. zeyheri*
RANUNCULACEAE	*Ranunculus multifidus*

Family name	Species Name
BRASSICACEAE	*Raphanus raphanistrum*
APOCYNACEAE	*Raphionacme hirsuta*
APOCYNACEAE	*Raphionacme velutina*
RHAMNACEAE	*Rhamnus prinoides*
VITACEAE	*Rhoicissus tridentata subsp. tridentata*
FABACEAE	*Rhynchosia albissima*
FABACEAE	*Rhynchosia minima var. prostrata*
FABACEAE	*Rhynchosia monophylla*
FABACEAE	*Rhynchosia nervosa var. nervosa*
FABACEAE	*Rhynchosia reptabunda*
FABACEAE	*Rhynchosia sp.*
FABACEAE	*Rhynchosia totta var. totta*
FABACEAE	*Rhynchosia venulosa*
RICCIACEAE	*Riccia atropurpurea*
RICCIACEAE	*Riccia congoana*
RICCIACEAE	*Riccia okahandjana*
RICCIACEAE	*Riccia trichocarpa*
RUBIACEAE	*Richardia scabra*
APOCYNACEAE	*Riocreuxia torulosa var. torulosa*
BRASSICACEAE	*Rorippa fluviatilis var. fluviatilis*
LAMIACEAE	*Rotheca hirsuta*
RUBIACEAE	*Rubia horrida*
ACANTHACEAE	*Ruellia cordata*
POLYGONACEAE	*Rumex acetosella subsp. angiocarpus*
POLYGONACEAE	*Rumex lanceolatus*
SALICACEAE	*Salix mucronata subsp. woodii*
LAMIACEAE	*Salvia disermas*
LAMIACEAE	*Salvia radula*
LAMIACEAE	*Salvia runcinata*
THEOPHRASTACEAE	*Samolus valerandi*
DRACAENACEAE	*Sansevieria aethiopica*
DIPSACACEAE	*Scabiosa columbaria*
ASTERACEAE	*Schistostephium heptalobum*
POACEAE	*Schizachyrium sanguineum*
ASTERACEAE	*Schkuhria pinnata*
CYPERACEAE	*Schoenoplectus brachyceras*
ANACARDIACEAE	*Sclerocarya birrea subsp. caffra*
ANACARDIACEAE	*Searsia ciliata*
ANACARDIACEAE	*Searsia dentate*
ANACARDIACEAE	*Searsia dregeana*
ANACARDIACEAE	*Searsia lancea*

Family name	Species Name
ANACARDIACEAE	*Searsia leptodictya forma leptodictya*
ANACARDIACEAE	*Searsia magalismontana subsp. magalismontana*
ANACARDIACEAE	*Searsia pyroides var. pyroides*
GENTIANACEAE	*Sebaea exigua*
GENTIANACEAE	*Sebaea grandis*
POLYGALACEAE	*Securidaca longepedunculata var. longepedunculata*
CONVOLVULACEAE	*Seddera capensis*
SCROPHULARIACEAE	*Selago densiflora*
SCROPHULARIACEAE	*Selago sp.*
ASTERACEAE	*Senecio burchellii*
ASTERACEAE	*Senecio coronatus*
ASTERACEAE	*Senecio isatideus*
ASTERACEAE	*Senecio latifolius*
ASTERACEAE	*Senecio venosus*
FABACEAE	*Senna italica subsp. arachoides*
FABACEAE	*Senna occidentalis*
PEDALIACEAE	*Sesamum triphyllum var. triphyllum*
FABACEAE	*Sesbania transvaalensis*
POACEAE	*Setaria lindenbergiana*
POACEAE	*Setaria plicatilis*
POACEAE	*Setaria sphacelata var. sphacelata*
MALVACEAE	*Sida chrysantha*
MALVACEAE	*Sida cordifolia subsp. cordifolia*
MALVACEAE	*Sida dregei*
MALVACEAE	*Sida ternate*
CARYOPHYLLACEAE	*Silene burchellii var. angustifolia*
CARYOPHYLLACEAE	*Silene undulate*
BRASSICACEAE	*Sisymbrium turczaninowii*
APIACEAE	*Sium repandum*
SOLANACEAE	*Solanum lichtensteinii*
SOLANACEAE	*Solanum nigrum*
SOLANACEAE	*Solanum panduriforme*
SOLANACEAE	*Solanum retroflexum*
SOLANACEAE	*Solanum supinum var. supinum*
ASTERACEAE	*Sonchus asper subsp. asper*
ASTERACEAE	*Sonchus integrifolius var. integrifolius*
ASTERACEAE	*Sonchus oleraceus*
ASTERACEAE	*Sonchus wilmsii*
POACEAE	*Sorghum bicolor subsp. arundinaceum*
MALPIGHIACEAE	*Sphedamnocarpus pruriens subsp. galphimiifolius*
FABACEAE	*Sphenostylis angustifolia*

Family name	Species Name
POACEAE	*Sporobolus fimbriatus*
POACEAE	*Sporobolus nitens*
POACEAE	*Sporobolus stapfianus*
LAMIACEAE	*Stachys spathulata*
APOCYNACEAE	*Stapelia gettliffei*
APOCYNACEAE	*Stenostelma corniculatum*
POACEAE	*Stipagrostis uniplumis var. uniplumis*
ASTERACEAE	*Stoebe vulgaris*
OROBANCHACEAE	*Striga asiatica*
OROBANCHACEAE	*Striga bilabiata subsp. bilabiata*
OROBANCHACEAE	*Striga elegans*
STRYCHNACEAE	*Strychnos pungens*
LAMIACEAE	*Syncolostemon canescens*
POTTIACEAE	*Syntrichia laevipila*
PORTULACACEAE	*Talinum caffrum*
LORANTHACEAE	*Tapinanthus rubromarginatus*
LORANTHACEAE	*Tapinanthus sp.*
ASTERACEAE	*Tarchonanthus camphoratus*
ASTERACEAE	*Tarchonanthus parvicapitulatus*
FABACEAE	*Tephrosia capensis var. angustifolia*
FABACEAE	*Tephrosia capensis var. capensis*
FABACEAE	*Tephrosia elongata var. elongata*
FABACEAE	*Tephrosia longipes subsp. longipes var. longipes*
FABACEAE	*Tephrosia lupinifolia*
FABACEAE	*Tephrosia multijuga*
FABACEAE	*Tephrosia purpurea subsp. leptostachya var. pubescens*
COMBRETACEAE	*Terminalia sericea*
LAMIACEAE	*Teucrium trifidum*
POACEAE	*Themeda triandra*
SANTALACEAE	*Thesium asterias*
SANTALACEAE	*Thesium rogersii*
SANTALACEAE	*Thesium utile*
ASPHODELACEAE	*Trachyandra asperata var. basutoensis*
ASPHODELACEAE	*Trachyandra laxa var. rigida*
ASPHODELACEAE	*Trachyandra saltii var. saltii*
POACEAE	*Trachypogon spicatus*
EUPHORBIACEAE	*Tragia rupestris*
POACEAE	*Tragus berteronianus*
ZYGOPHYLLACEAE	*Tribulus terrestris*
BORAGINACEAE	*Trichodesma angustifolium subsp. angustifolium*
POACEAE	*Trichoneura grandiglumis*

Family name	Species Name
POACEAE	*Tripogon minimus*
ASTERACEAE	*Tripteris aghillana var. aghillana*
POACEAE	*Tristachya biseriata*
POACEAE	*Triticum sp.*
IRIDACEAE	*Tritonia nelsonii*
IRIDACEAE	*Tritonia sp.*
MALVACEAE	*Triumfetta sonderi*
ALLIACEAE	*Tulbaghia cernua*
MELIACEAE	*Turraea obtusifolia*
POACEAE	*Urelytrum agropyroides*
ASTERACEAE	*Ursinia nana subsp. leptophylla*
VAHLIACEAE	*Vahlia capensis subsp. capensis*
VAHLIACEAE	*Vahlia capensis subsp. vulgaris var. linearis*
VERBENACEAE	*Verbena aristigera*
VERBENACEAE	*Verbena officinalis*
ASTERACEAE	*Vernonia galpinii*
ASTERACEAE	*Vernonia poskeana subsp. botswanica*
SCROPHULARIACEAE	*Veronica anagallis-aquatica*
SCROPHULARIACEAE	*Veronica persica*
FABACEAE	*Vicia sativa subsp. sativa*
FABACEAE	*Vigna unguiculata subsp. stenophylla*
FABACEAE	*Vigna vexillata var. vexillata*
VISCACEAE	*Viscum verrucosum*
LAMIACEAE	*Vitex zeyheri*
CAMPANULACEAE	*Wahlenbergia denticulata var. denticulata*
CAMPANULACEAE	*Wahlenbergia undulata*
TECOPHILAEACEAE	*Walleria nutans*
SOLANACEAE	*Withania somnifera*
ASTERACEAE	*Xanthium spinosum*
ASTERACEAE	*Xanthium strumarium*
CONVOLVULACEAE	*Xenostegia tridentata subsp. angustifolia*
OLACACEAE	*Ximenia caffra var. caffra*
APOCYNACEAE	*Xysmalobium brownianum*
APOCYNACEAE	*Xysmalobium undulatum var. undulatum*
AIZOACEAE	*Zaleya pentandra*
ASTERACEAE	*Zinnia peruviana*
RHAMNACEAE	*Ziziphus mucronata subsp. mucronata*
RHAMNACEAE	*Ziziphus zeyheriana*
FABACEAE	*Zornia linearis*
FABACEAE	*Zornia milneana*

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APPENDIX B. BIRD SPECIES LISTS

English Name	Map Status	General Status
Abdim's Stork	NBM-U	NBM-C
African Black Duck	R-U/C	R-U
African Crake	BM-U	BM-U
African Cuckoo	BM-U	BM-U
African Fish Eagle	R-U	R-C
African Green Pigeon	R-U	R-C
African Hawk Eagle	R-C	R-U
African Hoopoe	R-VC	R(n)-C
African Jacana	R-U	R-VC
African Marsh Harrier	R-U	R-C
African Marsh Warbler	BM-C	BM-C
African Pied Wagtail	R-U	R-C
African Rail	R-C	R/BM-C
African Scops Owl	R-C	R-C
African Sedge Warbler	R-C	R-C
African Spoonbill	R-C	R(n)-C
Alpine Swift	BM-U	BM-C
Anteating Chat	E-VC	E-C
Arrowmarked Babbler	R-VC	R-VC
Ashy Tit	E-C	Er-U
Baillon's Crake	R-U	R-C
Banded Martin	BM-C	BM-U
Barn Owl	R-C	R-C
Barthroated Apalis	R-U	R-C
Bearded Woodpecker	R-U	R-C
Bennett's Woodpecker	R-U	R-U
Black Crake	R-C	R-C
Black Crow	R-VC	R-C
Black Cuckoo	BM-U	BM-C
Black Cuckooshrike	R-C	R-U
Black Eagle	R-C	R-U
Black Egret	R-U/C	R-LC/R
Black Flycatcher	R-C	R-C
Black Harrier	NBM-U	E-U
Black Kite	NBM-U	NBM-LC
Black Sparrowhawk	R-U	R-C
Black Stork	R-U	R-U/R
Black Sunbird	R-VC	R-C
Black Swift	BM-U	R-C
Black Widowfinch	R-U	R(n)-LC

English Name	Map Status	General Status
Blackbreasted Snake Eagle	R-C	R-U
Blackcheeked Waxbill	R-C	R-LC
Blackchested Prinia	E-VC	Er-C
Blackcollared Barbet	R-VC	R-C
Blackcrowned Night Heron	R-U	R-C
Blackcrowned Tchagra	R-VC	R-C
Blackeyed Bulbul	R-VC/A	R-VC
Blackheaded Heron	R-VC	R-C
Blackheaded Oriole	R-VC	R-C
Blacknecked Grebe	R-U	R(n)-U
Blackshouldered Kite	R-VC	R(n)-C
Blacksmith Plover	R-VC/A	R-VC
Blackthroated Canary	R-VC	R-C
Blackwinged Pratincole	NBM-C	NBM-LA
Blackwinged Stilt	R-C	R-C
Blue Crane	E-U	E-U
Blue Waxbill	R-A	R-C
Bluebilled Firefinch	R-U	R-C
Bluecheeked Bee-eater	NBM-C	NBM-LC
Bokmakierie	E-VC	Er-C
Booted Eagle	NBM-U	R/NBM-C
Bronze Mannikin	R-U	R-VC
Bronzewinged Courser	NBM-U	R/BM-U
Brown Snake Eagle	R-C	R-U
Brownhooded Kingfisher	R-VC	R-C
Brownthroated Martin	R-U/C	R-C
Brubru	R-U/VC	R-C
Buffy Pipit	R-U	R-U
Burchell's Coucal	R-VC	R-C
Burchell's Starling	E-VC	Er-C
Burntnecked Eremomela	R-C	R-C
Bushveld Pipit	R-U	R-LC
Cape Bunting	R-U	R-C
Cape Penduline Tit	E-U	Er-C
Cape Reed Warbler	R-C	R-C
Cape Robin	R-VC	R-C
Cape Shoveller	E-VC	Er-C
Cape Sparrow	E-A	Er-VC
Cape Teal	R-U/C	R-C
Cape Turtle Dove	R-A	R-VC
Cape Vulture	E-C	E-LC

English Name	Map Status	General Status
Cape Wagtail	R-VC	R-C
Cape Weaver	E-U	E-C
Cape White-eye	E-VC	E-VC
Capped Wheatear	R-C	R/BM-C
Cardinal Woodpecker	R-C	R-C
Caspian Plover	NBM-U/C	NBM-U
Caspian Tern	R-U	R-LC
Cattle Egret	R-A	R-C
Chat Flycatcher	E-C	Er-C
Chestnutbacked Finchlark	R-C	R(n)-C
Chestnutbanded Plover	R-U	R-U
Chinspot Batis	R-C/VC	R-C
Cloud Cisticola	R-C	R-C
Common Moorhen	R-C	R-C
Common Quail	R-U	R/BM/NBM-C
Common Sandpiper	NBM-C	NBM-C
Common Waxbill	R-VC	R-C
Coqui Francolin	R-C	R-C
Crested Barbet	R-VC	R-C
Crested Francolin	R-C/VC	R-VC
Crimsonbreasted Shrike	E-VC	Er-C
Crowned Plover	R-VC	R-C
Cuckoofinch	BM-U	R/BM-U
Curlew Sandpiper	NBM-C	NBM-VC
Cutthroat Finch	R-C	R(n)-U
Dabchick	R-VC	R-C
Darter	R-C	R-C
Desert Barred Warbler	E-U	Er-C
Desert Cisticola	R-C	R-C
Diederik Cuckoo	BM-C	BM-VC
Doublebanded Courser	R-U	R-LC
Doublebanded Sandgrouse	E-C	Er-C
Dwarf Bittern	BM-U	BM-R
Eastern Clapper Lark	E-C	Er-C
Eastern Redfooted Kestrel	NBM-U	NBM-C
Egyptian Goose	R-VC	R-A
Ethiopian Snipe	R-C	R-LC
Eurasian Bee-eater	NBM-VC	NBM/BM-C
Eurasian Cuckoo	NBM-U	NBM-U
Eurasian Golden Oriole	NBM-U	NBM-U
Eurasian Marsh Harrier	NBM-U	NBM-R

English Name	Map Status	General Status
Eurasian Marsh Warbler	NBM-U	NBM-C
Eurasian Nightjar	NBM-U	R-U
Eurasian Roller	NBM-C	NBM-C
Eurasian Sedge Warbler	NBM-U	NBM-C
Eurasian Swallow	NBM-VC	NBM-A
Eurasian Swift	NBM-U	NBM-C
Fairy Flycatcher	NBM-C	E-C
Familiar Chat	R-C	R-C
Fantailed Cisticola	R-C	R-VC
Fantailed Flycatcher	R-U	R-U
Fawncoloured Lark	R-U	R-C
Feral Pigeon	R-C	R-A
Fierynecked Nightjar	R-U	R/BM-C
Fiscal Flycatcher	E-VC	E-C
Fiscal Shrike	R-A	R-C
Forktailed Drongo	R-A	R-C
Freckled Nightjar	R-U/VC	R-C
Fulvous Duck	R-U	R-C
Gabar Goshawk	R-C	R-C
Garden Warbler	NBM-U	NBM-C
Giant Eagle Owl	R-U	R-U
Giant Kingfisher	R-U	R-U
Glossy Ibis	R-C	R-U
Glossy Starling	E-VC	Er-C
Golden Bishop	R-U/C	R(n)-LC
Goldenbreasted Bunting	R-VC	R-U
Goldentailed Woodpecker	R-U	R-C
Goliath Heron	R-C	R-U
Grass Owl	R-U	R-U
Grassveld Pipit	R-VC	R-C
Great Crested Grebe	R-C	R(n)-U
Great Reed Warbler	NBM-U	NBM-C
Great Sparrow	R-C	R-U
Great Spotted Cuckoo	BM-U	NBM-U
Great White Egret	R-C	R-C
Greater Flamingo	R-C	R(n)-LA
Greater Honeyguide	R-C	R-U
Greater Kestrel	R-C	R-C
Greater Striped Swallow	BM-VC	BM-C
Green Sandpiper	NBM-U	NBM-R
Greenbacked Heron	R-U	R-U

English Name	Map Status	General Status
Greenshank	NBM-C	NBM-C
Greenspotted Dove	R-A	R-C
Grey Heron	R-C	R-C
Grey Hornbill	R-C/VC	R-C
Grey Lourie	R-VC/A	R-C
Grey Plover	NBM-U	NBM-C
Greybacked BleatingWarbler	R-VC	R-C
Greybacked Finchlark	E-C	Er-VC
Greyheaded Bush Shrike	R-VC	R-C
Greyheaded Gull	R-U	R-VC
Groundscraper Thrush	R-VC	R-C
Gymnogene	R-U/C	R-C
Hadeda Ibis	R-A	R-A
Halfcollared Kingfisher	R-U	R-U
Hamerkop	R-VC	R-C
Harlequin Quail	BM-U	R/BM-C
Helmeted Guineafowl	R-VC	R-VC
Honey Buzzard	NBM-U	NBM-U
Horus Swift	BM-U	BM-LC
Hottentot Teal	R-U	R-C
House Martin	NBM-U	NBM-LC
House Sparrow	R-VC	R-VC
Icterine Warbler	NBM-U	NBM-C
Indian Myna	R-VC	R-VC
Jackal Buzzard	E-U	E-C
Jacobin Cuckoo	BM-C	BM-C
Jameson's Firefinch	R-U/C	R-C
Kalahari Robin	E-VC	Er-C
Karoo Thrush	E-VC	E-C
Kittlitz's Plover	R-C	R-C
Klaas's Cuckoo	BM-U	R/BM-C
Knobbilled Duck	R-U	R-LC
Kori Bustard	R-VC	R-R
Kurrichane Buttonquail	R-U	R(n)-U/LC
Kurrichane Thrush	R-VC	R-C
Lanner Falcon	R-U/C	R-C
Lappetfaced Vulture	R-C	R-U
Larklike Bunting	E-U/VC	Er-VC
Laughing Dove	R-A	R-VC
Lazy Cisticola	R-U	R-C
Lesser Flamingo	R-C	R(n)-LA

English Name	Map Status	General Status
Lesser Grey Shrike	NBM-C	NBM-C
Lesser Honeyguide	R-U	R-LC
Lesser Kestrel	NBM-C	NBM-VC
Lesser Masked Weaver	R-U	R-LC
Lesser Striped Swallow	BM-VC	R/BM-C
Levaillant's Cisticola	R-VC	R-C
Lilacbreasted Roller	R-VC	R/LM-C
Little Banded Goshawk	R-U	R-C
Little Bee-eater	R-VC	R-C
Little Bittern	R-U	R/NBM-U
Little Egret	R-C	R-C
Little Sparrowhawk	R-U	R-C
Little Stint	NBM-C	NBM-C
Little Swift	R-VC	R/BM-VC
Longbilled Crombec	R-VC	R-C
Longbilled Pipit	R-U	R-C
Longtailed Shrike	R-VC	R-C
Longtailed Widow	R-VC/A	R(n)-C
Maccoa Duck	R-VC	R-U
Malachite Kingfisher	R-U	R-C
Marabou Stork	R-U	R-R/LC
Marico Flycatcher	E-VC	Er-C
Marico Sunbird	R-VC	R-C
Marsh Owl	R-U/C	R-C
Marsh Sandpiper	NBM-C	NBM-C
Martial Eagle	R-C	R-U
Masked Weaver	R-VC	R-C
Melba Finch	R-U/VC	R-C
Melodious Lark	E-U/C	E-U
Meyer's Parrot	R-C	R-C
Mocking Chat	R-C	R-C
Monotonous Lark	E-U	Er-C
Montagu's Harrier	NBM-U	NBM-R
Mountain Chat	E-C	Er-C
Namaqua Dove	R-VC	R-VC
Namaqua Sandgrouse	E-U	Er-C
Natal Francolin	E-U	Er-C
Neddicky	R-C	R-C
Northern Hobby Falcon	NBM-U	NBM-U
Old World Painted Snipe	R-C	R-U
Orange River Francolin	R-C	R-C

English Name	Map Status	General Status
Orangebreasted Waxbill	R-U/C	R-LC
Orangethroated Longclaw	E-VC	E-C
Osprey	NBM-U	NBM-U
Ostrich	R-C	R-C
Ovambo Sparrowhawk	R-U	R-U
Pale Chanting Goshawk	E-U	Er-C
Pallid Harrier	NBM-U	NBM-R
Palm Swift	R-C	R-C
Paradise Flycatcher	BM-VC	BM-C
Paradise Whydah	R-VC	R-C
Pearlbreasted Swallow	R-U	R/BM-C
Pearlspotted Owl	R-C/VC	R-C
Peregrine Falcon	NBM-U	R/NBM-R
Pied Avocet	R-U	R-LC
Pied Babbler	E-VC	E-C
Pied Barbet	E-VC	Er-C
Pied Crow	R-A	R-A
Pied Kingfisher	R-C	R-C
Pied Starling	E-C	E-C
Pinkbacked Pelican	R-U	R-LC/R
Pinkbilled Lark	E-C	Er-C
Pintailed Whydah	R-VC	R(n)-C
Plainbacked Pipit	R-U	R-C
Plumcoloured Starling	BM-VC	BM-U
Puffback	R-A	R-C
Purple Gallinule	R-C	R-C
Purple Heron	R-U/C	R-U
Purple Roller	R-C/VC	R-U
Purple Widowfinch	R-U	R-U
Quail Finch	R-C	R-C
Rameron Pigeon	R-C	R-LC
Rattling Cisticola	R-VC	R-C
Red Bishop	R-VC	R-C
Redbacked Shrike	NBM-VC	NBM-C
Redbilled Buffalo Weaver	R-VC	R-LC
Redbilled Firefinch	R-C	R-C
Redbilled Hornbill	R-VC	R-C
Redbilled Oxpecker	R-VC	R-C
Redbilled Quelea	R-VC	R(n)-LA
Redbilled Teal	R-C	R-C
Redbilled Woodhoopoe	R-VC	R-C

English Name	Map Status	General Status
Redbreasted Swallow	BM-C	BM-C
Redcapped Lark	R-U/C	R(n)-C
Redchested Cuckoo	BM-C	BM-C
Redchested Flufftail	R-U	R-C
Redcollared Widow	R-U/VC	R(n)-LC
Redcrested Korhaan	E-VC	Es-C
Redeyed Bulbul	E-A	Er-VC
Redeyed Dove	R-VC	R-C
Redfaced Mousebird	R-VC	R-C
Redheaded Finch	E-VC	Er-VC
Redheaded Weaver	R-U	R-C
Redknobbed Coot	R-C/VC	R-A
Redwinged Starling	R-VC	R-VC
Reed Cormorant	R-U/VC	R-C
Ringed Plover	NBM-U	NBM-C
Rock Bunting	R-VC	R(n)-LC
Rock Kestrel	R-U	R-C
Rock Martin	R-VC	R-C
Rock Pigeon	R-VC	R-C
Ruddy Turnstone	NBM-U	NBM-C
Ruff	NBM-C	NBM-C
Rufouscheeked Nightjar	BM-C	BM-C
Rufousnaped Lark	R-VC	R-C
Sabota Lark	E-VC	Er-C
Sacred Ibis	R-VC	R-C
Sand Martin	NBM-U	NBM-C
Sanderling	NBM-U	NBM-C
Scalyfeathered Finch	E-VC	Er-C
Scimitarbilled Woodhoopoe	R-VC	R-C
Secretarybird	R-C	R-U
Shafttailed Whydah	E-VC	Er-C
Sharpbilled Honeyguide	R-U	R-U
Shortclawed Lark	E-U/C	E-U
Shorttoed Rockthrush	E-U	Er-U
Sociable Weaver	E-U	E-C
South African Cliff Swallow	BM-C	Ebm-LC
South African Shelduck	E-U	E-C
Southern Black Tit	E-VC	Er-C
Southern Boubou	E-VC	E-C
Southern Greyheaded Sparrow	E-VC	Er-C
Southern Pochard	R-C	R-C

English Name	Map Status	General Status
Southern Yellowbilled Hornbill	E-VC	Er-C
Speckled Mousebird	R-C/VC	R-C
Spikeheeled Lark	E-VC	Er-C
Spotted Crake	Rare	R-U
Spotted Dikkop	R-C	R-C
Spotted Eagle Owl	R-C	R-C
Spotted Flycatcher	NBM-C	NBM-C
Spottedbacked Weaver	R-U	R-VC
Spurwinged Goose	R-C/VC	R-VC
Squacco Heron	NBM-U	R/NBM-U
Steelblue Widowfinch	R-C	R(n)-C
Steppe Buzzard	NBM-C	NBM-C
Stonechat	R-VC	R-VC
Streakyheaded Canary	R-U	R-C
Striped Cuckoo	BM-U	BM-U
Striped Kingfisher	R-VC	R-C
Striped Pipit	R-U	R-LC
Swainson's Francolin	E-VC	Er-C
Swallowtailed Bee-eater	R-VC	R-LC
Swee Waxbill	E-U	Er-LC
Tawny Eagle	R-U	R-LC
Tawnyflanked Prinia	R-VC	R-C
Temminck's Courser	R-U/C	R-U
Threebanded Plover	R-VC	R-C
Threestreaked Tchagra	R-VC	R-C
Tinkling Cisticola	R-U	R-U
Titbabbler	E-VC	Er-C
Violeteared Waxbill	E-U/VC	Er-LC
Wahlberg's Eagle	BM-U	BM-C
Wattled Plover	R-U	R/BM-LC
Wattled Starling	R-VC	R(n)-LA
Western Redfooted Kestrel	NBM-U	NBM-R
Whimbrel	NBM-U	NBM-C
Whiskered Tern	BM-U/C	R(n)-LC
White Helmetshrike	R-VC	R-C
White Pelican	R-U	R-LC/R
White Stork	NBM-C	NBM-C
Whitebacked Duck	R-U	R-U
Whitebacked Mousebird	E-VC	E-C
Whitebacked Vulture	R-U	R-C
Whitebellied Korhaan	E-U	E-U

English Name	Map Status	General Status
Whitebellied Sunbird	R-U/VC	R-C
Whitebreasted Cormorant	R-VC	R-C
Whitebrowed Robin	R-U/VC	R-C
Whitebrowed Sparrowweaver	R-VC	R-VC
Whitecrowned Shrike	E-VC	Er-C
Whitefaced Duck	R-VC	R-C
Whitefaced Owl	R-C	R-C
Whitefronted Bee-eater	R-C	R-C
Whiterumped Swift	BM-C	BM-VC
Whitethroat	NBM-U	NBM-U
Whitethroated Robin	E-C	E-C
Whitethroated Swallow	BM-C	BM-C
Whitewinged Korhaan	E-VC	E-VC
Whitewinged Tern	NBM-C	NBM-A
Whitewinged Widow	R-C	R(n)-LC
Willow Warbler	NBM-C	NBM-VC
Wood Sandpiper	NBM-C	NBM-C
Woodland Kingfisher	BM-U	BM-C
Yellow Canary	E-VC	Er-C
Yellow Wagtail	NBM-C	NBM-U
Yellowbellied Eremomela	R-C	R-U
Yellowbilled Duck	R-VC	R-A
Yellowbilled Egret	R-U/C	R-U
Yellowbilled Kite	BM-U	BM-C
Yellowbilled Stork	NBM-U	NBM/R-LC
Yelloweyed Canary	R-U/VC	R-C
Yellowfronted Tinker Barbet	R-VC	R-C
Yellowthroated Sparrow	R-C	R-U

R=RESIDENT; E=ENDEMIC; BM=BREEDING MIGRANT; NBM=NON-BREEDING MIGRANT; V=VAGRANT; A=ABUNDANT; VC=VERY COMMON; C=COMMON; U=UNCOMMON; R=RARE

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APPENDIX B – MAMMAL SPECIES LISTS

Scientific name	Vernacular name	Status (Friedman & Daly, 2004)
Acinonyx jubatus	**Cheetah**	**Vulnerable**
Acomys spinosissimus	Spiny mouse	Least concern
Aepyceros melampus	Impala	Least Concern
Aethomys chrysophillus	Red veld rat	Least Concern
Aethomys ineptus	Tete veld rat	Least concern
Aethomys namaquensis	Namaqua rock mouse	Least concern
Alcephalus buselaphus	Red hartebeest	Least concern
Aonyx capensis	Cape clawless otter	Least concern
Atelerix frontalis	**South African Hedgehog**	**Near threatened**
Atilax paludinosus	Water mongoose	Least concern
Antidorcas marsupilais	Springbok	Least concern
Canis mesomelas	Black backed jackal	Least concern
Caracal caracal	Caracal	Least concern
Cercopithecus aethiops pygerythrus	Vervet monkey	Least concern
Civettictis civetta	African civet	Least concern
Connochaetes gnou	Black wildebeest	Least concern
Connochaetes taurinus taurinus	Blue wildebeest	Least concern
Crocidura cyanea	**Reddish grey musk shrew**	**Data deficient**
Crocidura fuscomurina	**Tiny musk shrew**	**Data deficient**
Crocidura hirta	**Lesser red musk shrew**	**Data deficient**
Crocidura mariquensis	**Swamp musk shrew**	**Data deficient**
Crocidura silacea	**Lesser grey-brown musk shrew**	**Data deficient**
Cryptomys hottentotus	Common molerat	Least concern
Cynictis penicillata	Yellow mongoose	Least concern
Damaliscus pygargus phillipsi	Blesbok	Least concern
Dendromus melanotis	Grey climibing mouse	Least concern
Desmodillus auricularis	Short-tailed gerbil	Least concern
Elephantulus myurus	Rock elephant shrew	Least concern
Equus burchelli	Plains zebra	Least concern
Felis nigripes	Blackfooted cat	Least concern
Felis silvestris	African wild cat	Least concern
Galago moholi	Southern Lesser bushbaby	Least concern
Galerella sanguinea	Slender mongoose	Least concern
Genetta genetta	Small spotted genet	Least concern
Genetta tigrina	Large spotted genet	Least concern
Gerbillurus paeba	Hairy footed gerbil	Least concern
Giraffae camelopardalis	Giraffe	Least concern
Graphiurus murinus	**Woodland dormouse**	Least concern
Hippotragus equinus	**Roan antelope**	**Vulnerable**
Hipposideros caffer	**Sundevall's leaf-nosed bat**	**Data deficient**
Hyaena brunnea	Brown hyaena	Near threatened
Hystrix africaeaustralis	Porcupine	Least concern
Ichneumia albicauda	White-tailed mongoose	Least concern

Scientific name	Vernacular name	Status (Friedman & Daly, 2004)
Ictonyx striatus	Striped polecat	Least concern
Kobus ellipsiprymnus ellipsiprymnus	Waterbuck	Least concern
Lemniscomys rosalia	**Single striped mouse**	**Data deficient**
Leptailurus serval	**Serval**	**Near threatened**
Lepus capensis	Cape or brown hare	Least concern
Lepus saxatilis	Schrub hare	Least concern
Malacothrix typica	Large-eared mouse	Least concern
Manis temminckii	**Pangolin**	**Vulnerable**
Mastomys coucha	Multimammate mouse	Least concern
Mellivora capensis	**Honey badger**	**Near threatened**
Miniopteris schreibersii	**Schreiber's long-fingered bat**	**Near threatened**
Mungos mungo	Banded mongoose	Least concern
Mus indutus	Desert pygmy mouse	Least concern
Mus munitoides	Pygmy mouse	Least concern
Mystromys albicaudatus	**White tailed rat**	**Endangered**
Neoromicia capensis	Cape serotine bat	Least concern
Neoromicia zuluensis	Aloe bat	Least concern
Nycteris thebaica	Common slit-faced bat	Least concern
Oreotragus oreotragus	Klipspringer	Least concern
Orycteropus afer	Antbear	Least concern
Oryx grasella	Gemsbok	Least concern
Otocyon megalotis	Bat-eared fox	Least concern
Otomys angoniensis	Angoni vlei rat	Least concern
Otomys irroratus	Vlei rat	Least concern
Panthera pardus	Leopard	Least concern
Papio ursinus	Chacma baboon	Least concern
Paraxerus cepapi	Tree squirrel	Least concern
Pedetes capensis	Spring hare	Least concern
Phacochoerus africanus	Warthog	Least concern
Pippistrellus rusticus	**Rusty bat**	**Near threatened**
Poecilogale albinucha	**African weasel**	**Data deficient**
Potamochoerus porcus koiropotamus	Bushpig	Least concern
Procavia capensis	Rock dassie	Least concern
Pronolagus randensis	Jameson's red rock rabbit	Least concern
Proteles cristatus	aardwolf	Least concern
Raphicerus campestris	Steenbok	Least concern
Redunca arundinum	Common or southern reedbuck	Least concern
Redunca fulvorufula	Mountain reedbuck	Least concern
Rhabdomys pumilio	Striped mouse	Least concern
Rhinolophus darlingi	**Darling's horseshoe bat**	**Near threatened**
Saccostomus campestris	Pouched mouse	Least concern
Scotophilus dinganii	Yellow house bat	Least concern
Steatomys krebsii	Kreb's fat mouse	Least concern
Suricata suricatta	Suricate	Least concern

Scientific name	Vernacular name	Status (Friedman & Daly, 2004)
Sylvicapra grimmia	Common duiker	Least concern
Syncerus caffer	Cape buffalo	Least concern
Tadarida aegyptiaca	Egyptian free-tailed bat	Least concern
Tatera brantsii	Highveld gerbil	Least concern
Tatera leucogaster	**Bushveld gerbil**	**Data deficient**
Taurotragus oryx	Eland	Least concern
Thallomys paedulcus	Tree rat	Least concern
Thryonomus swinderianus	Greater Cane rat	Least concern
Tragelaphus scriptus	Bushbuck	Least concern
Tragelaphus strepsiceros	Kudu	Least concern
Vulpes chama	Cape fox	Least concern
Xerus inaurus	Cape ground squirrel	Least concern

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APPENDIX C – HERPETOFAUNA LIST

LIST OF REPTILES (BRANCH, 1998)

Scientific name	Vernacular name	Conservation status
Agama aculeata	Ground agama	Not threatened
Agama atra	Southern rock agama	Not threatened
Aparallactus capensis	Cape centipede eater	Not threatened
Atractaspis bibronii	Southern Burrowing Asp	Not threatened
Atractaspis duerdeni	Duerden's burrowing asp	Not threatened
Atractaspis duerdeni	Beaked burrowing asp	Not threatened
Bitis arietans	Puffadder	Not threatened
Causus rhombeatus	Common night adder	Not threatened
Chamaeleo dilepis	Flap-neck chameleon	Not threatened
Cordylus vittifer	Transvaal girdled lizard	Not threatened
Crotaphopeltis hotamboeia	Red-lipped snake	Not threatened
Dalophia pistillum	Blunt-tailed worm lizard	Not threatened
Dasypeltis scabra	Common egg eater	Not threatened
Dendroaspis polepis	Black mamba	Not threatened
Dispholidus typus	Boomslang	Not threatened
Elapsoidea boulengeri	Boulenger's garter snake	Not threatened
Geochelone pardalis	Leopard tortoise	Not threatened
Gerrhosaurus flavigularis	Yellow-throated plated lizard	Not threatened
Hemachatus haemachatus	Rinkhals	Not threatened
Hemidactylus mabouia	Moreau's tropical house gecko	Not threatened
Homopholis wahlbergi	Wahlberg's velvet gecko	Not threatened
Ichnotropis squamulosa	Common rough scaled lizard	Not threatened
Kinixys lobatsiana	Lobatse Hinged tortoise	Not threatened
Lamprophis fuliginosus	Brown house snake	Not threatened
Leptotyphlops scutifrons	Peter's thread snake	Not threatened
Lycodonomorphus rufulus	Common brown water snake	Not threatened
Lycophidion capense	Cape wolf snake	Not threatened
Lygodactylus capensis	Cape dwarf gecko	Not threatened
Mabuya capensis	Cape skink	Not threatened
Mabuya striata	Striped skink	Not threatened
Mabuya sulcata	Westeren rock skink	Not threatened
Mabuya varia	Variable skink	Not threatened
Mehelya capensis	Cape file snake	Not threatened
Monopeltis infuscata	Dusky spade-snouted worm lizard	Not threatened
Naja annulifera	Snouted cobra	Not threatened
Naja mossambica	Mosambique spitting cobra	Not threatened
Nucras holubi	Holub's sandveld lizard	Not threatened
Nucras intertexta	Spotted sandveld lizard	Not threatened

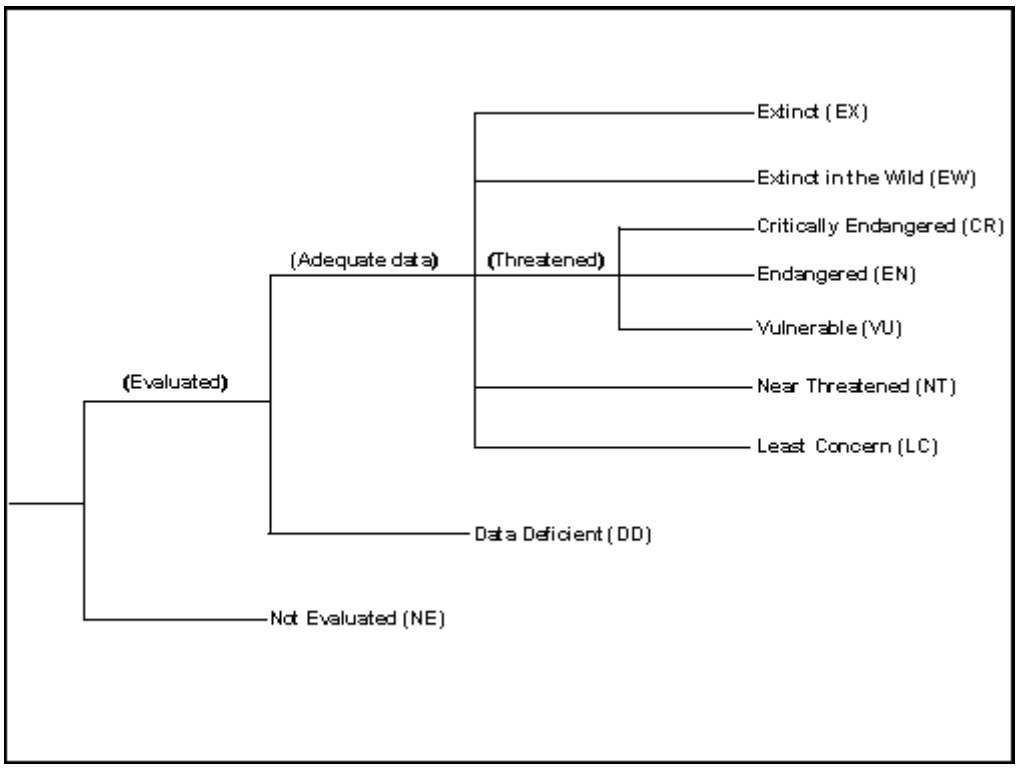
Scientific name	Vernacular name	Conservation status
Pachydactylus capensis	Cape thick-toad gecko	Not threatened
Pachydactylis turneri	Turner's thick-toed gecko	Not threatened
Panaspis wahlbergii	Wahlberg's snake eyed skink	Not threatened
Pedioplanis lineoocellata	Spotted sand lizard	Not threatened
Pelomedusa subrufa	Marsh terrapin	Not threatened
Philothamnus haplogaster	Green Water Snake	Not threatened
Philothamnus natalensis	Eastern green snake	Not threatened
Philothamnus semivariegatus	Spotted bush snake	Not threatened
Prosymna bivittata	Two-striped shovel snout	Not threatened
Psammobates oculiferus	Serrated Tent Tortoise	Not threatened
Psammophis brevirostris	Short snouted grass snakes	Not threatened
Psammophis subtaeniatus	Stripe-bellied sand snake	Not threatened
Psammophylax tritaeniatus	Striped skaapsteker	Not threatened
Pseudaspis cana	Mole snake	Not threatened
Python natalensis	South African Python	Vulnerable
Rhinotyphlops lalandei	Delalande's beaked blind snake	Not threatened
Teloscopus semiannulatus	Eastern tiger Snake	Not threatened
Thelotornis capensis	Vine snake	Not threatened
Varanus albigularis	Rock Monitor	Not threatened
Varanus niloticus	Nile monitor	Not threatened
Xenocalamus bicolor	Bicoloured-quil snouted snake	Not threatened

LIST OF AMPHIBIANS (MINTER ET. AL. 2004)

Common Name	Genus	Species	Conservation Status
Angola River Frog	*Afrana*	*angolensis*	Least Concern
Common rain frog	*Breviceps*	*adspersus*	Least Concern
Pygmy toad	*Bufo*	*fenoulheti*	Least Concern
Garman's toad	*Bufo*	*garmani*	Least Concern
Guttural toad	*Bufo*	*gutturalis*	Least Concern
Power's toad	*Bufo*	*poweri*	Least Concern
Ranger's toad	*Bufo*	*rangeri*	Least Concern
Boettger's dainty frog	*Cacosternum*	*boettgeri*	Least Concern
Grey tree frog	*Chiromantis*	*xerampelina*	Least Concern
Senegal kassina	*Kassina*	*senegalensis*	Least Concern
Natal puddle frog	*Phrynobatrachus*	*natalensis*	Least Concern
Banded rubber frog	*Phrynomantis*	*bifasciatus*	Least Concern
Anchieta's ridged frog	*Ptychadena*	*anchietae*	Least Concern
Anchieta's ridged frog	*Ptychadena*	*anchietae*	Least Concern
Giant bullfrog	***Pyxicephalus***	***adspersus***	**Near threatened**

Common Name	Genus	Species	Conservation Status
Red toad	*Schismaderma*	*carens*	Least Concern
Cryptic sand frog	*Tomopterna*	*cryptotis*	Least Concern
Tandy's sand frog	*Tomopterna*	*tandyi*	Least Concern
Natal sand frog	*Tomopterna*	*natalensis*	Least Concern
Common plantanna	*Xenopus*	*laevis*	Least Concern

APPENDIX E. RED LIST CATEGORIES



THE CATEGORIES

EX EXTINCT (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EW EXTINCT IN THE WILD (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CR CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

EN ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VU VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of

extinction in the wild.

NT NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LC LEAST CONCERN (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DD DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.